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RACES OF MAIZE IN BRAZIL AND ADJACENT AREAS

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CONTENTS

Acknowledgments

The work of collecting, preserving, planting, and taking notes of the many maize strains is the product of the cooperative efforts of many individuals. A complete list of all who helped in one way or the other would be impractical. In regard to the establishment of the Brazilian Germ Plasm Bank and the collecting activities, acknowledgments have already been made elsewhere (Brieger *et al.*, 1958).

Special credit is due to Dr. E. J. Wellhausen who spent many days with the senior author inspecting all original strains and deciding which samples should be bulked to represent the different races or populations.

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Introduction

The preservation of the diversity represented by the many local and regional varieties of maize has been recognized to be of great importance to the future of maize research and for future corn breeding. A thorough effort has been made in the past 20-25 years to collect and preserve the native corn varieties of the Americas. As a result of this work over 250 races have been described [Wellhausen *et al.* (1952), Hatheway (1957), Roberts *et al.* (1957), Wellhausen *et al.* (1957), Brieger *et al.* (1958), Brown (1960), Grobman *et al.* (1961), Ramirez *et al.* (1961), Timothy *et al.* (1961), Grant *et al.* (1963), Timothy *et al.* (1963), Rodríguez *et al.* (1968), Hernández and Alanis (1970)]. For the preservation of these races, three Germ Plasm Banks representing three distinct geographic regions have been established in Mexico, Colombia, and Brazil. A recent review of this work has been published by Brandolini (1970), and a preliminary report on an extensive series of studies on the geographical relationships among collections on the basis of similarities in chromosome knob constitution has recently appeared [Kato and Blumenschein (1967)].

These studies have yielded considerable knowledge about the genetic variation of maize. Although *Zea mays* L. has long been recognized as being a polytypic species, it was not until recently that the foregoing studies revealed the amount of germ plasm variation. Among the described races, some are represented more than once (frequently with different names), since they occur in different regions, but it is possible that other races have not yet been described. Nevertheless, it is unquestionable that the available maize germ plasm represents a tremendous store of natural genetic variation, probably greater than that of any other cultivated plant species.

It is interesting to note that, of the approximately 250 described races, about 50 percent are adapted to low altitudes (0 to 1000 m), almost 40 percent grow at elevations higher than 2000 m, and slightly more than 10 percent are from intermediate altitudes (1000 to 2000 m). Regarding endosperm type, almost 40 percent are floury, almost 30 percent are flints, slightly more than 20 percent are dents, about 10 percent are popcorns, and only about 3 percent are sweet corns. Since the history of maize is quite long, probably 6600 years or older (Goodman, 1965), the adaptation to different altitudes may be mainly the result of natural selection, while the distribution of endosperm types may be primarily a question of human preferences. While it is probably correct that the prevalence of floury corns at the time of the discovery was due to their ease of grinding with the primitive tools available, many people of indigenous descent still prefer floury types in today's era of the transistor radio. In some areas of Peru, floury corns are widely used even on haciendas owned by people of almost strictly Spanish descent. However, most of the races so far utilized in improvement programs are the more advanced dents and flints from the United States, Mexico, Central America, and the West Indies. While the preference of people of European descent for flints and dents may be in part due to the greater insect resistance of the harder kernels, certainly not all flints are insect resistant. Although there are more floury races than either dent or flint races, very little has been done to evaluate the floury races for usefulness for breeding. The recent discovery that the opaque-2 and floury-2 genes greatly improve the nutritive value of corn by increasing lysine and tryptophan content [Mertz, Bates and Nelson (1964)] certainly will draw more attention to the many floury germ plasms available.

The creation of the Brazilian Germ Plasm Bank in 1952 led to the collection, study, and maintenance of extensive collections of native corn varieties. The area pertaining to this center was by far the largest of the three germ plasm centers, since it comprised Argentina, Uruguay, Paraguay, lowland Bolivia, Brazil, and the Guianas (Figure 1), a total of 12,885,000 km^2, which corresponds to 72 percent of South America. Most of this area has an altitude of less than 1500 m above sea level, as can be seen in the map of Figure 2. Actually, a great part is below 500 m, and only relatively small areas reach 1500 m or more. There is, nevertheless, considerable variation in humidity, rainfall, soil type, and, of course, latitude. However, these differences do not seem to greatly affect the adaptation of the different collections to the growing conditions present in Piracicaba, São Paulo. Only the collections from the high Andean valleys in northwestern Argentina are definitely unadapted to the conditions in São Paulo. Although they undergo some modification, the lowland Cateto Sulinos from Uruguay and Argentina can be grown reasonably well in São Paulo. Here the plants are earlier, smaller, and less productive than in the original region.

About 3000 original collections from this region have been studied in Piracicaba. A description of the recognized

Figure 1. Map showing most of South America including the area of the Brazilian Germ Plasm Center.

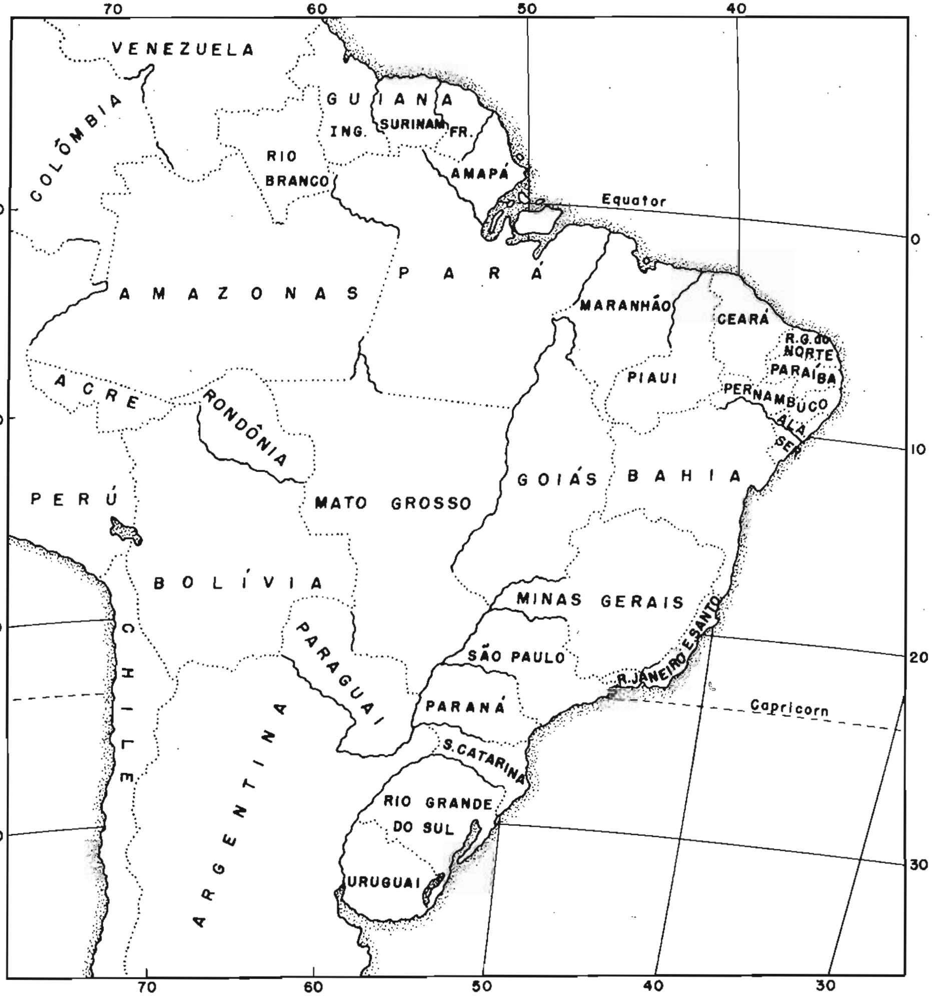
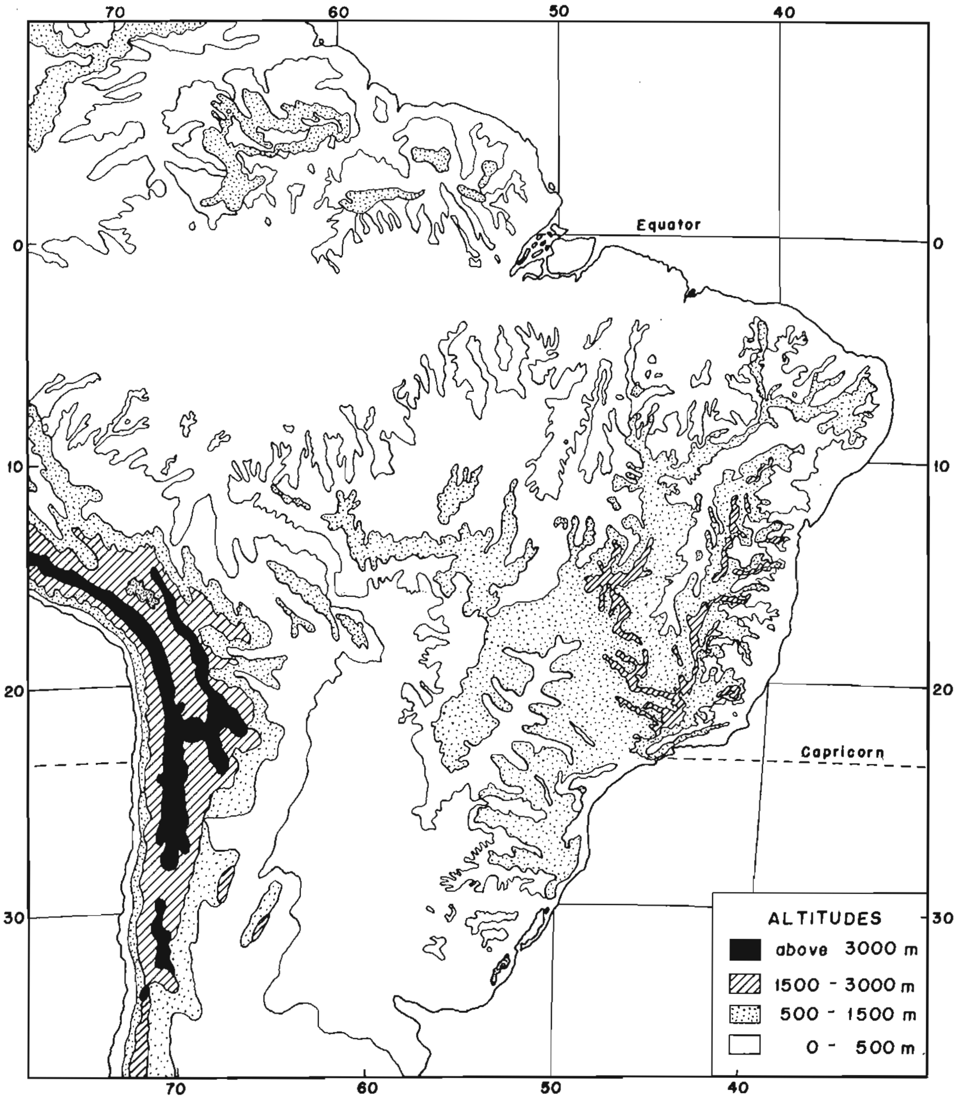


Figure 2. Map showing differences in altitude for most of South America including the area of the Brazilian Germ Plasm Center.



races has been published (Brieger *et al.,* 1958), and limited applications of some techniques of numerical taxonomy were later applied to a few of these races [Goodman (1967, 1968b)]. In 1960 the collections were restudied, and, based on flowering times and plant and ear type, the similar collections within a given area were grouped into one population. This was done by Dr. E. J. Wellhausen and the senior author. The compositing was done by taking equal numbers of remnant seeds from each of the individual collections. A total of about 1200 original collections were selected and grouped into 91 populations (Table 1). Thirty populations have since been propagated in open-pollinated, isolated blocks; the rest have been maintained by hand sib-pollinations. Although most of these races have been described by Brieger *et al.* (1958), the purpose of the present work is to add the additional data accumulated in the past few years on the populations mentioned above and to provide the documentation necessary to describe the composite populations representing these populations as well as the individual collections representing the races. In addition, some races not previously available are herein included. Information regarding the current utility of these materials in breeding programs (usually obtained from varietal cross yield trials) will be presented wherever data are available. Their long term potential cannot be judged so readily, however.

All the races included in the present study come from the lowland areas of the region being studied. The races of the Humahuaca Valley (which ranges from 1700 m to 3500 m in altitude) of northwestern Argentina are not included, since these races do not grow well in São Paulo. Furthermore, the popcorns are not described in detail, since they have not been studied in the same way as the other races.

2 General survey of the races of maize in the area

Maize has been grown in this area from pre-Columbian times, but lack of archaeological remains preclude the exact determination of the age of corn cultivation in the area. Corn from the area was reportedly described as early as 1500 (Hoehne, 1937). At that date terminology was not well defined, but by 1528 maize was clearly described (Ramírez, 1888, p. 17). Numerous somewhat later descriptions indicate that the most common corn in eastern Brazil was a white flint, while in southern Brazil and Paraguay a white or yellow floury type predominated. Much of this has been admirably summarized by Hoehne (1937). The critical descriptions are those of Thivet [1944, pp. 188 and 342 (first published in 1557, he describes the area near Rio de Janeiro)], Léry [1964, p. 115 (first published in 1578; the author traveled along the Brazilian coast from Paraiba to Rio about 1557)]. Sousa [undated, p. 331, Chapter XLV (a description of Bahia in 1587)], and Dobrizhoffer [(1822), first published in 1784], Azara [(1850, pp. 88-89), describing a trip made about 1785], and Dardye (1892, pp. 163-164), the latter three describing the maize of Paraguay. Other reports of interest include those of Peckholt (1878), Seixas (1880), and Lobbe (1928). More recent descriptions are those of Marino (1934) and Parodi (1935, 1966), which cover the southern portions of the area included in this report. A preliminary report [Goodman (1968a)] on the early literature on maize in Brazil has also appeared.

For convenience the races of maize have been grouped into the following categories: Indigenous, Ancient Commercial, Recent Commercial, and Exotic races.

Indigenous races are the corns which have apparently been cultivated only by Indians. In this way, presumably, these races have been maintained in approximately the same state as in pre-Columbian times, since these corns have not been greatly disturbed by the influence of the peoples who arrived after 1492.

On the other hand, the Ancient Commercial races are the races that existed in pre-Columbian times, but which the early European immigrant farmers adopted from the Indians. These races are also indigenous in their origin, but presumably they have been changed somewhat as a result of their recent large-scale cultivation. They probably do not represent precisely the populations present in pre-Columbian times.

Recent Commercial races are the races that have come into use in post-Columbian times. These races were introduced from other places or originated by natural hybridization among existing and/or introduced races. These races are quite recent; the older among them are probably not more than about one hundred years old.

Finally, the Exotic races are those which originally were found in other areas and which were introduced into our region in modern times.

Some comments regarding the indigenous races collected from the various Indian tribes might be of interest. The Guaraní are a major group of Indians which occupied Paraguay and parts of Bolivia and southern Brazil [Service and Service (1954), Schaden (1962)]. These people cultivated the following types of corn: *Avatí Morotí* a floury yellow corn, was the principal crop; *Cristal* (which they called *Avatí Tupí*), a white flint; and two types of pop corns, *Avatí Pichingá Ihú*, which has round kernels, and *Avatí Pichangá*, which has pointed kernels. Descriptions of the latter date back to 1784 under such names as Bisangallo, Pisangallo, etc.; however, Dardve (1892, p. 164) gave an excellent description along with the name "abati pichinga." Morotí has been described by many writers including Dobrizhoffer (1822), while Cristal was apparently first described by Sousa (n.d., first written 1587).

Another important group of Indians is the Tupí-Guaraní, who lived all along the Atlantic Coast from Argentina to Northern Brazil [Fernandes (1963)]. These Indians may have cultivated the Cateto race, an orange or yellow flint corn [Cutler (1946)]. This was probably the first corn extensively grown by white men in Brazil. While the earliest description of this race dates back to 1819 [Ribeiro, 1841, p. 187], dictionary listings [Pinto (1873, p. 318), Ayrosa (1934, p. 122)] date back to the mid-eighteenth century [see Peckholt (1878) and Bueno (1964) also]. In the early literature the name "Catete" was usually used [and continued to be used sporadically until about 1950 —see Kalckmann *et al.* (1948)]. However, "Cateto" began to be used in the early 1930's. Mendes (1932), who earlier had used "Catete," appears to have been the first to use "Cateto."

The Caingang Indians who lived between the areas occupied by the southern Guaraní and the Tupí-Guaraní (a somewhat narrow belt extending from São Paulo to Uruguay) had a quite distinct floury, dented white corn.

Finally, in central Brazil (Mato Grosso and Goiás) there are a number of heterogeneous groups, which can be represented by the Chavante Indians, who cultivate the Entrelaçado, race, a floury corn having long, flexible ears with interlocked rows and with kernels segregating for pericarp and aleurone colors. Most ears of corn with regularly arranged kernels have the rows of kernels arranged in pairs, resulting in an even number of kernel rows. With interlocking the kernels from what would ordinarily be the left-hand member of such a pair are intermeshed with the kernels which would ordinarily be the right-hand member of the neighboring pair to form a single row. This is very much like the arrangement of the teeth of two intermeshed hair combs and effectively halves the row number, often resulting in odd numbers of kernel rows.

Lenha is a race of white, floury corn with thick, many-rowed ears. It was collected at only one location in the southernmost state of Brazil, Rio Grande do Sul. It seems to be an indigenous corn, since white men in this area are not known to grow floury corns. However, it is not known who actually cultivated this race.

It is interesting to note that each of the Indian groups is ethnologically distinct, and each one also cultivates distinct types of corn. The Guaraní, Caingang, and Chavante speak different languages as well.

3 The major forces for the development of the corn races

The development of races of corn is simply an example of evolution, since evolution corresponds to changes in the gene frequencies in successive generations. The forces that contribute to changes in gene frequencies are selection, mutation, genetic drift, migration, and hybridization. It is unlikely that only one of these factors is responsible for the development of a given race. Undoubtedly all play a major or a minor role in the evolutionary process, the final product being the result of all factors. The two factors generally considered most important for the development of races of corn are hybridization and selection.

Wellhausen *et al.* (1952) place major emphasis on hybridization, while recognizing that selection also had some secondary effects. On the other hand, Kempton (1936), Weatherwax (1942), and Brieger *et al.* (1958) credit the Indians as being efficient plant breeders who selected for desired goals. While perhaps the exact situation will never be known, some pertinent facts must be considered. It seems the Indians must have selected for some definite types. The four different groups of Indians just mentioned each seem to have had a quite different maize, although they lived in more or less the same area of adaptation. The Guaraní and Caingang, living practically side by side, may be very illustrative in this respect. While the main race of the Guaraní was Morotí, they also had Cristal and two types of popcorn. Within the race Morotí there are varieties for special purposes such as segregating aleurone colors used for ceremonial purposes and a white variety grown on a limited scale. On the other hand, the Caingang had only one race, a floury, dented, mostly white corn with cylindrical ears. They are the only Indians that had a white dent maize in the area under consideration. It is known that the two tribes had many kinds of relationships, both friendly and unfriendly. In this way, if they had not had definite preferences for different types of corn, they would have undoubtedly been found to be growing essentially the same races of corn. Furthermore, in the area under consideration, the closest wild relative, *Tripsacum australe*, apparently does not cross with maize, excluding complications caused

Table 1

List of the 91 Populations Representing the Races of Maize and the Corresponding Number of Original Collections (Listed in Table 10) that Were Bulked to Form Each Population of the Brazilian Germ Plasm Bank.

Populations	No. of original collections bulked
1. INDIGENOUS	
1.1. Morotí	
RGS XIX	2
Pr I	8
Pr II	1
Pe I	1
Mt II	2
Mt III	2
Mt IV	9
Mt V	9
Pag V	21
Pag VI	8
Pag VII	3
Bol II	3
Bol III	3
1.1.1. Morotí Precoce	
Bol I	12
1.1.2. Morotí Guapí	
Pag VI-A	1
1.2. Caingang	
Pr III	27
SP XIII	5
SP XIV	2
1.3. Lenha	
RGS XX	3
1.4. Entrelaçado	
Mt VI	11

Populations	No. of original collections bulked
2. ANCIENT COMMERCIAL	
2.1. Cristal Sulino	
Arg I	1
Arg VIII	10
Urg VIII	1
2.2. Cristal	
SP X	9
SP XI	14
SP XII	1
MG III	7
Ba II	1
2.2.1. Cristal Semi-Dentado	
Pag II	9
Pag III	2
2.3. Canario de Ocho	
Arg IV	1
Arg VI	1
Urg VI	1
2.4. Cateto Sulino Precoce	
Arg VII	1
2.5. Cateto Sulino	
Arg II	4
Arg III	37
Arg V	2
Urg I	2
Urg II	35
Urg IV	31
2.5.1. Cateto Sulino Escuro	
Urg V	4
Urg V-A	1
2.6. Cateto Sulino Grosso	
Urg III	6
2.7. Cateto	
SP VII	19
SP VIII	51
MG II	12
Ba I	2
Ma I	1
Desc I	2
Ce I	1
Pontinha	1
2.7.1. Cateto Assis Brasil	
RGS XIV	10
2.7.2. Cateto Grande	
Mt I	2
2.8. Cateto Nortista	
GFr I	1
GFr II	1
GFr III	1
GFr IV	2
Sur II	1
GFr VI	1
Sur III	5
Gln I	2
Gln II	5
Gln III	1
2.8.1. Cateto Nortista Precoce	
Sur I	1

Populations	No. of original collections bulked
3. RECENT COMMERCIAL	
3.1. Dente Riograndense	
3.1.1. Dente Riograndense Rugoso	
RGS I	5
RGS II	77
RGS III	3
RGS IV	185
3.1.2. Dente Riograndense Liso	
RGS V	24
RGS VI	4
SC I	20
3.2. Dente Paulista	
SP III	20
SP IV	197
MG I	23
3.3. Dente Branco	
3.3.1. Dente Branco Riograndense	
RGS X	37
RGS XI	8
RGS XII	4
RGS XIII	3
SC II	6
3.3.2. Dente Branco Paulista	
SP V	10
3.4. Semi-Dentado	
3.4.1. Semi-Dentado Riograndense	
RGS XV	6
RGS XVI	39
3.4.2. Semi-Dentado Paulista	
SP IX	5
Mt VII	3
Pag I	5
3.5. Cravo	
3.5.1. Cravo Riograndense	
RGS VII	12
RGS VIII	46
3.5.2. Cravo Paulista	
SP I	2
SP II	13

Populations	No. of original collections bulked
4. EXOTIC COMMERCIALS	
4.1. Hickory King	
RGS IX	16
4.2. Tusón	
Ba III	1
Populations	91
Total original collections	1210

ABBREVIATIONS

Arg - Argentina
Ba - Bahia
Bol - Bolivia
Ce - Ceará
Desc - unknown
GFr - French Guiana
GIn - Guyana
Ma - Maranhão
MG - Minas Gerais
Mt - Mato Grosso
Pag - Paraguay
Pe - Pernambuco
Pr - Paraná
RGS - Rio Grande do Sul
SC - Santa Catarina
SP - São Paulo
Sur - Surinam
Urg - Uruguay

by introgressive hybridization with other species [Graner and Addision (1944)].

Based on these points, it seems that the main factor for the development of the Indigenous races was selection practiced by the different peoples. Parallels between races of maize and ethnologically or geographically isolated groups have been mentioned repeatedly in the studies of the races of maize. Recently more detailed work on such relationships has been initiated by Bird (1970) and Hernandez [Hernandez and Alanis Flores (1970), Hernandez (1971)]. After the arrival of the white man, there is no doubt that hybridization played an important role in the development of the Recent Commercial races. In other regions, hybridization could have been the leading factor in the development of races of maize. However, if hybridization played any role in the development of the Indigenous races of Brazil and the adjacent areas included in this study, this must have happened far too long ago to detect at present.

Finally, it must be remembered that corn is remarkable for its ability to change through selection. No other single species of cultivated crop has such tremendous variability. All this variation is the result of gene recombinations and changes in gene frequencies only, since chromosomal rearrangements have been shown to be of very little importance in maize (Randolph, 1955). These facts seem to substantiate the role of selection in the evolution of the races of maize.

4 Materials and methods

As explained in the introduction, almost all the original collections of the Brazilian Seed Center (about 3000) were grouped into 91 populations according to the similarities of plant and ear characters and place of origin. Since then, these pooled populations have been maintained by hand sib-pollinations or isolated plantings. Observation plots have been planted to obtain plant, tassel, and ear data. These plantings were made in Piracicaba, S.P., in 1960, 1963, 1964, and 1965, using single-row plots 20 meters long. For the plant data, ten competitive plants (i.e., plants bordered on each side) were used, while for tassel and ear measurements, five individuals from each entry were utilized.

Since the 1965 data were complete for all characters (as well as essentially all populations), while the data for other years were less complete, all means were calculated using the 1965 data and the average of the other data available. Thus, for plant characters, the procedure used may be symbolized as: $[(1960 + 1963 + 1964)/3 + 1965]/2$. For tassel characters: $[(1960 + 1964)/2 + 1965]/2$. For ear characters: $[(1960 + 1963)/2 + 1965]/2$.

Most of the characters used in previous studies of corn [Wellhausen *et al.* (1952), Brieger *et al.* (1958), and others] were also employed in the present work. The relative merits of the characters used have been discussed elsewhere [Goodman and Paterniani, 1969]. In general, ear and kernel characters are most reliable, while plant or vegetative characters are least reliable.

4.1 Plant Characters

Except for days to flowering, all the plant characters were recorded on ten competitive plants of each entry. The data presented were obtained from the plantings of 1960, 1963, 1964, and 1965.

Days to Flowering. For each plot, the date was recorded when about fifty percent of the plants had the silks (stigmas) appearing on the ears. The data presented correspond to the median number of days from planting to silking.

Ear Height was recorded as the number of centimeters from the ground to the ear-bearing node. For plants bearing more than one ear, the uppermost (first) ear was always used.

Plant Height was recorded as the number of centimeters from the ground to the base of the tassel.

Ear Height/Plant Height Index. This index was obtained each year by dividing the average ear height by the average plant height. This index provides an indication as to the relative position of the ear on the plant.

Number of Leaves per Plant. Actual counts were made of the number of leaves below and above the ear. The data presented are the sums of these two values.

Number of Leaves Above the Ear. As indicated, an actual count was made of the number of leaves per plant above the ear.

Leaf Length was measured in centimeters as the length of the leaf blade emerging from the ear-bearing node. When more than one ear per plant was present, the first (uppermost) ear was used.

Leaf Width was measured in centimeters, for the same leaf used for length, at the mid-point of its length.

Venation Index was calculated in the same way as described by Wellhausen *et al.* (1952). It was obtained by dividing the average number of veins counted at the mid-point of the length of the ear-bearing-node leaf by the width of the leaf.

Internode Pattern. Following Anderson and Cutler (1942), the length of all successive internodes of the plant were plotted on a diagram of coordinates. The lengths of the internodes are represented on the vertical scale and the order of the internodes from the base upwards are plotted on the horizontal scale. Ears are represented by triangles and tassels by circles. When possible, five plants from each entry were measured for this character in 1960 and in 1964.

4.2 Tassel Characters

Tassel data were recorded for five completely mature tassels from each entry. The data presented were obtained from the plantings made in 1960, 1964, and 1965. The characters considered are listed below:

Length of the Sheath of the Uppermost Leaf. Although this is not strictly a tassel character, it is included here because of its relationship with the tassel peduncle. It was measured in centimeters as the length of the sheath of the uppermost leaf.

Peduncle Length was measured in centimeters as the distance between the uppermost node of the stalk and the lowermost branch in the tassel.

Tassel Length was measured in centimeters from the point of attachment of the lowermost branch of the tassel to the tip of the central spike.

The *Length of the Branching Space of the Tassel* was measured in centimeters as the distance between the points of attachment of the first and the last branch along the central axis of the tassel.

The *Length of Central Spike* was measured in centimeters as the distance along the central axis of the tassel from the point of attachment of the uppermost branch to the tip of the central spike.

The *Peduncle Covering Index* was obtained by dividing the peduncle length by the sheath length as in Brieger *et al.* (1958). It gives an indication of the degree to which the tassel is enclosed by the sheath of the last leaf. If this index is greater than 1.0, only part of the peduncle is covered by the sheath. If it is equal to 1.0, the entire peduncle is covered by the sheath; and if it is less than 1.0, part of the branching space is also covered by the sheath.

Number of Tassel Branches. All branches (primary, secondary, and tertiary) were counted on the same tassels used for the other characters.

4.3 Ear Characters

Ear characters were usually recorded from five normal ears from each entry. When more than one ear was available per plant, the first or uppermost ear was always used. **The ear photographs used to illustrate the races are reproduced at approximately half size.**

A centimeter scale is included in each photograph. The data reported were obtained from the plantings of 1960, 1963, and 1965. Both external and internal characters were recorded as follows:

Ear Length was measured in centimeters.

Row Number. Actual counts were made of the number of rows of kernels at the mid-point of the ears.

4.3.1 **Ear Cross Section Diameters**: For the measurement of these characters, the ear was broken or sawed at the mid-point of its length. Then using a compass, the following five diameters were transferred to a sheet of paper for later measurement:

Ear Diameter was measured in millimeters as the diameter of the ear at the point at which the ear was broken.

Cob Diameter was measured in millimeters as the distance between the outer edges of opposite glumes appearing in the cross section of the ear.

Kernel Base Diameter was measured in millimeters as the distance between the bases of opposite kernels seen in the cross-section of the ear.

Rachis Diameter was measured in millimeters as the distance between the bases of opposite glumes appearing in the ear cross-section.

Pith Diameter was measured in millimeters as the distance corresponding to the diameter of the pith of the ear at the point of breakage.

All ear cross-sectional diagrams are reproduced full size in this report.

4.3.2. **Indices:** With the above measurements the following indices were calculated:

The *Cob/Rachis Index* was obtained by dividing the diameter of the cob by the diameter of the rachis. According to Mangelsdorf and Smith (1949) this index should give an indication of the length of the glumes and thus of the presence of intermediate alleles at the *Tu-tu* locus.

The *Glume/Kernel Index* was obtained as in Wellhausen *et al.* (1952), by subtracting the diameter of the rachis from the diameter of the cob and dividing the figure obtained by twice the average length of the kernel. According to those authors, this index should give an indication of the length of the glume in relation to the length of kernel and, thus, an indication of the alleles at the *Tu-tu* locus.

Rachilla/Kernel Index. Wellhausen *et al.* (1952) consider this index to have a greater probability of being useful than the rachilla length itself. It is a measure of the relationship between the length of the rachilla and the length of the kernel. It was obtained by subtracting the rachis diameter from the kernel base diameter and dividing the result by twice the average kernel length.

Kernel Covering Index. If degree of tunication is indicated by the portion of the kernel covered by the glume, then the relation of glume length to kernel length should give a good estimate of the degree of tunication. This index has been used by Paterniani (1954) and Brieger *et al.* (1958). It was obtained by subtracting the kernel base diameter from the cob diameter and dividing the result by twice the length of the kernel. If this index equals 1.0, this indicates that the kernels are completely covered by the glumes; if it is greater than 1.0 then the glumes are longer than the kernels and the corn is highly tunicate; indices lower than 1.0 indicate progressively lower degrees of tunication.

4.3.3 Kernel Characters: All kernel characters were recorded as averages of the measurements of five kernels from the center of the ear.

Kernel Width was measured in millimeters with a caliper by placing five kernels taken from the middle of the ear side-by-side.

Kernel Thickness was measured in millimeters with a caliper on the same five kernels.

Kernel Length was measured in millimeters with a caliper by placing the same five kernels end-to-end.

EDITOR'S NOTE

This book is designed primarily for reference use, with each of the populations identified by ear photograph, internode pattern, and ear cross-sectional diagram. The page layout is organized for easier photo-copying of the data for each individual race.

Each of the ear photographs is shown at approximately one-half size.

All ear cross-sectional diagrams are reproduced at full size.

Table 1 (pages 6 & 7) serves as a basic reference guide; all other tabular data are listed on page 77 and are collected at the end of the report.

5 The races of maize in the area

Maize races from the area are described on the following pages. The summarized data referring to the plants, tassels, and ears are presented in Tables 2 to 4 at the end of this book. A more detailed presentation of the data for the individual populations is presented in Tables 5 to 7. Since the data in the tables are worth many words, the descriptions will be very brief. The tables should be consulted to provide a better and more precise idea of the material under consideration. Simultaneously the ear cross-section diagrams, internode patterns, and ear photographs will help to give a better picture of the races.

The discussions regarding origin and relationship are essentially criticisms of the pertinent literature based on the available knowledge of the races. It is recognized that this aspect is greatly subject to speculation, but an attempt to confront the available ideas may be of value.

Finally, in cases where experimental data are available, information regarding the breeding value of the races will be presented. This is one of the most important aspects (if not the most important) of any germ plasm collection.

Undoubtedly a different classification could be, and would be, made by different investigators. Furthermore, as the knowledge of the material increases, it is very likely that different conclusions will also be reached regarding the origins and relationships of the races.

5.1 Indigenous Races

Indigenous races of maize are those found in cultivation by Indians and which have not been cultivated, at least on a large scale, by others. This distinction is made since these races are probably in a state similar to that of pre-Columbian times. In addition to the Guaraní popcorns, four other races are described here as belonging to this group: Morotí, Caingang, Lenha, and Entrelaçado. All are floury corns, which is further confirmation for the strong preference Indian peoples throughout the Americas gave to this type of corn. White men in this area always preferred flint and dent corns and have never (as far as is known) cultivated the floury races. With the possible exception of Lenha, these races were collected from the descendants of people that cultivated them in pre-Columbian times. Today, Morotí is fairly widely grown in Paraguay by people directly descended from the Guaraní Indians. The others have little or no commercial importance.

5.1.1. The Guaraní Popcorns

Among the Indians of the region considered, apparently only the Guaraní cultivated popcorn. They had two types, one with round kernels and another with pointed grains. No detailed descriptions will be given of these types since they have not been studied in direct comparison with the other races. Nevertheless, typical samples of the two types of popcorn can be seen in Figures 3 and 4. The round popcorn is called Avatí Pichingá Ihú In Paraguay and is widely distributed throughout the area. The ears are short and cylindrical with small kernels. The kernel color is commonly white, but pericarp colors, ranging from the faintest red or pink to dark red are very frequent. No variegated pericarp or aleurone colors are found. The pointed popcorn is called Avatí Pichingá in Paraguay and is characterized by hard kernels with pointed tips. This type is only rarely found at present. The samples of pointed popcorn studied seem to fall into two groups: A. The more common type which has smaller ears and less pointed kernels; and B. Those collections with larger ears and highly pointed, imbricate kernels and widely spaced rows. Generally all ears are completely white. Colored ears have probably not been found because the pointed popcorn is seldom grown today. It is apparently related to Pisankalla of Bolivia [Ramírez *et al.* (1961), Rodríguez *et al.* (1968)], and is so distinctive that it was well described at an early date [Dobrizhoffer (1822), Dardye (1892)]. Some references indicate that Pororo from Bolivia (Ramírez *et al.* (1961), Pira and Pira Naranja from Colombia (Roberts *et al.* (1957), Perlilla from Peru, Avatí Pichingá Ihú, and probably Curagua from Chile [Timothy *et al.* (1961), Grobman *et al.* (1961)] all belong to the same group. On the other hand, it seems that Grant *et al.* (1963) do not agree with these relationships with respect to Pira from Venezuela.

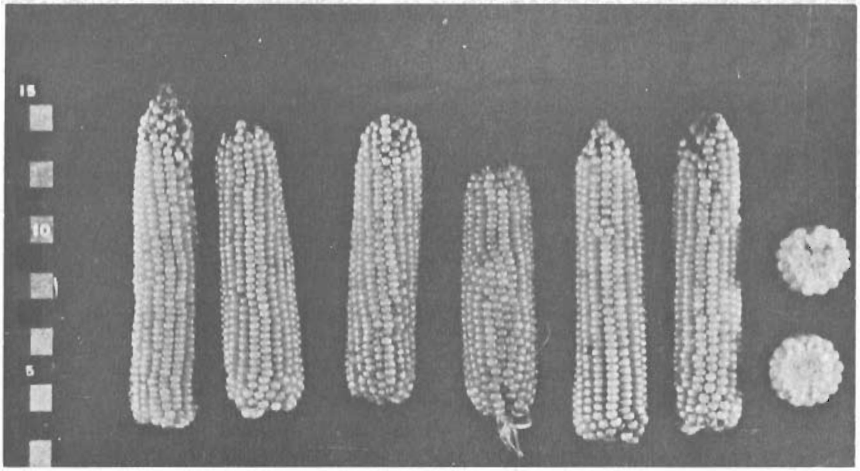


Figure 3. Guaraní Popcorns. Avatí Pichingá Ihú. Approximately 1/2 size.

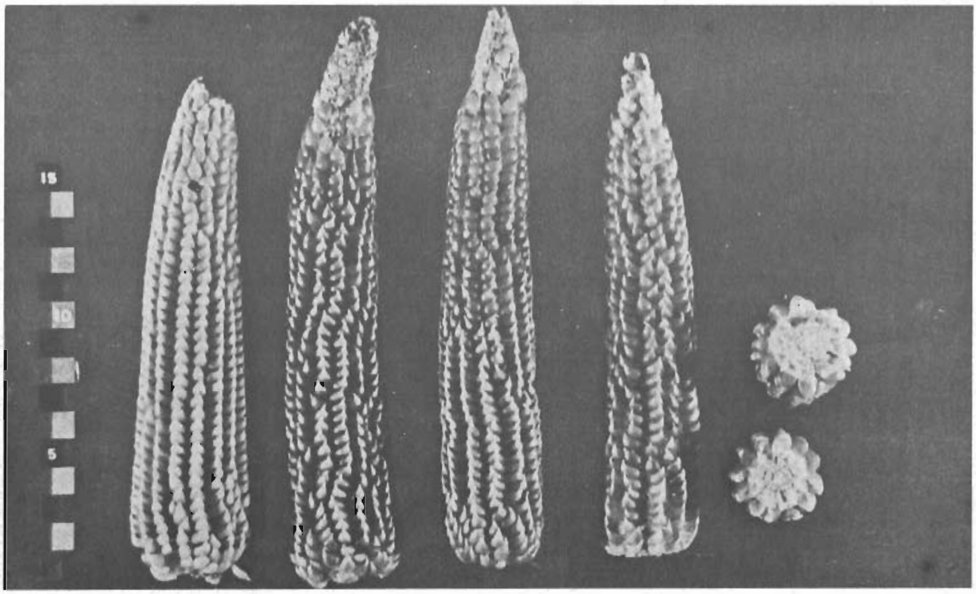


Figure 4. Guaraní Popcorns. Avatí Pichingá.

5.1.2. Morotí

5.1.2.1. Morotí Precoce
5.1.2.2. Morotí Guapí

Derivation of Name. This race is called *Avatí Morotí* by the Guaraní people in Paraguay. Avatí means corn and Morotí means white. This race has yellow kernels, but it was explained by Paraguayan people that "white" refers to the flour obtained by grinding the kernels, white because the endosperm is white. Brieger *et al.* (1958) have called this race Guaraní Yellow Soft Corn. It is suggested to name it "Morotí", a short and original Indian name.

Comparison to Previous Studies. The race has been described previously [Brieger *et al.* (1958)]. Herein the races described by those authors as Avatí Morotí, Avatí Morotí Mitá, Avatí Morotí Tí, and Avatí Djakaira are grouped into Morotí. Although the values presented here are in general similar to the previous study, some values presented here (such as ear height and plant height) are somewhat higher. On the other hand, leaf length and venation index have somewhat smaller values than previously reported. Tassel characters in general show more agreement. Ear characters are also in good agreement.

Cutler (1946) described this race using the Indian name "abati moroti". Ramírez *et al.* (1961) described the Bolivian race Pojoso Chico, which is very similar to Morotí. In general, the characters agree quite well with the present descriptions. Pojoso Chico (grown in Colombia) has somewhat shorter plants, higher ear height, and longer leaves. Tassels have a slightly longer peduncle and a shorter terminal spike. The ears are shorter with smaller grains. Timothy *et al.* (1963) suggest that the Ecuadorian race Pojoso Chico Ecuatoriano may have affinities with the Pojoso and Coroico types of Amazonian Peru and Bolivia.

Plants. The race is of average maturity, flowering in about 74 days. The medium height plants average 2.5 meters, varying from 2.0 to 2.8 meters. Ear height averages 1.3 meters, ranging from 0.9 to 1.4 meters. The ear is located at or slightly above the middle of the plant as indicated by the ear/plant height index of 0.51. The number of leaves (15.6 with 6 above the ear) is about average. Leaves are long (92 cm.) with a width of 10.5 cm. and a venation index of 2.33.

Internode Pattern. (Fig. 5). Internodes increase to three internodes below the ear, stabilize, then decrease above the ear; the last one being the longest.

Tassels are large with many branches. The sheath of the last leaf is somewhat small and generally does not reach the first branch. Both the branching space and the central spike are medium to long.

Ears (Figs. 6 and 7) are of medium length, commonly with 12 or 14 rows. They are slightly tapered with a medium diameter (3.9 cm.). The mean rachilla length is 3.1 mm, which is rather long. The average cob/rachis index is 1.88, the glume/kernel index 0.65, and the rachilla/kernel index is 0.31, which is medium to large. The kernels have about 34 percent of their length covered by the glumes, which is somewhat greater than average.

Kernels are of medium size (width 8.7 mm, thickness 4.6 mm, and length 10 mm). The endosperm is white and floury with lemon yellow to dark yellow aleurone color. The pericarp is usually colorless, although some samples are found having variegated pericarp. Occasionally blue aleurone color is also found.

Distribution. The main area of Morotí corresponds to Paraguay, but the race also spread to the lowlands of Bolivia and parts of the bordering states of Brazil such as Mato Grosso, Paraná, and Rio Grande do Sul (see map in Fig. 1). A few samples have also been collected in a quite distant area in northeastern Brazil in the state of Ceará. It is not known whether these samples represent some recent introduction or a remnant from a wider area of distribution.

Origin and Relationship Since this is an ancient corn, its origin can only be speculated. It is probably the result of selection practiced by the Guaraní Indians in ancient times. Brieger *et al.* (1958, pp. 136-137) consider this race to be "the most southern representative of a large group of maize varieties characterized by nearly round kernels, very soft endosperm, and yellow aleurone." Grant *et al.* (1963, p. 39), describing the Venezuelan race Cariaco, agree with Brieger *et al.* "that Cariaco belongs to the complex of soft flour races of the South American lowland Indians." According to Brieger *et al.*, the most northern representative of this group is Cariaco from northern Colombia. Roberts *et al.* (1957) suggest that a race similar to Morotí may have crossed with Costeño to produce Cariaco. Wellhausen *et al.* (1952, p. 198) mention a corn very similar to Morotí called Maiz Blando de Sonora and considered "very similar to the prehistoric maize from Cañon del Muerto described by Anderson and Blanchard (1942) which dates back to 500 and 700 A.D." More recently Wellhausen (1965) suggested that Morotí may have had an influence upon the evolution of the Mexican race Pepitilla.

It may well be that Morotí or some similar type was distributed in early times. Presumably, in those times, just a few races of maize existed. From this early ancient, floury corn several distinct races might have arisen through natural and artificial selection practiced in different regions.

Value for Improvement. Morotí is well adapted to low altitude, subtropical regions with average rainfall. Its yielding ability is medium to low compared to the most highly selected materials for the São Paulo area, yielding about 68 percent relative to the double crosses H6999 and Ag 17 (Table 8). Among the indigenous races, Morotí and Caingang are the most productive. Morotí, however, shows considerably greater variability which could be used for selection. In a series of diallel crosses, the lowest heterotic response involved intercrosses of the races Morotí, Caingang, and Cristal [Paterniani and Lonnquist,(1963)],which substantiates the high degree of relationship among these races postulated by Brieger *et al.* (1958). Crosses of Morotí that gave high heterotic response (more than 120 percent in relation to the mid-parent mean) involved the races Cateto, Vandeño, Lenha, Zapalote Grande, and Canario de Ocho (Paterniani, 1961a).

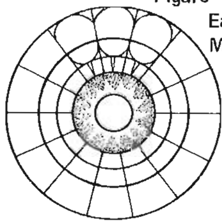


Figure 7. Ear cross-section Morotí.

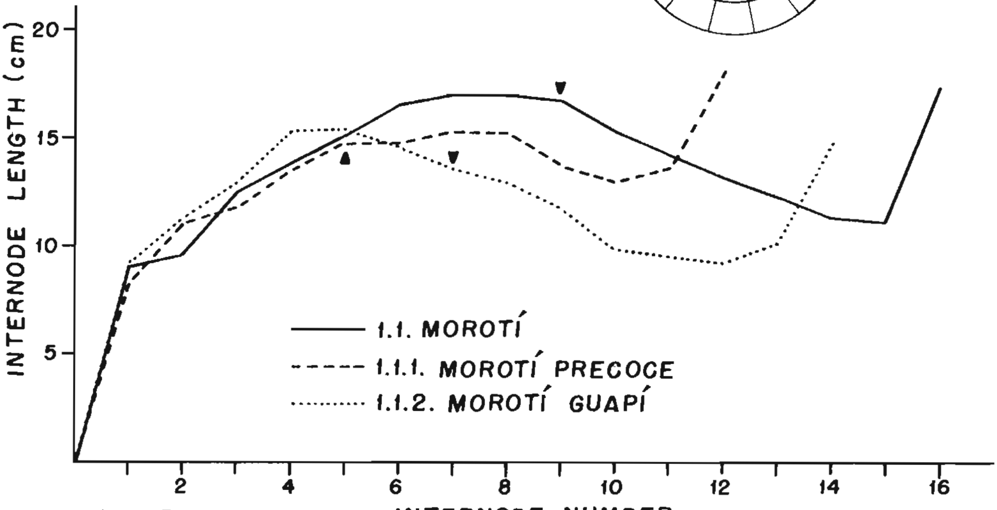


Figure 5.

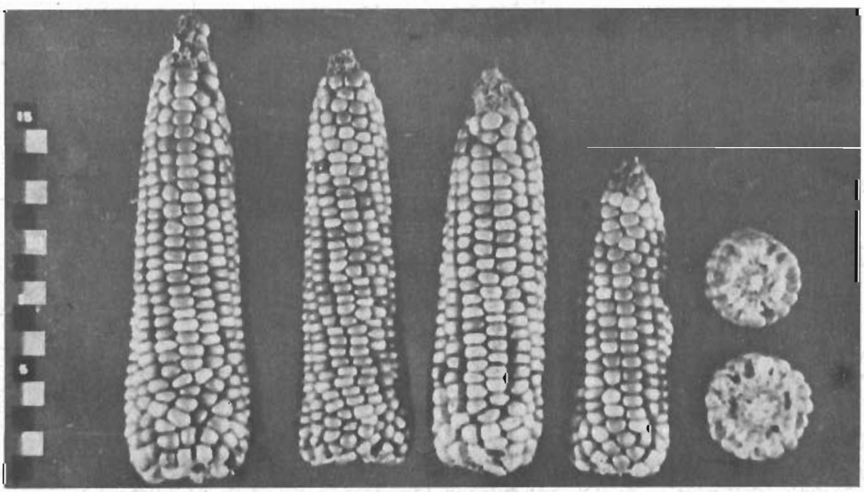


Figure 6. Morotí.

5.1.2.1. Sub-race Morotí Precoce (Figs. 8 and 9)

Some collections of Morotí from Bolivia are about two weeks earlier than the regular Morotí from Paraguay. Some plant characters also have smaller means. It is interesting that, in general, the earlier varieties with smaller plants also have a lower ear height/plant height index.

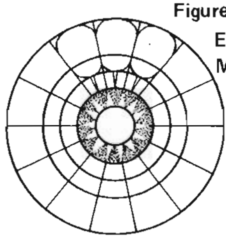


Figure 9. Ear cross-section Morotí Precoce.

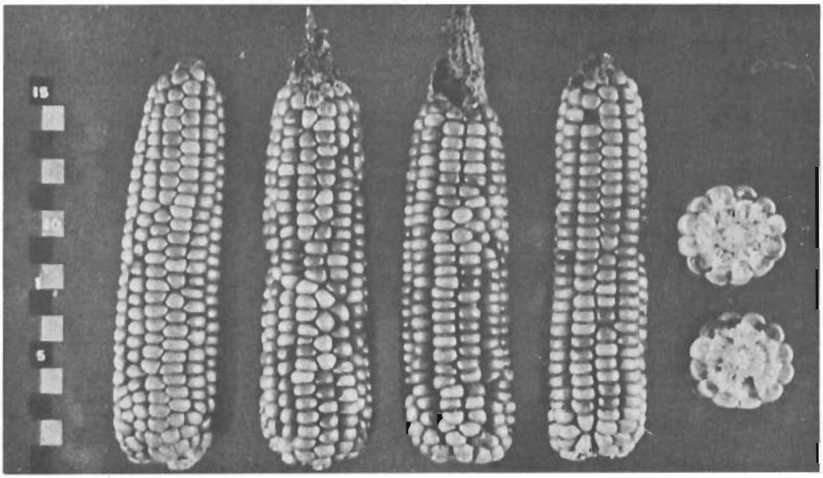


Figure 8. Morotí Precoce.

5.1.2.2. Sub-race Morotí Guapí (Figs. 10 and 11)

A variant of Morotí characterized by short bulky ears with irregular rows, making it difficult to determine row number, was found in Paraguay. It is very rarely grown, early flowering, and has somewhat shorter plants and lower ear height than Morotí. Tassels are a bit smaller, mainly due to the shorter central spike. Sometimes the sheath of the last leaf covers the first branches of the tassel. All indices are rather low.

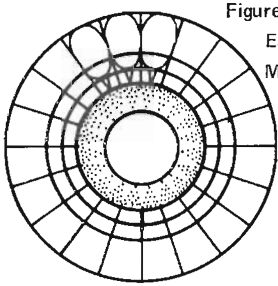


Figure 11. Ear cross-section Morotí Guapí.

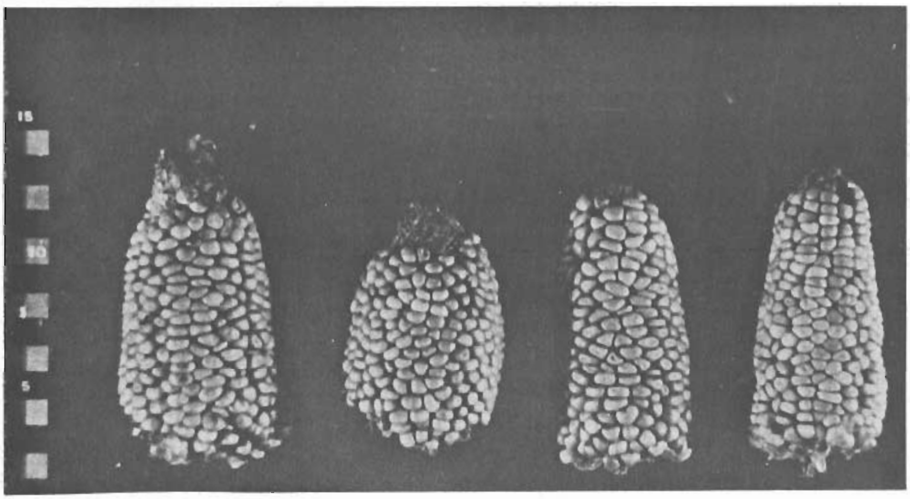


Figure 10. Morotí Guapí.

5.1.3. Caingang

Derivation on Name. "Caingang" is the name of the Indian tribe that cultivated this race.

Comparison to Previous Studies. The descriptions of this race by Paterniani (1954) and Brieger *et al.* (1958) agree well in regard to plant characters on the whole. Plant height and ear height are somewhat higher for the studies reported here. Regarding the tassel, the data of Brieger *et al.* indicate more branching space (18.0 cm vs. 14.4 in the present study) and more branches (29.6 vs. 22.8) than reported here.

Ear characters are also in general agreement. The cob/rachis index is lower in the present study (1.77) than reported by the above authors (1.9). Kernel covering is also lower here (0.27) than reported previously (0.32).

Plants have average maturity, flowering in 74 days. The values for plant and ear height, ear height/plant height index, number of leaves, and length, width, and venation index of the leaves are about average.

Internode Pattern. (Fig. 12). Internodes increase up to the internode below the ear, stabilize, then decrease, the last one being longest.

Tassels have average dimensions, except for the terminal spike that is rather long (28.2 cm), the relatively low peduncle covering index (1.38), and the many branches (around 23).

Ears (Figs. 13 and 14) are of medium length, usually with 12 rows. They are cylindrical with a medium ear diameter (40 mm), rachilla length of 2.8 mm, and indices of average values.

The dented kernels are long (10.8 mm) with average thickness (4.3 mm). The kernels are above average size, especially in length and width (9.5 mm). The endosperm is floury white. Aleurone colors are frequently found, especially blue. Variegated pericarp is also frequent.

Distribution. Caingang is grown by Indians who lived in a belt from the state of São Paulo to Uruguay. The collected samples were obtained from a few Indian reservations maintained by the Brazilian government.

Origin and Relationships. No reliable facts are available to permit conclusions regarding its origin. It is an indigenous race, having only floury endosperm in common with the other indigenous races. It is significant that it is the only indigenous race of this area having white, dented kernels on cylindrical ears. It is also the only one with dented kernels. Similar ear and kernel types belonging to distinctly different races appear in northern Colombia, in Mexico, and in Central America, leading Brieger *et al.* (1958, p. 169) to consider this "one of the most outstanding facts showing the efficiency of indigenous and pre-Columbian plant breeding."

Value for Improvement. Caingang is the indigenous race that most closely approximates the standards required for commercial corn, which led Brieger *et al.* (1958, p. 174) to consider it as "potentially very promising material for breeding work." It is adapted to subtropical conditions with average rainfall and low altitude, having medium to low yielding ability when compared to the double crosses H6999 and Ag 17 (Table 8). In a group of diallel crosses, highly heterotic responses (over 120 percent in relation to mid-parent) were obtained in crosses to Carmen (Tuxpeño germ plasm), Vandeño, Lenha, Zapalote Grande, Chapalote, and Canario de Ocho [Paterniani (1961a), Paterniani and Lonnquist (1963)].

Besides having ear characteristics similar to some Mexican races (like Vandeño, for instance), Caingang also has genes that strongly dilute yellow color in the endosperm. These properties, together with its great combining ability, appear to indicate that this race could be a promising source for improvement of Mexican corn.

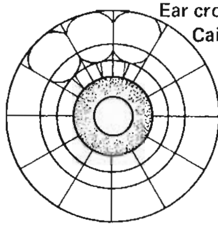


Figure 14.

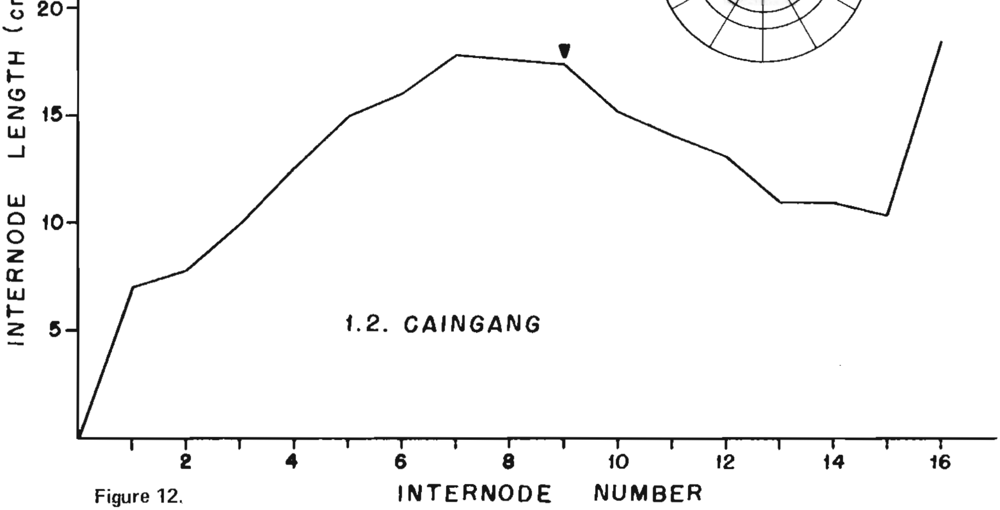


Figure 12.

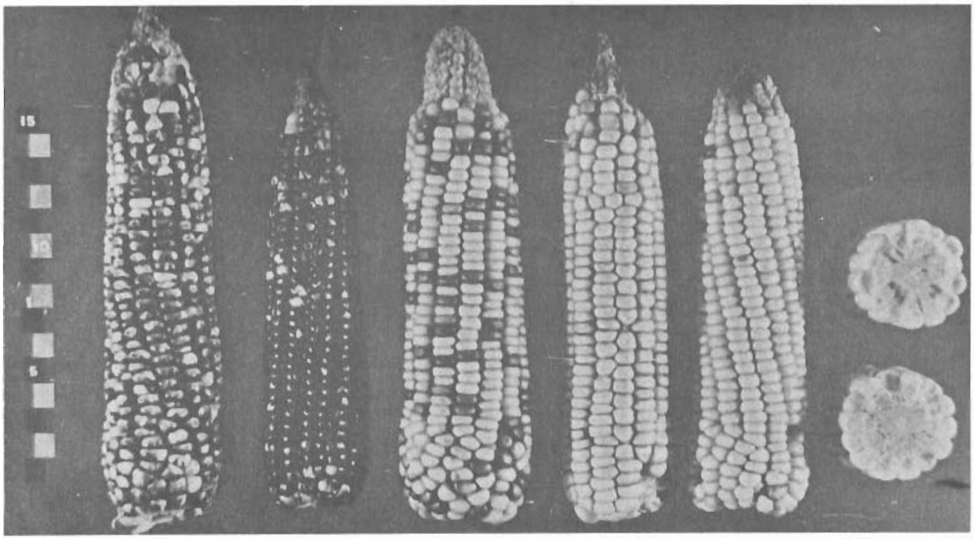


Figure 13. Caingang.

5.1.4. Lenha

Derivation of Name. Since no native name is known for this material, Professor Brieger has called it "Lenha" meaning firewood, as the cobs were used for that purpose (Brieger *et al.*, 1958).

Comparison to Previous Studies. Plant and tassel characters presented here are in general of lower magnitude than the corresponding ones reported by Brieger *et al.* (1958). The ear characters seem to be in somewhat better agreement, although smaller values are reported here. These comparisons may be of special interest, since essentially the same material was analyzed in both cases. Only the growing seasons were different.

Plants. The relative short plants (1.92 m) with low ears (81.6 cm) flower early (69 days) and have a low ear/plant height index (0.42). There is an average of 14.4 short (71.4 cm), narrow (8.9 cm) leaves per plant. The venation index is high (2.61).

Internode Pattern. (Fig. 15). Internodes increase in length up to the ear, then decrease, the last one being the longest.

Ears (Figs. 16 and 17) are cylindrical or slightly-tapering, short, thick, frequently fasciated, and many rowed (usually 22 or more). The rachilla is very long (4.1 mm). This means the kernels are very easily depressed into the surface of the cob. The pith diameter (14.8 mm) is very large and often hollow.

The kernels are short, floury, and white; no pericarp, aleurone, or endosperm colors are ever found.

Distribution. Lenha was found in only one location, in Rio Grande do Sul, the southernmost Brazilian state. It is apparently no longer in cultivation, and the distribution of this race in previous times is not known.

Origin and Relationship. Almost nothing can be said about its origin, since even the people that developed and cultivated this race are completely unknown. Brieger *et al.* (1958) suggested that some indigenous group from southern Brazil and Uruguay probably developed floury and flint type corns with thick cobs.Cateto Sulino Grosso,which will be described later, is a race very similar to Lenha found in Uruguay.

Value for Improvement. Lenha is not very productive, even considering the standards of the indigenous races. Its yielding ability is only half that of the double crosses H6999 and Ag 17 (Table 8). In crosses to other races, however, it regularly exhibits considerable heterosis relative to the mid-parent mean (137 percent on the average of a set of diallel crosses (Paterniani and Lonnquist, 1963)). This may well be due to some inbreeding that has occurred in the material during its maintenance. However, some very high yields were obtained in crosses to Dente Paulista, Carmen (Tuxpeño germ plasm), Cateto, and Zapalote Grande (Paterniani, 1961a). Furthermore, Lenha might be a good source for high row number and low ear height.

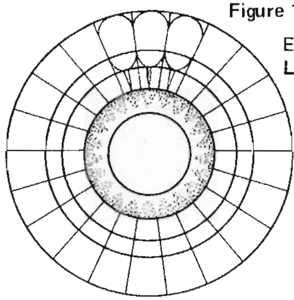


Figure 17.

Ear cross-section Lenha.

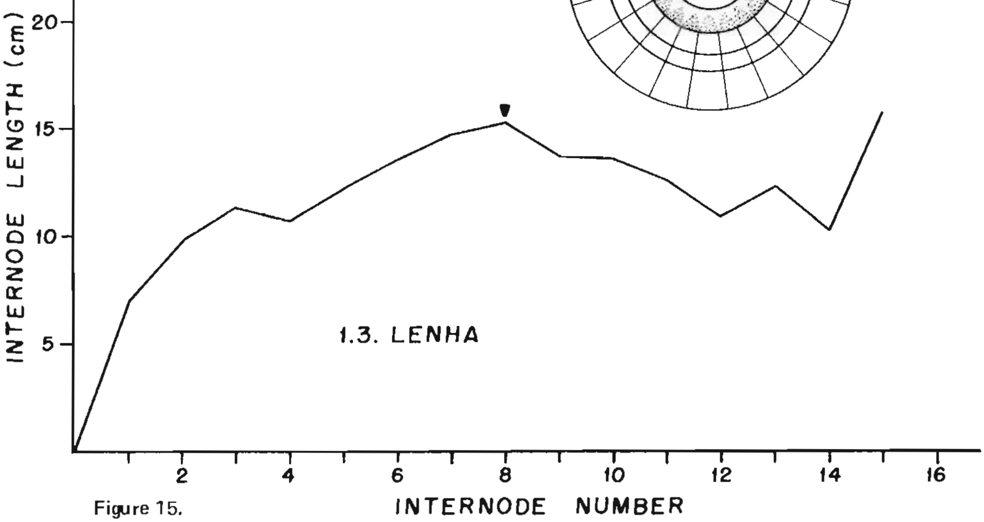


Figure 15.

Figure 16. Lenha.

5.1.5. Entrelaçado

Derivation of Name. Entrelaçado is the Portuguese word for interlocked, used by Brieger *et al.* (1958), and this name has been used locally since then. No indigenous name that is widely used for this race is known. The Peruvian name is Piricinco, and in Bolivia it is known as Pojoso [Grobman *et al.* (1961), Rodríguez *et al.* (1968)]. Cutler (1946) described the race under the name Coroico, the locality in Bolivia where the material was first collected, and the same name was used by Ramírez *et al.* (1961) in their description of the Bolivian races.

Comparison to Previous Studies. Herein, all those races described by Brieger *et al.* (1958) for the Amazon Basin and its margins, with the exception of the northern Catetos (Cateto Nortista), are grouped together into Entrelaçado. Available descriptions of Brieger *et al.* (1958), Grobman *et al.* (1961), and Rodríguez *et al.* (1968) agree fairly well, in general, with the present data. The Peruvian material flowers eight days later and has shorter plants and lower ear height; fewer, shorter, and narrower leaves; and higher venation index. Tassels are highly branched; in all cases there are more than 30 branches. While the data for other characters agree reasonably well with those of Brieger *et al.* (1958), the values obtained are somewhat larger than those of Grobman *et al.* (1961). The characters of the ears appear to be in closest agreement. One distinction may be the smaller number of rows in the Peruvian material.

Ramírez *et al.* (1961) described the Bolivian race Coroico, which is essentially the same as Entrelacado. Their description is remarkably similar to the present one. The only differences noted are that Coroico has somewhat shorter plants, lower ear heights, longer leaves, and a shorter central spike. The descriptions by Rodríguez *et al.* (1968) indicate shorter ears and plants and smaller, simpler tassels. The Ecuadorian race Pojoso Chico Ecuatoriano, described by Timothy *et al.* (1963), which looks remarkably similar to the type of "Morotí" called "Morotí Precoce", is probably just a smaller version of Entrelaçado.

Plants. The late (88 days), tall, many-leaved (16.0) plants with high ears have a correspondingly high ear/plant height index (0.54). The leaves are long (91.9 cm) and wide (10.9 cm).

Internode Pattern. (Fig. 18). Internodes increase in length up to two internodes below the ear, stabilize, then decrease slightly beyond the ear, the last one being the longest.

Tassels are long (44.4 cm) and highly branched (32 branches).

Ears (Figs. 19 and 20) are very long (29.2 cm) with irregular, interlocked rows, the main characteristic of this race (hence the name). Actual counts give an average of 13 rows which, as Brieger *et al.* (1958) showed, is half the value which a non-interlocked ear would have (26 rows). The kernel size and the ear cross-section diameters are of average size. The indices in general are high. The kernels are floury with white endosperm, but frequently with red or variegated pericarp and many aleurone colors (yellow, orange, blue, and purple).

Distribution. Several types of maize very similar to Entrelaçado (probably of the same race) occur throughout the Amazon Basin from Peru (where the race is described under several names of which the most "typical" is Piricinco) to the eastern edge of the Amazon Basin. As pointed out by Grobman *et al.* (1961, p. 218), this "is perhaps the most widely distributed corn race with a single continuous geographical range." The area of Entrelaçado is one of the most difficult in which to travel, which is responsible for the small number of collections made. A more thorough collection of this race would be highly desirable.

Origin and Relationship. Brieger *et al.* (1958) consider the origin of this race to be a mystery, but suggested that it is probably a very ancient, primitive type developed mainly through selection. This selection was for high row number and for increased ear length, especially the alicole length component, which resulted in the interlocking of the ears. They also assume that the interlocking feature is a primitive character dating back to the very early days of domestication. Grobman *et al.* (1961), however, advanced the idea that this race arose as a hybrid between the two Peruvian races, Rabo de Zorro and Enano. This postulate seems somewhat improbable, since these same authors consider Entrelaçado (which they call Piricinco) a stable race with primitive characters. Furthermore, inbreeding does not cause major segregation for phenotypic characters extraneous to the average racial pattern. In addition, Entrelaçado is definitely a race adapted specifically to low altitude, while Rabo de Zorro is adapted to altitudes ranging from 2300 to 3200 meters above sea level. While it is certainly possible that some introgression may have occurred in Entrelaçado, it seems quite unlikely that the postulated hypothetical parentage, based upon similarities of phenotypic characters of existing races, is correct.

Roberts *et al.* (1957) suggest that Entrelacado may have played a role in the origin of Cariaco and Negrito, providing these races with the pericarp and aleurone colors that distinguish them. However, the genes for these colorations are scattered throughout many races.

Value for Improvement. Entrelaçado presents a yet unsolved problem regarding its adaptation. Plantings made in Piracicaba, S.P., Brazil, with seeds collected from the Indians have always resulted in plants showing definite signs of lack of adaptation. Plants show a high susceptibility to disease (mainly rust), and many plants die or do not produce a good ear. This is striking in view of the large well-filled ears received from the Indians. It seems unlikely that only a difference in climatic conditions is responsible for this behavior. It would be appropriate to investigate the soil types and soil properties, rate of planting, and type of cultivation found in the original environment of Entrelaçado. Finally an examination of the corn fields of the Indians should be made to determine the average type of plants and ears. Recent personal communication indicated that the Indians use a low rate of planting, resulting in wide spacing (1 m or more) between plants.

In recent years, however, large plantings comprising several thousand plants have been made in Piracicaba, providing an opportunity for selection. After only two generations considerable improvement has been realized. Ears of about the same size as the original ones are frequent in these plantings. It may be of interest to point out that Entrelaçado, as is common in many long-eared types, frequently fails to set seed near the base of the ear. By selecting kernels only from ears with well filled bases, substantial progress was also achieved in this regard in the two generations (i.e., long ears well filled from the base to the tip).

Recently, certain Bolivian collections of this race have been found to have multiple-layered aleurones, resulting in an increase in both the quality and quantity of the protein content of the grain [Wolf *et al.* (1972)].

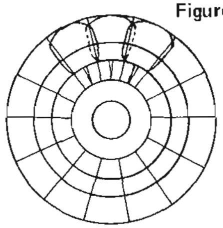


Figure 20.
Ear cross-section Entrelaçado.

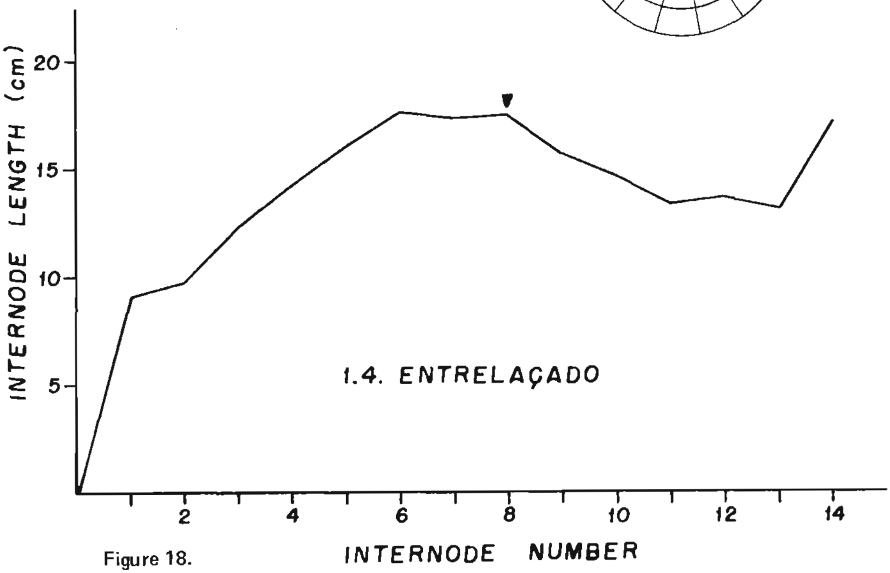


Figure 18.

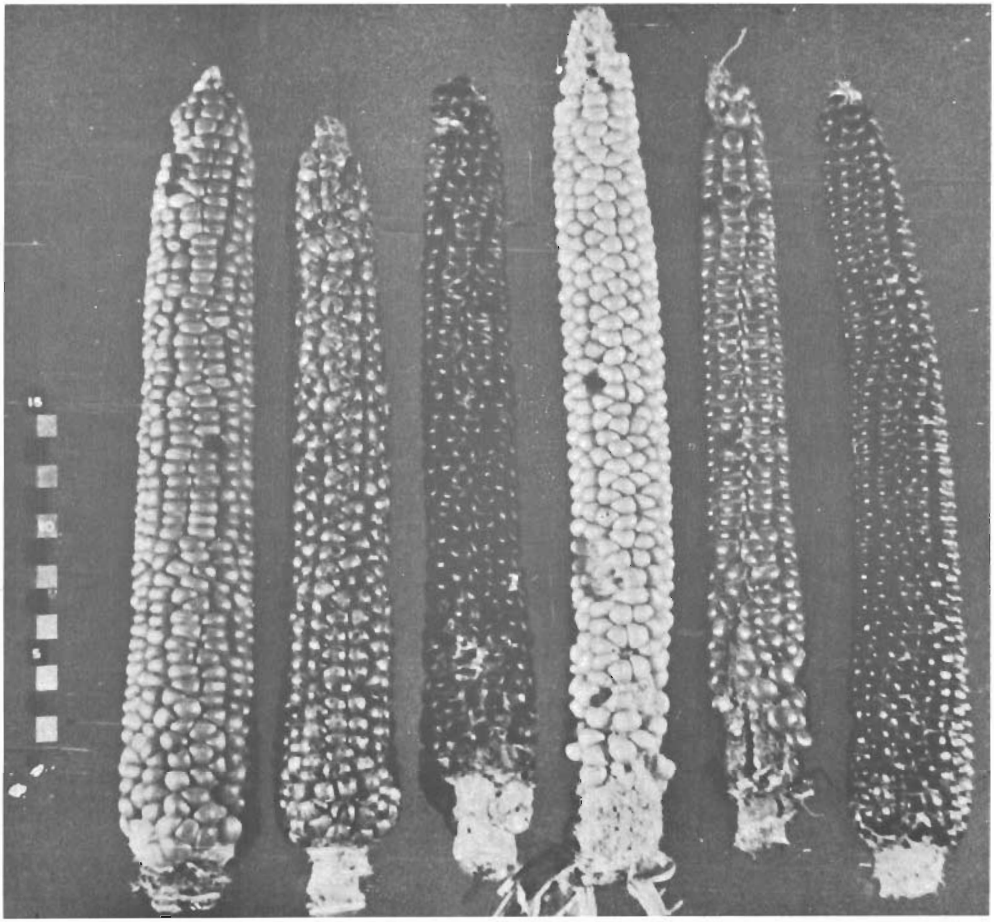
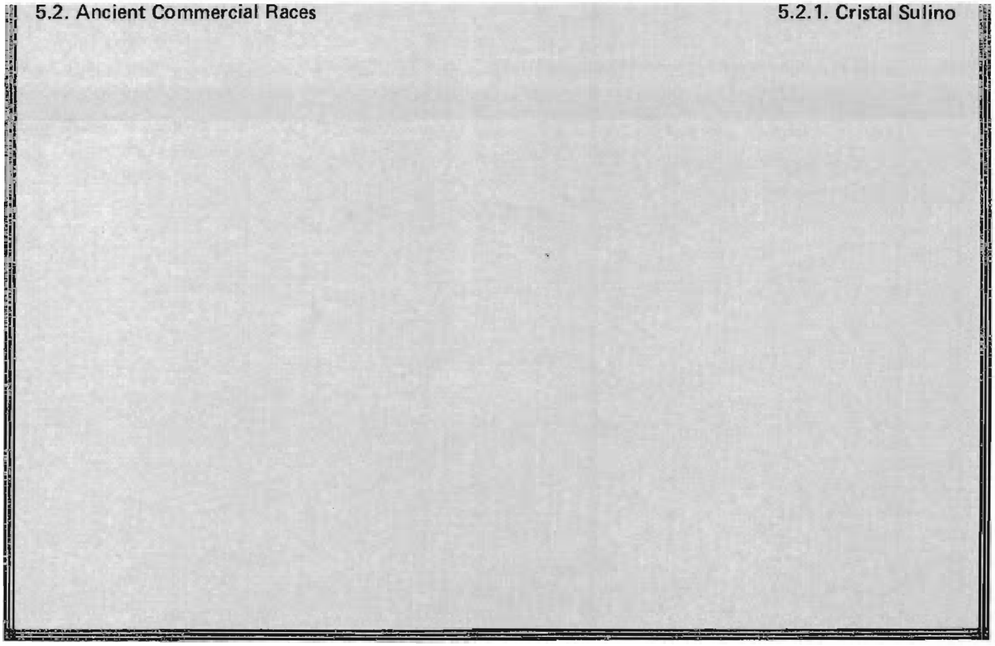


Figure 19. Entrelaçado.

5.2. Ancient Commercial Races

Ancient Commercial races are those races that existed in the area in pre-Columbian times, when they were cultivated by Indians. These races are in a sense indigenous. However, today these materials are widely cultivated, and for this reason they are called commercial. The reason this group of races is distinguished from the indigenous group of races is that the commercial races have undoubtedly undergone changes since the initial cultivation by the white man. How much change has occurred is not known, nor is it known whether this change was similar for all such races. On the other hand, the indigenous races (with the exception of Lenha) are cultivated by the same kinds of people that grew them in pre-Columbian times, so it is reasonable to assume that they have changed less since the discovery of the New World than have the commercial races.



5.2.1. Cristal Sulino

Derivation of Name. The name Cristal usually refers to white, flint corn. Since this is the southernmost white, flint corn, the name Cristal Sulino seems appropriate.

Comparison to Previous Studies. This race is very similar to the Calchaqui race described by Brieger *et al.* (1958). The plant heights presented here indicate, however, that these plants are taller.

Plants. The early flowering (61.8 days), relatively short plants (2 m) with ears about one meter from the ground have a relatively low number of short leaves of medium width.

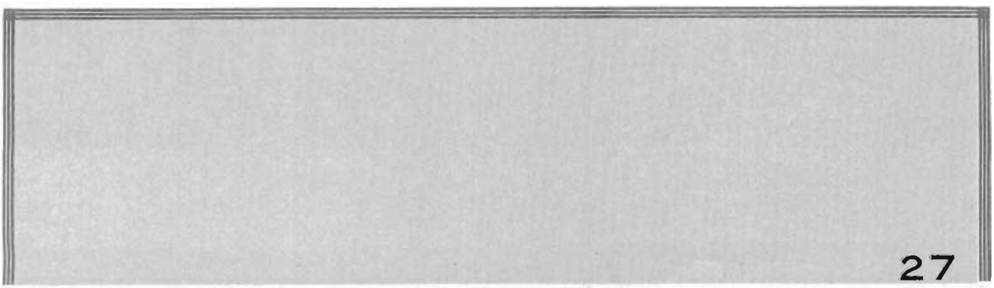
Internode Pattern. (Fig. 21). Internodes increase up to one or two internodes below the ear, stabilize, then beyond the ear they decrease slightly and become constant until the last one, which is the longest.

Tassels are of average dimensions, the peduncle being rather long and the terminal spike somewhat short. There are many branches.

Ears. (Figs. 22 and 23). The ears are of average size with 14 rows of average-sized, white, flinty kernels.

Distribution. This race was found in cultivation on a limited scale by farmers in Argentina and Uruguay in the La Plata region.

Origin and Relationship. This material probably originated from the Calchaqui race as a result of selection by farmers. Calchaqui occurs in the "northwestern Argentinian lowlands up to valleys of nearly 2000 meters," (Brieger *et al.*, 1958, p. 131). Rodríguez *et al.* (1968) suggest that this type of maize originated from crosses between Guaraní maize and the racial complex typified by Morocho, an eight-rowed flint spread widely during Inca times. Some hybridization with varieties of Cateto Sulino could also have occurred.



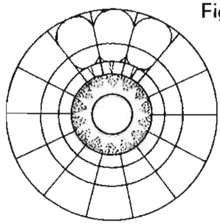


Figure 23. Ear cross-section Cristal Sulino.

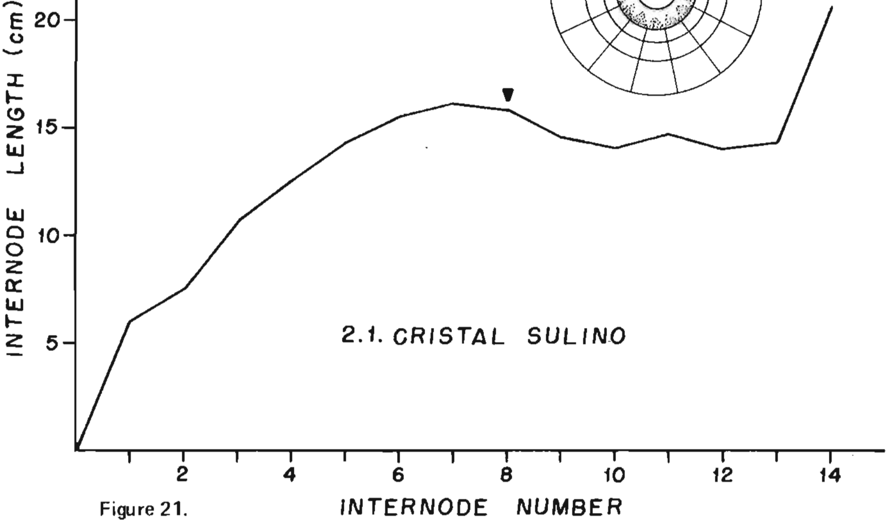


Figure 21.

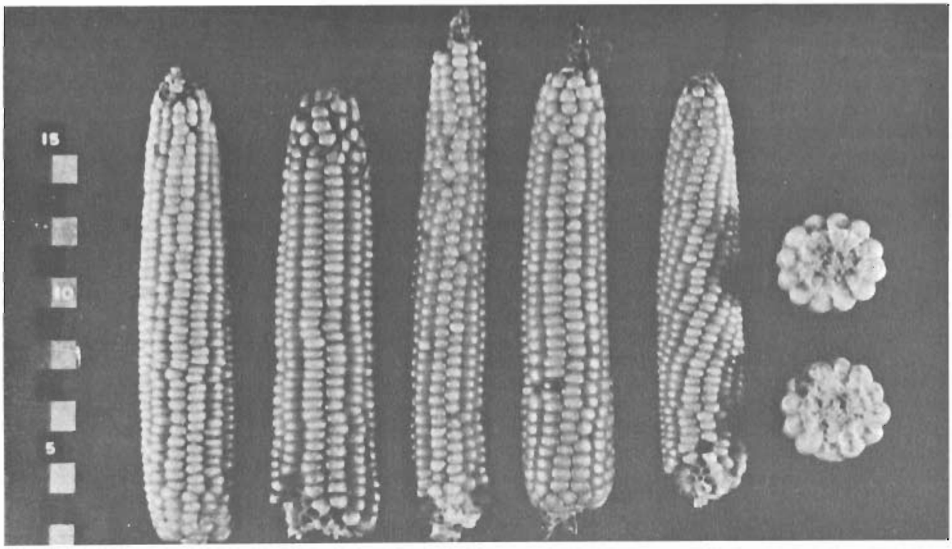


Figure 22. Cristal Sulino.

5.2.2. Cristal

5.2.2.1. Cristal Semi-Dentado

Derivation of Name. Cristal is the most common name for this kind of corn among farmers.

Comparison to Previous Studies. The data reported by Brieger *et al.* (1958) for Cristal Paulista and Cristal Paraguay agree reasonably well with the present data. The present data reveal taller plants and higher ear heights. Tassels are also larger, but the data of Brieger *et al.* indicate more branches per tassel. Ear characteristics are very similar in the two sets of data. Cutler (1946) gives a short description of this race, using the Indian name "abati Tupi."

Plants. The tall, late-maturing (81 days) plants with very high ears have an average number of long, wide leaves.

Internode Pattern. (Fig. 24). Internode lengths increase up to two or three internodes below the ear, stabilize, then decrease beyond the ear until the last one which is the longest.

Tassels. The entire length of the peduncle including a portion of the branching space of the large, many branched tassel is sometimes covered by the last leaf sheath.

Ears. (Figs. 25 and 26). The rather long, frequently 12-rowed ears have average dimensions for the ear cross-section diameters and indices. The white, flinty kernels are medium to large size.

Distribution. The main area of this race is Paraguay, where it is surpassed in acreage only by Morotí. Cristal is also grown in Brazil, being used as corn meal and hominy for human consumption. In Brazil, this race is grown mainly in Minas Gerais, São Paulo, and neighboring states. Sousa's (n.d.) description of the most common type of corn in Bahia in 1587 fits this race and indicates a wide, early dispersal.

Origin and Relationship. Cristal probably was cultivated in pre-Columbian times by the Guaraní Indians of Paraguay and surrounding areas. Cristal must have been obtained from the Guaraní Indians by white men. As for the origin of Cristal, Brieger *et al.* (1958) suggest it originated from natural hybridization between Calchaqui White Flint and Morotí. Calchaqui White Flint is grown in Northwestern Argentina, and its similarity to Cristal indicates a close relationship. It may also have some relationship to Perola from Bolivia, described by Ramírez *et al.* (1961). It may be worthwhile to mention that Guaraní people in Paraguay call Cristal "Avati Tupi" (Cutler, 1946). Tupi frequently means exotic, something obtained from other people, although other interpretations exist [Bertoni (1914), Goodman (1968a)]. Thus it is quite possible that Cristal in Paraguay originated from Calchaqui from Argentina.

Value for Improvement. Cristal is one of the poorest races with respect to agronomic merit. It is fairly late, with tall plants having very high ears and much lodging. The productivity is about 30 percent lower than commercial hybrids (Table 8). In unfavorable seasons its yielding ability is considerably lower. It shows no heterosis with Morotí, which may indicate some common background. High heterosis values (above 130 percent relative to the mid-parent mean) were obtained in crosses to Vandeño, Tabloncillo, Zapalote Grande, and Canario de Ocho. Higher than average F_1 yields were obtained in crosses with Dente Paulista, Carmen (Tuxpeño germ plasm), Cateto, Vandeño, and Tabloncillo (Paterniani, 1961a). In another series of crosses (Table 9), Cristal was also the lowest in yielding ability as a parent as well as in the F_1's, F_2's, and backcrosses.

Recurrent selection for general combining ability has been carried out in Cristal with an improvement of about 7 percent in the first cycle (Paterniani, unpublished). This indicates the presence of a sizeable additive genetic variance for yielding ability.

5.2.2.1. Sub-race Cristal Semi-Dentado (Figs. 24, 27, and 28)

The major difference from Cristal is the semi-dent kernel type probably due to mixture with some white dents. Except for being about eight days earlier in flowering time and having shorter plants with lower ears, the plants are quite similar to Cristal.

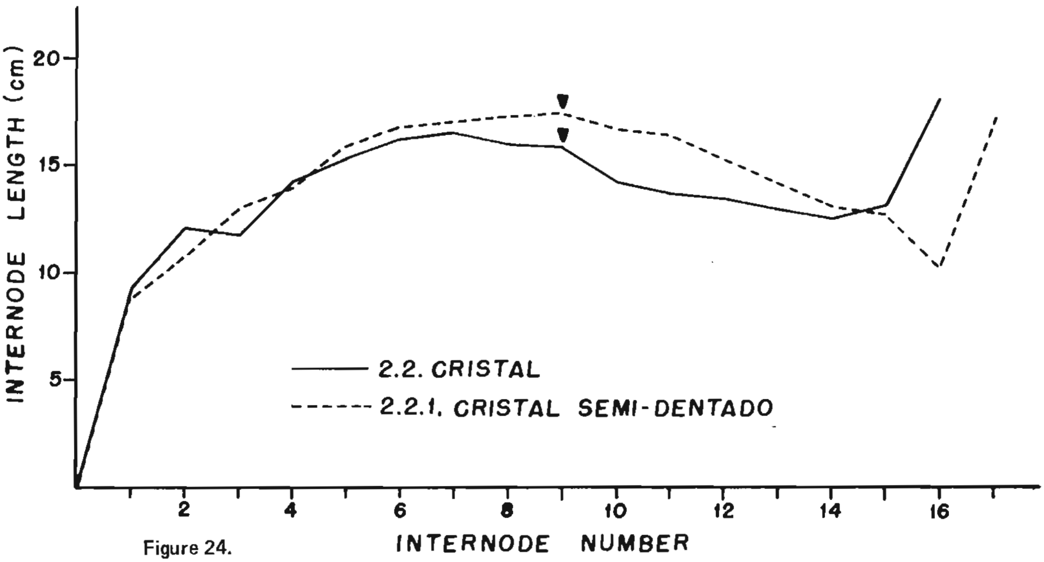

INTERNODE LENGTH (cm)
20
15
10
5
2.2. CRISTAL
2.2.1. CRISTAL SEMI-DENTADO
2
4
6
8
10
12
14
16
INTERNODE NUMBER

Figure 24.

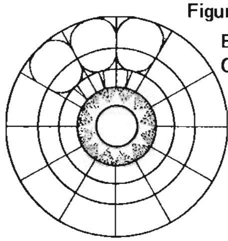


Figure 26.
Ear cross-section
Cristal.

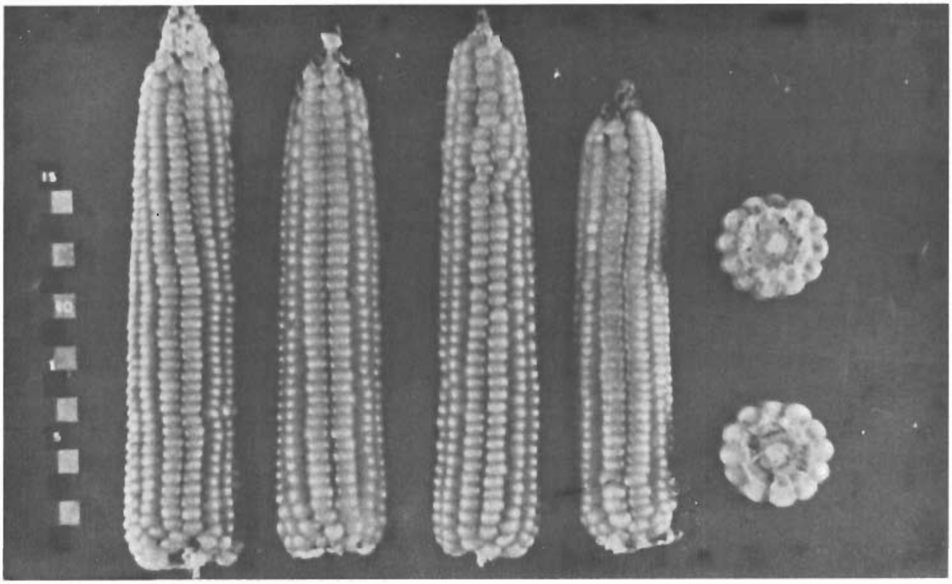


Figure 25. Cristal.

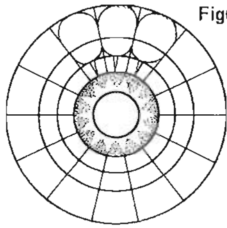


Figure 28
Ear cross-section
Cristal Semi-Dentado.

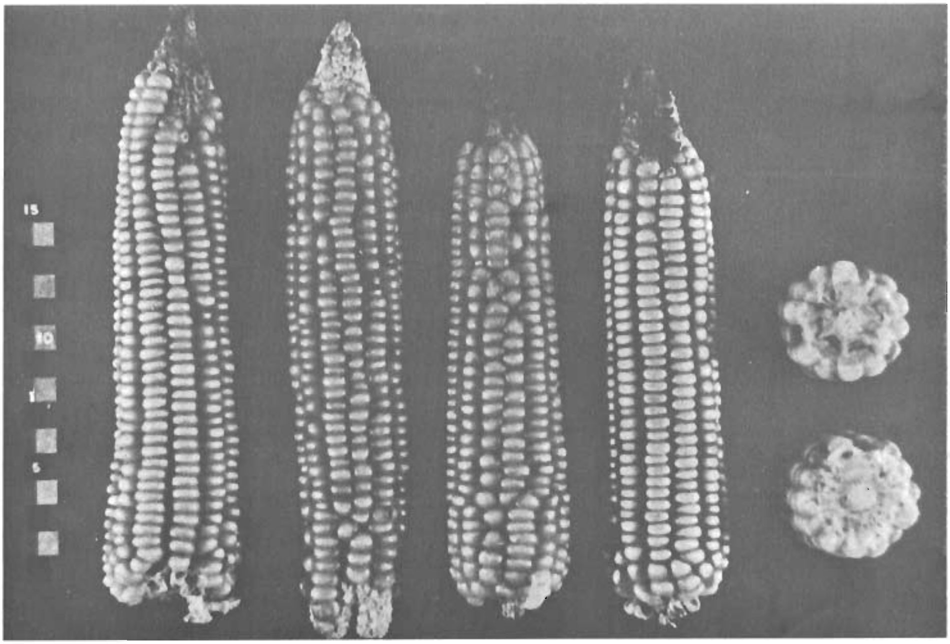


Figure 27. Cristal Semi-Dentado.

5.2.3. Canario de Ocho

Derivation of Name. The name is employed in Uruguay and Argentina and refers to the bright orange canary color and the eight-rowed characteristic.

Comparison to Previous Studies. In general, the characters reported by Brieger *et al.* (1958) agree fairly well with the present ones. Plant and ear heights are higher in the present study. Cristalino Norteño from Chile [described by Timothy *et al.* (1961)] also has generally similar values. Some differences (mainly with respect to plant data) can be ascribed mostly to environmental differences.

Plants. The short, early flowering (60 days) plants have very low ears and a small number of short leaves.

Internode Pattern. (Fig. 29). Internode lengths increase up to the ear-bearing node, then stabilize, the last one being the longest.

Tassels have average dimensions, except for a rather long peduncle and a relatively small number of branches.

Ears. (Figs. 30 and 31). The rather long, narrow, frequently eight-rowed ears have average values for the internal characters, except for rachilla/kernel index, which is low. The large, flinty, orange kernels have identical means for length and width.

Distribution. This race is grown in the lowlands of Argentina and Uruguay throughout the La Plata region.

Origin and Relationship. Brieger *et al.* (1958) consider this race to be a result of hybridization between a sub-race of Morotí, Avatí Morotí Mitá (characterized by having ears with eight rows and early plants), and Cateto, the main coastal corn. At present it is difficult to decide between this and other possibilities, such as the following: (1) Canario de Ocho could be the relic of a once widespread race. The fact that a very similar corn is also found in Chile [described under the name of Cristalino Norteño by Timothy *et al.* (1961) and assumed to be introduced from the northeastern United States] gives further support to this possibility. Instead of being the result of hybridization, this race could have introgressed into others to yield the more productive Cateto Sulino. (2) Canario de Ocho could have resulted by selection from the more variable Cateto Sulino. (3) Canario de Ocho may have arisen as a result of introgression of northeastern flints from the United States into South American Catetos. The presence of primitive eight-rowed races (especially the Karapampa flints) in Bolivia (Ramírez *et al.* 1961) lends additional support to the first of these alternatives. Rodríguez *et al.* (1968) suggest that most of the Catetos were derived from the eight-rowed flint complex they call Morocho, of which Karapampa is one member.

Value for Improvement. This race is early but low yielding in the environment of São Paulo. Its yielding ability is about one third that of the double crosses H6999 and Ag 17 (Table 8). Data available indicate substantial heterosis (above 130 percent relative to the mid-parent mean) in crosses to Cristal, Carmen (Tuxpeño germ plasm), Vandeño, Lenha, Tabloncillo, and Zapalote Grande. However, only the cross to Carmen resulted in an F_1 mean higher than the average of all F_1 means (Paterniani, 1961a).

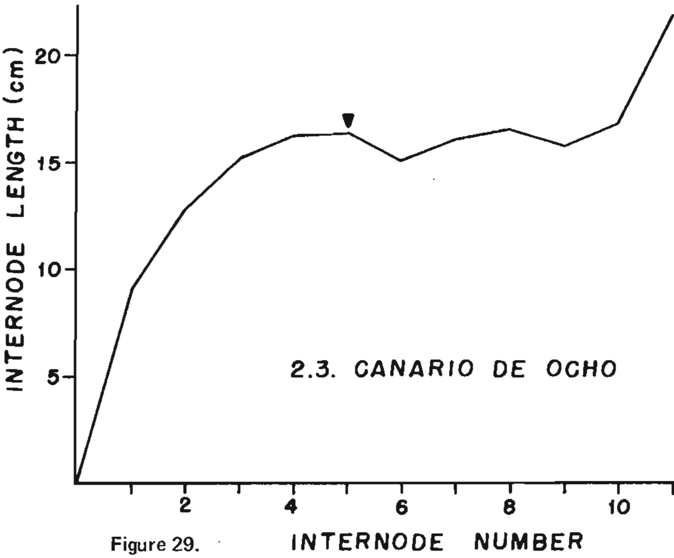
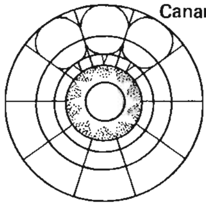


Figure 29.

Figure 31.
Ear cross-section
Canario de Ocho.



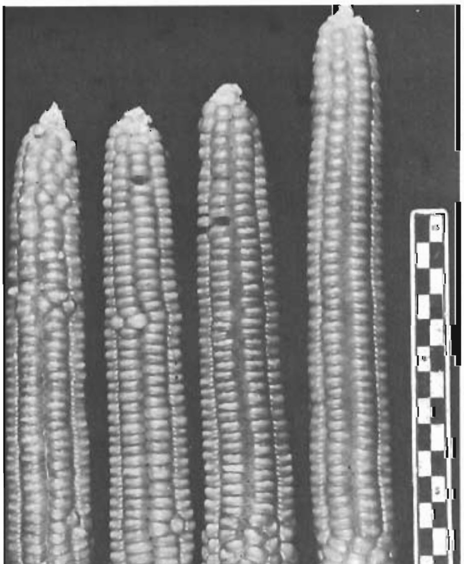


Figure 30. Canario de Ocho.

5.2.4. Cateto Sulino Precoce

Derivation of Name. It is proposed to call this material Cateto Sulino Precoce to indicate its origin and its earliness, which is its most distinctive characteristic.

Comparison to Previous Studies. Cateto Sulino Precoce has not been described previously.

Plants. The plants are very early (the earliest of all considered), flowering in 49 days. The ears are placed extremely low on very short plants, giving the smallest ear height/plant height index among these races (0.16). There are only a few short, narrow leaves.

Internode Pattern. (Fig. 32). Internode lengths increase continually, the last one being the longest.

Tassels have average dimensions, thus representing rather large and highly branched tassels for such small plants.

Ears. (Fig. 33). The short ears with an average of 10.5 rows have a rather large pith and short rachilla length (2.4 mm). The indices are average size. Kernels are rather small with orange, flinty endosperm.

Distribution. This race is grown in lowland areas of the La Plata region in Argentina and Uruguay.

Origin and Relationship. It was probably derived by selection from the Cateto Sulino race, with which it shares many similarities.

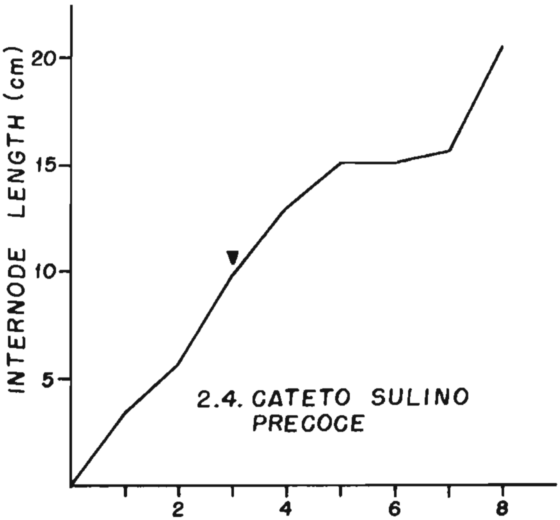


Figure 32. INTERNODE NUMBER

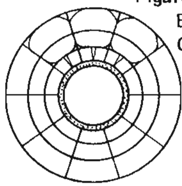


Figure 33.
Ear cross-section
Cateto Sulino Precoce.

5.2.5. Cateto Sulino

5.2.5.1. Cateto Sulino Escuro

Derivation of Name. Cateto is the name employed for the whole group of yellow to orange flint corns occurring in Brazil. These have many similarities to the corresponding types from Uruguay and Argentina such as Amarillo, Cuarentón, Colorado, etc. Thus it is proposed to call this latter material Cateto Sulino to indicate the southern Cateto type.

Comparison to Previous Studies. Ear characters agree quite well with Amarillo and, to some extent, with Cuarentón, described by Brieger *et al.* (1958). Differences are found, however, in relation to some tassel characters of Amarillo, which, for instance, was reported to have a quite short peduncle and many branches. Cuarentón tassel characters agree very well with the present data. Plant characters also show some differences, mainly relative to taller plants in the present study.

Plants. The early flowering, short plants have low ears and a low ear height/plant height index. There is a small number of short leaves.

Internode Pattern. (Fig. 34). Internode lengths increase to just below the ear-bearing node, then stabilize, the last one being the longest.

Tassels. Except for a relatively long peduncle, the tassels are of average dimensions.

Ears. (Figs. 35 and 36). The average size ears have an average of 12.5 rows and have average dimensions for the cross-section diameters, indices, and kernels. The kernels are flinty with intense orange color.

Distribution. The race is found in the lowland areas of the La Plata Region in Argentina and Uruguay.

Origin and Relationship. Cateto Sulino certainly is an old type of flint corn which was presumably grown by the Indian inhabitants who lived in the southern Atlantic coastal area from Brazil to Argentina. While early descriptions are lacking, dictionary listings date back to the 18th century [Pinto (1873, p. 318), Ayrosa (1934, p. 122)]. The various subraces of Cateto Sulino must have been grown locally for a very long time, as they show definite ecological adaptations. According to Brieger *et al.* (1958), all representatives of Cateto Sulino originated in this southern area. Due to the absence of archaeological evidence, it is difficult to draw more conclusions regarding details of their origin. The hypothesis of Rodríguez *et al.* (1968), that these races are descended from the highland flints of Bolivia, was discussed in section 5.2.3.

Several improved varieties belonging to this race exist in cultivation in both Argentina and Uruguay. These were derived quite recently by a few official and private institutions and have local names such as Amarillo, Cuarentón, Cuarentino, Colorado, etc. These varieties differ in characters such as the intensity of yellow to orange color in the kernels and maturity.

5.2.5.1. Sub-race Cateto Sulino Escuro (Figs. 34, 37, and 38)

This is very similar to Cateto Sulino in most characters. The main distinction is the very dark, intense orange color of the endosperm, and hence the local name Colorado (meaning red color) used in Argentina and Uruguay. The ears have a high row number (generally more than 16), and the kernels are somewhat smaller (mainly in width) than those of Cateto Sulino.

5.2.5.1. Cateto Sulino Escuro

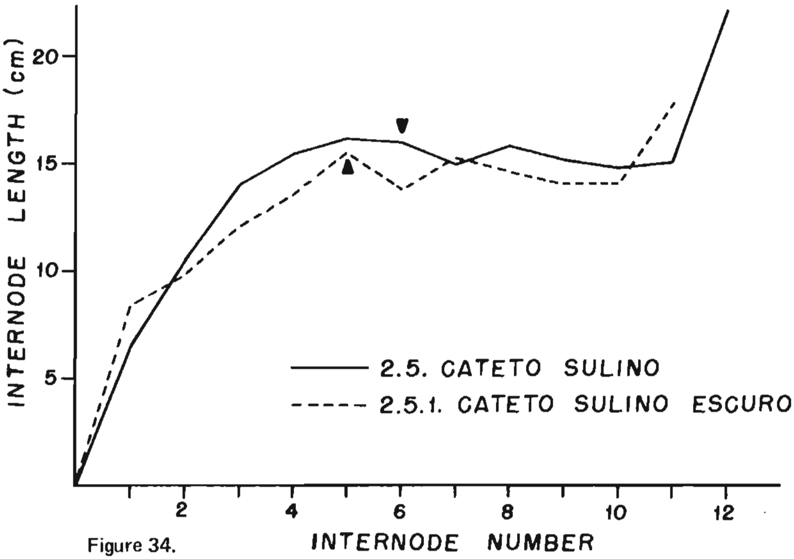


Figure 34.

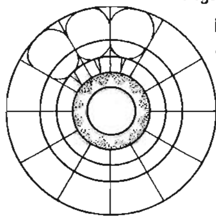


Figure 36. Ear cross-section Cateto Sulino.

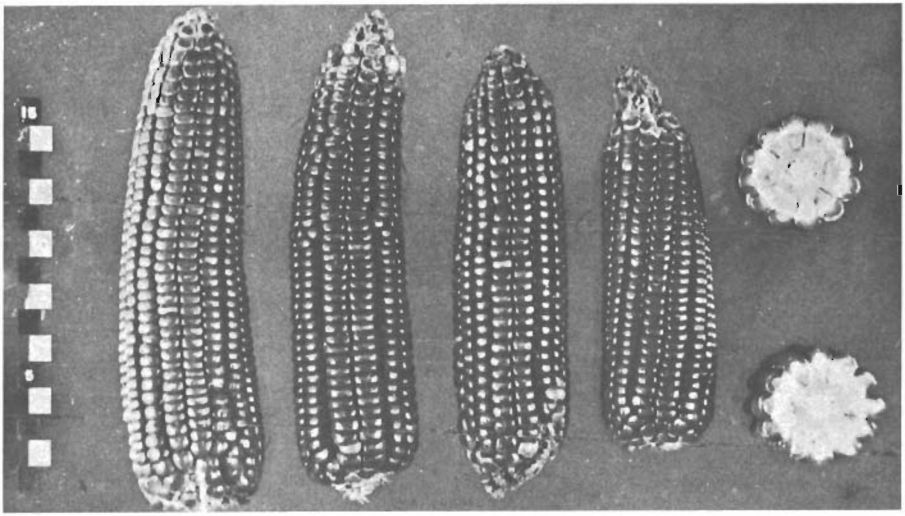


Figure 35. Cateto Sulino

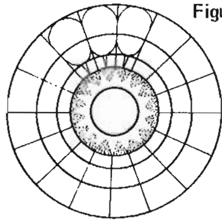


Figure 38.

Ear cross-section
Cateto Sulino Escuro.

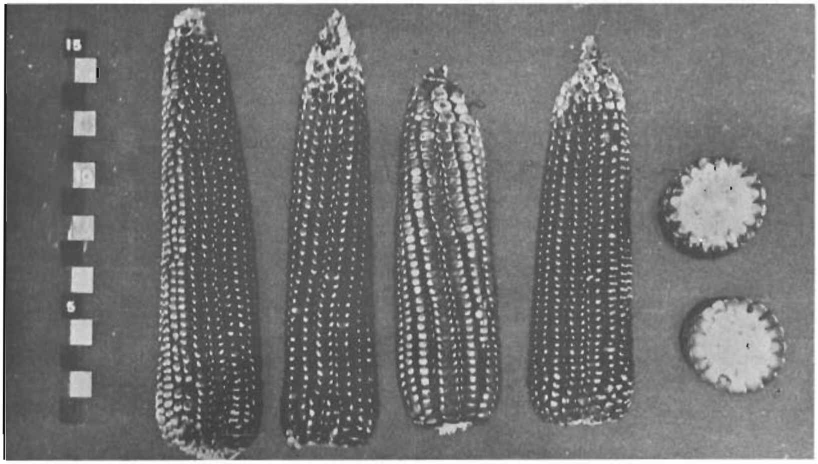


Figure 37. Cateto Sulino Escuro.

5.2.6. Cateto Sulino Grosso

Derivation of Name. The name "Cateto Sulino Grosso" is proposed in view of the hard, orange-colored flint kernels typical of Cateto, its southern origin, and the thick ears. In Uruguay, a local name employed is Amarillo Canario de Muchas Hileras.

Comparison to Previous Studies. Cateto Sulino Grosso appears to be similar to or identical with Cateto Conico mentioned briefly by Brieger *et al.* (1958).

Plants. The early flowering, short plants have a low ear height, a very low ear height/plant height index, and a small number of short, narrow leaves. The venation index is high.

Internode Pattern. (Fig. 39). Internode lengths increase up to the ear-bearing node, then decrease slightly and stabilize, the last one being the longest.

Tassels are of medium size except for a long peduncle and a correspondingly high peduncle covering index. There are fewer than average branches.

Ears. (Figs. 40 and 41). The ears, which frequently show fasciation, are short and thick with many rows. The race has a large pith diameter and long rachilla length (3.3 mm). The kernels are somewhat small with orange flint endosperm.

Distribution. The samples obtained came from the La Plata region in Uruguay. This race can probably also be found in the corresponding areas of Argentina.

Origin and Relationship. Cateto Sulino Grosso and Lenha share many common characteristics besides the high row number. The similarities in maturity, plant, tassel, and ear characters are striking. Perhaps the major difference is the long tassel peduncle of Cateto Sulino Grosso, a characteristic of the Cateto Sulino group. Furthermore, the two races occur in nearly the same geographic area. Based on these facts, the conclusion that both races have some degree of parentage in common is only natural. At present, however, no more details can be advanced regarding the origin of these types.

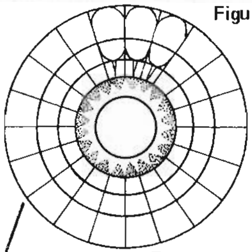


Figure 41.

Ear cross-section Cateto Sulino Grosso.

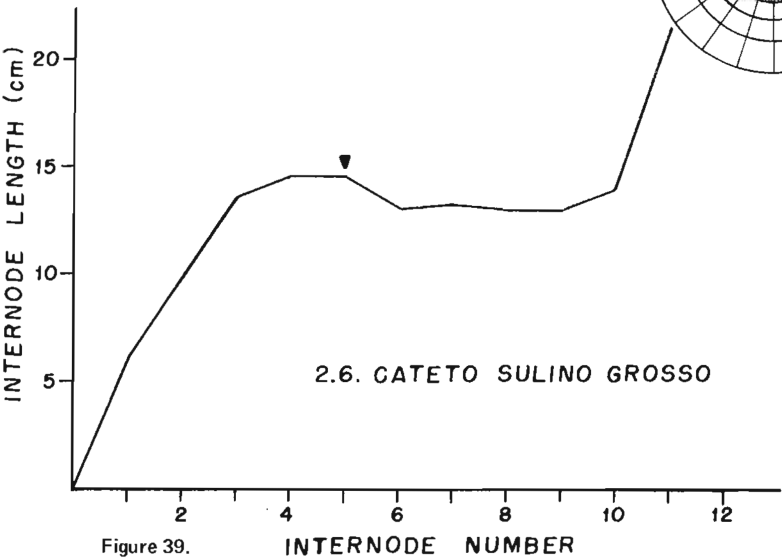


Figure 39.

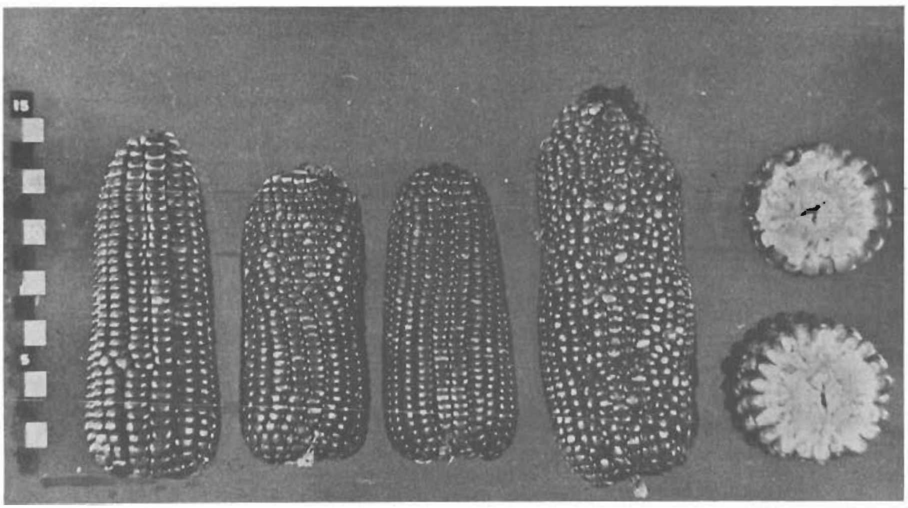


Figure 40. Cateto Sulino Grosso.

5.2.7. Cateto
5.2.7.1. Cateto Assis Brasil
5.2.7.2. Cateto Grande

Derivation of Name. Cateto is an old name of indigenous origin, but the meaning of the word is not known. As Brieger *et al.* (1958) pointed out, even the residence of the President of Brazil in Río de Janeiro has the name Catete. Before Mendes (1932), "Catete" was also the name generally used for this race of corn.

Brown (1960), who used the same name of Coastal Tropical Flint used by Cutler (1946) and Brown (1953), pointed out that it is synonymous with the Maíz Criollo of Cuba described by Hatheway (1957). Brown (1960, p. 22) referred to South American Cateto and agreed with Brieger *et al.* (1958) that this type "probably reached the West Indies from the lowlands of eastern South America."

Comparison to Previous Studies. Cateto has been described by Brieger *et al.* (1958), and their data for Cateto Fino and Cateto Grosso agree quite well with the present ones. Relatively small differences are found mainly in regard to somewhat greater development of the plants.

Plants have average maturity (flowering in 74.4 days) and average plant height with ears placed a little above the mid-plant height. There are many long, wide leaves.

Internode Pattern. (Fig. 42). Internode lengths increase up to just below the ear-bearing node, then decrease a little, the last one being the longest.

Tassels have average dimensions with a relatively high number of branches.

Ears. (Figs. 43 and 44). The ear is of average length, with a mean of 13.7 rows of kernels. The ear cross-section diameters are below average size. The rachilla length is 3.0 mm. The cob/rachis index is high. The flinty, dark orange kernels are below average in size.

Distribution. Cateto is assumed to have been grown by the Indians living on the Atlantic coast all the way from Argentina to the Guianas. It was the first important corn white farmers cultivated as they became established in that region. Thereafter Cateto spread to the interior where it can be found almost everywhere. Even after the appearance of the more productive dents in the last hundred years, Cateto remained very popular. In the state of Minas Gerais, where Cateto seems to have gained more acceptance, it has been found in a "purer" state. Since the recent development of superior semi-dent hybrids, Cateto is no longer grown on a large scale.

Origin and Relationship. Brieger (1949) suggested that tropical flints from the Caribbean region have been dispersed to several parts of the world, including the eastern coast of South America as far south as Argentina. More recently, however, Brieger *et al.* (1958) stated that Cateto probably originated in the southern coastal area from Brazil to Argentina. As pointed out by these authors, the Cateto group has attained a considerable degree of ecological adaptation to specific areas, which suggests it originated in ancient times. Dictionary listings of "Abaxi Cateite" or "Catete" date back to the 18th century [Pinto (1873, p. 318), Ayrosa (1934, p. 122)]. Cateto is one of the more widespread corns in South America, and it must have influenced several other races. As to the details of its origin, it again seems difficult to draw definite conclusions.

Roberts *et al.* (1957) suggest a natural relationship of the Colombian race Costeño to the Catetos of Brazil, Uruguay, and Argentina. They also pointed out that another Colombian race, Pira Naranja, has many ear characteristics similar to Cateto. Grant *et al.* (1963, p. 56) state that the Venezuelan race Cuba Yellow Flint, "may represent modern introductions (either from Cuba or Brazil) or they could be relicts of orange Cateto flints that may have extended into Venezuela in pre-Columbian times." Rodríguez *et al.* (1968) suggest that the highland flint complex (Morocho) of Bolivia is ancestral to the Catetos and Coastal Tropical Flints.

Cateto with all its sub-races and closely related races may represent the most widespread of all racial groups, since it goes from Argentina all the way to Central America and the West Indies. It "was one of the more prevalent varieties of maize in southeastern United States prior to the introduction of hybrid corn" (Brown, 1960, p. 22), and it is quite certain it was introduced into Europe soon after the discovery (Finan, 1948). Cutler (1946, p. 280), who named the race "Coastal Tropical Flint," made a brief description of Brazilian Cateto and stated that it "belongs to the race of tropical flints described by Anderson and Cutler (1942)."

Several varieties, often with local names, are known in many parts of Brazil. For a corn race of such widespread acceptance, this is only natural. The names of most of these varieties refer to size of the kernels, to the anthocyanin coloration in the husks, or to the degree of maturity.

Value for Improvement. Cateto is the only native Brazilian race that has been extensively employed in local hybrid corn programs. Except for southern Brazil, most of the available maize hybrids are of the semi-dent type and result from crosses between two Cateto and two Tuxpeño inbreds. Cateto is not a high yielding material, since it yields about 25 percent less than the double crosses H6999 and Ag 17 (Table 8), but it exhibits high combining ability when crossed with many races. Among a group of interracial crosses, Cateto showed more than 140 percent heterosis relative to the mid-parent mean in crosses to Dente Paulista, Carmen (a Tuxpeño variety), Vandeño, Lenha, Tabloncillo, Zapalote Grande, and Chapalote. Except for the crosses to Canario de Ocho, Chapalote, and Zapalote Grande, all crosses with Cateto showed higher values than the average F_1's (Paterniani, 1961a). In another series of crosses (Table 9), Cateto exhibited high heterosis values (when calculated as percent of the mid-parent mean) in crosses to Piracar (a synthetic variety made up of orange flint lines of Guatemalan origin) and Dente Rio Grandense.

(Continued on page 45)

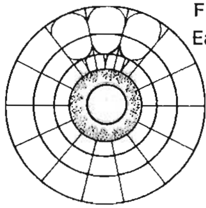


Figure 44.
Ear cross-section Cateto.

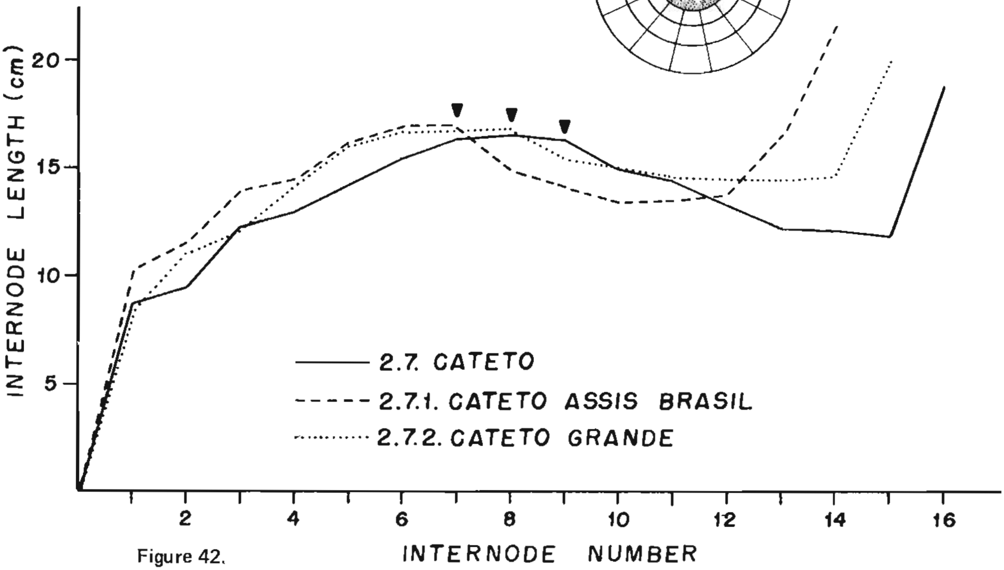


Figure 42.

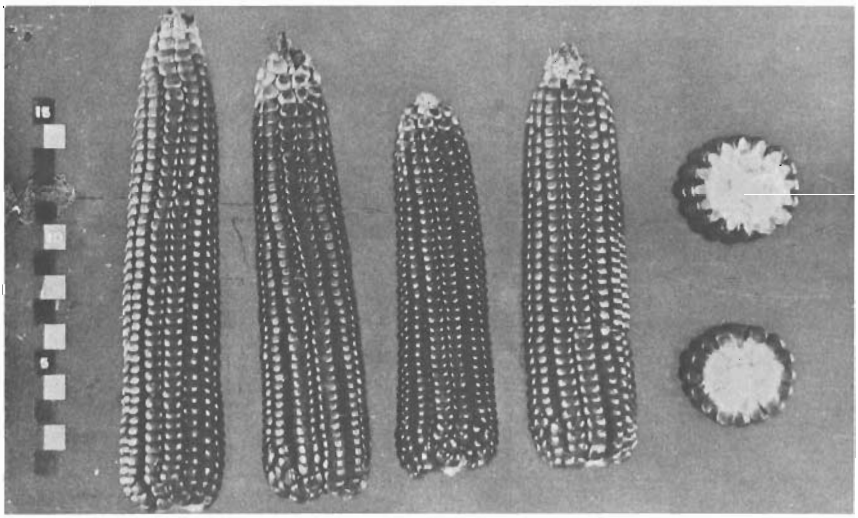


Figure 43. Cateto.

(Concluded from page 43)

High actual yields were obtained from the cross with Piracar.

Cateto seems to be somewhat more tolerant to drought than the more productive dents grown locally. Besides this advantage, Cateto has a high frequency of the fertility restorer gene Rf_1, which made it excellent to restore the fertility of Texas male sterile cytoplasm prior to the 1970 blight epidemic. Among 25 random plants of Cateto, Drummond (1963) found 10 plants homozygous for the restorer gene, 14 heterozygous, and only one without the restorer gene. The experience of Brazilian corn breeders indicates that it is quite easy to obtain Tuxpeño inbreds with perfect male sterility and Cateto inbreds for good restoration. This greatly simplified the work involved in local hybrid corn production.

Cateto has also been subjected to recurrent selection for general combining ability. Although it displayed limited variability, reasonable progress was obtained after one cycle (Paterniani, unpublished).

5.2.7.1. Sub-race Cateto Assis Brasil (Figs. 42, 45, and 46)

This sub-race is found in the state of Rio Grande do Sul and is believed to be the result of hybridization of Cateto with Canario de Ocho. It has fewer rows and larger kernels than Cateto. The plants are earlier and shorter, which probably is primarily the result of its adaptation to the southern part of Brazil. Its yielding ability is similar to Cateto or slightly higher (Table 8). It is essentially identical to Charua of Brieger *et al.* (1958).

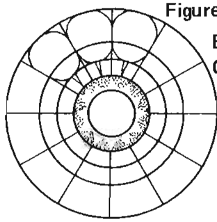


Figure 46. Ear cross-section Cateto Assis Brasil.

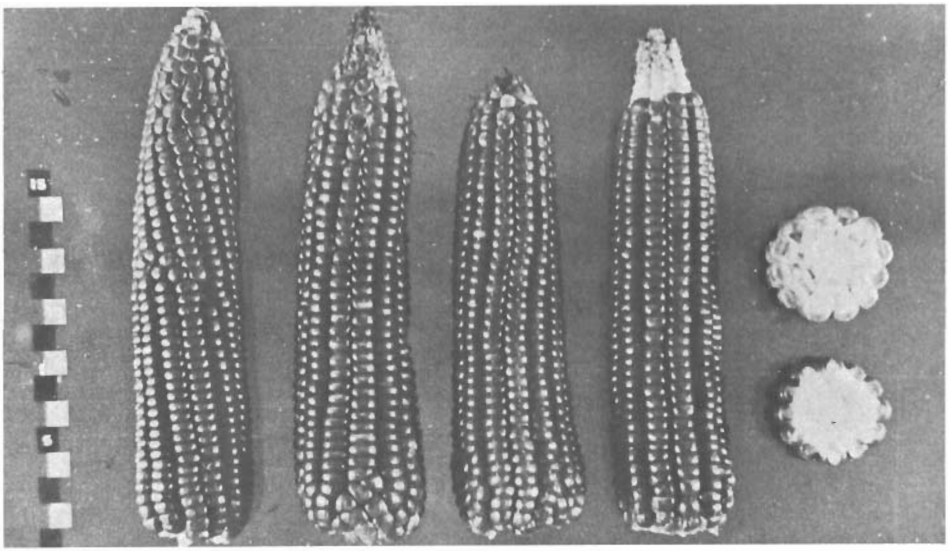


Figure 45. Cateto Assis Brasil.

5.2.7.2. Sub-race Cateto Grande (Figs. 42, 47, and 48)

Occasionally a Cateto with larger kernels is found. It is very similar to Cateto Assis Brasil except for being a little later and having fewer rows and wider kernels. It may well be a selection from Cateto Assis Brasil, but was not described in Brieger *et al.* (1958).

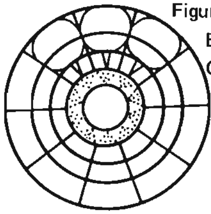


Figure 48. Ear cross-section Cateto Grande.

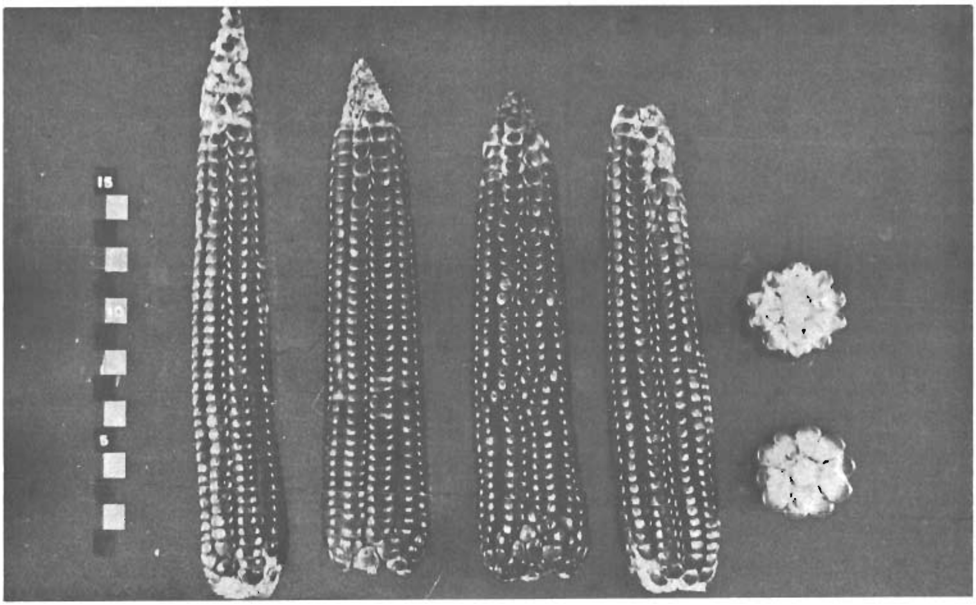


Figure 47. Cateto Grande.

5.2.8. Cateto Nortista

5.2.8.1. Cateto Nortista Precoce

Derivation of Name. Due to its similarity to Cateto, it is called Cateto Nortista here to indicate the place where it was collected.

Comparison to Previous Studies. The two samples of Northern Cateto Flints from the Guianas described by Brieger *et al.* (1958) share similar characteristics with the maize described here, except that the tassels studied in this case have longer peduncles, more branching space, longer central spikes, and fewer branches. Ear characters are also similar. The similarities between the characters of Cuban Criollo (Hatheway, 1957) and the present data for Cateto Nortista are remarkable. Ear characteristics reported for Coastal Tropical Flint by Brown (1953) also show similarities to the corresponding data presented herein.

Plants. The late flowering, tall plants have a relatively high ear height and a high ear height/plant height index. There are many long, broad leaves.

Internode Pattern. (Fig. 49). Internodes increase up to two internodes below the ear, then decrease, the last one being the longest, however.

Tassels have average dimensions, except for a relatively short central spike. There are many branches.

Ears. (Figs. 50 and 51). The rather short, thick, usually tapering ears have a high row number. The pith diameter is large and the rachilla length is very long (3.7 mm). The indices and kernels are average in size. Kernels have yellow or orange endosperm color of the flint type. Frequently, however, the kernels are of the semi-dent type. Reddish and medium-red pericarp color are also found.

Distribution. This race is found in the Guianas.

Origin and Relationship. It is quite certain that this race is a representative of the Coastal Tropical Flints (Brown, 1953) and probably is also related to the Cuban corn Criollo [described by Hatheway (1957)] to which most of its characters are quite similar.

Value for Improvement. The material first tested in Piracicaba, S.P. showed a low yielding ability; about 36 percent less than the double crosses H6999 and Ag 17 (Table 8). However, since there is great variability among the different collections, after a few generations of selection, the population of Cateto Nortista obtained appeared to have improved greatly.

5.2.8.1. **Sub-race Cateto Nortista Precoce** (Figs. 49, 52, and 53)

This is similar to Cateto Nortista in many respects. The differences are earlier flowering, slightly shorter plants, much lower ear height, and shorter leaves. Most of the tassel characteristics (except for a longer peduncle) are similar. Except for fewer rows and smaller ear diameters, the ears are also similar.

5.2.8. Cateto Nortista

5.2.8.1. Cateto Nortista Precoce

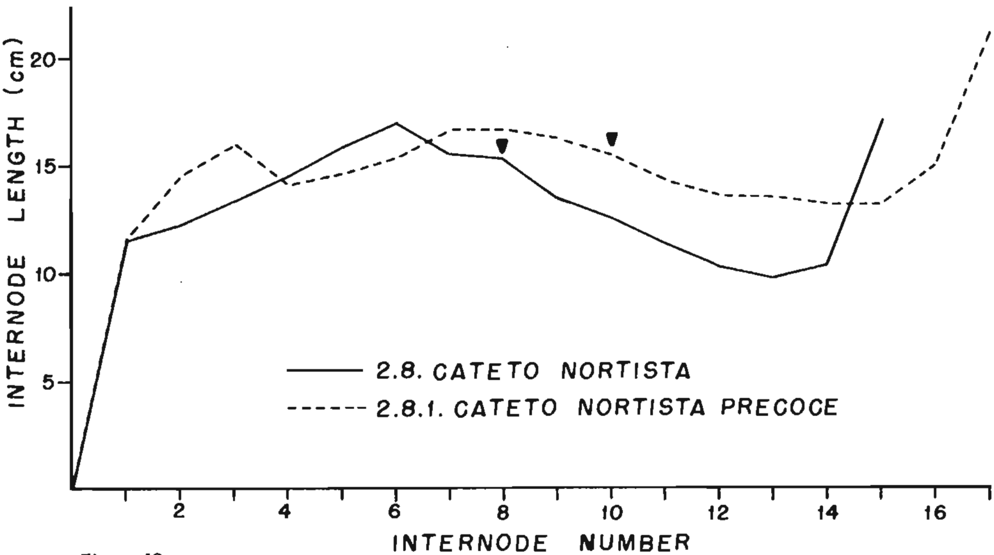


Figure 49.

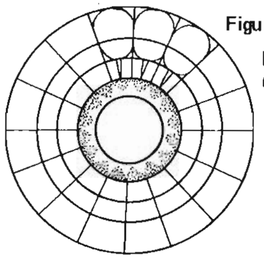


Figure 51.
Ear cross-section Cateto Nortista.

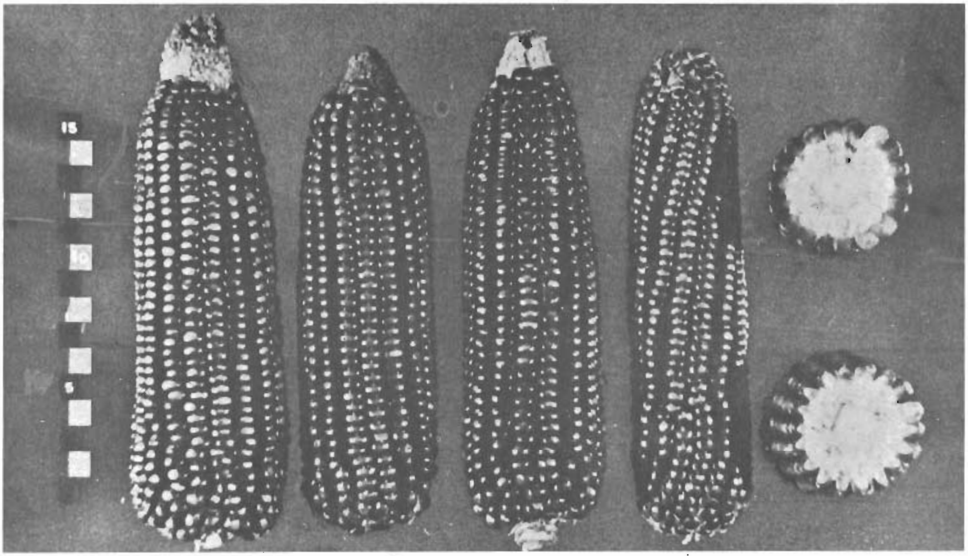


Figure 50. Cateto Nortista.

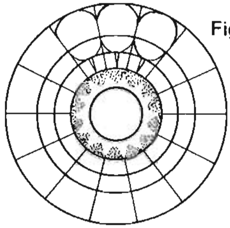


Figure 53.
Ear cross-section
Cateto Nortista Precoce.

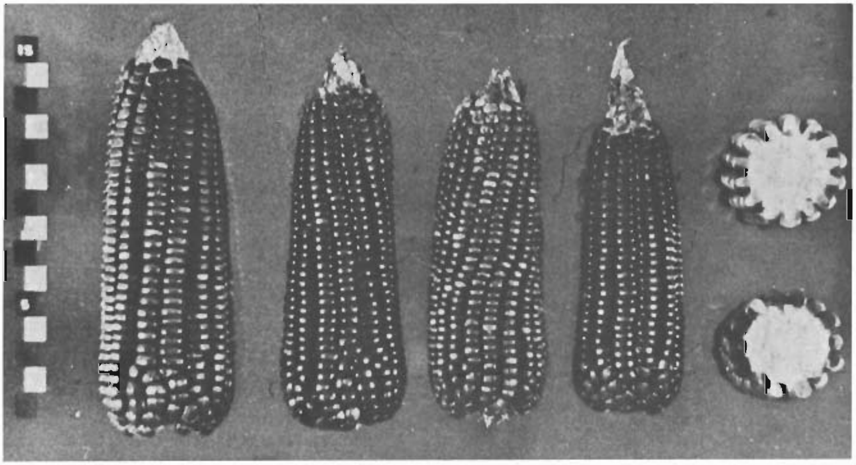


Figure 52. Cateto Nortista Precoce.

5.3. Recent Commercial Races

These are modern races of maize established or developed in the area quite recently. None is probably more than one hundred years old. All are dent types, although some are semi-dent. Most of the dents from Rio Grande do Sul, the southernmost state of Brazil, are "purer" dents, showing little or no introgression from flint types. Dents from São Paulo and nearby states show a great amount of introgression from Cateto.

Dent corns (with the exception of the floury Caingang) are not native to this area. They were introduced in the last hundred years, probably mostly from the United States. After their introduction, the dents and varieties derived from them gained general acceptance due to their high yields in relation to the local Cateto.

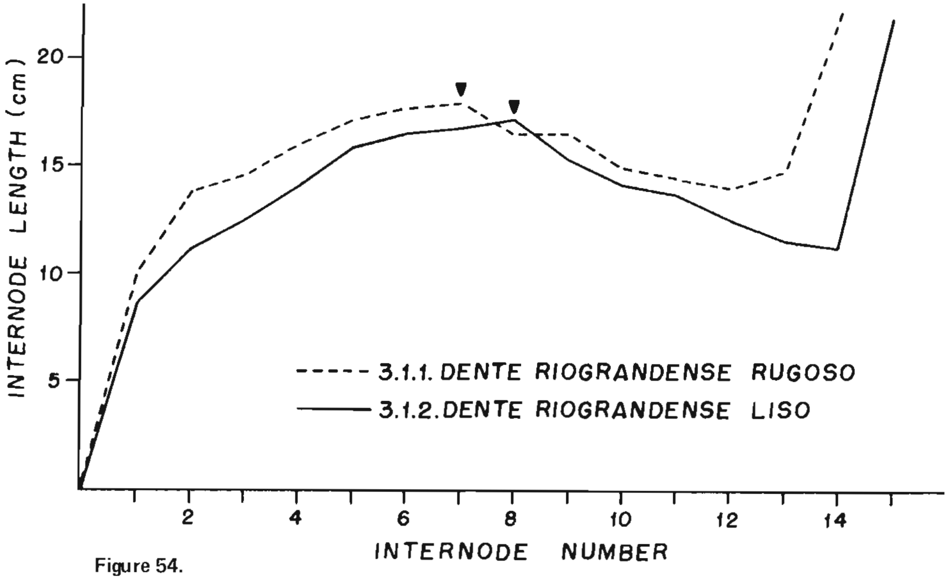


Figure 54.

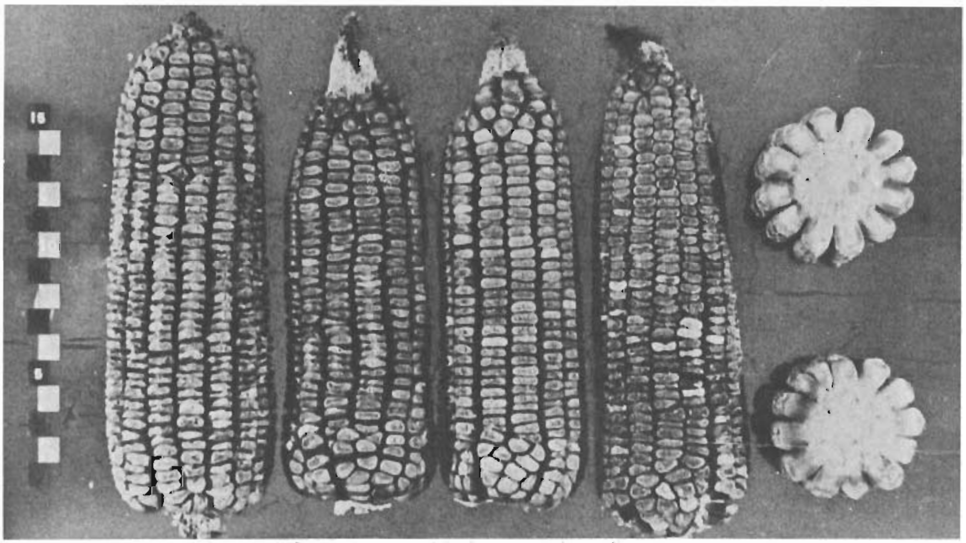


Figure 55. Dente Riograndense Rugoso.

5.3.1. Dente Riograndense

5.3.1.1. Dente Riograndense Rugoso
5.3.1.2. Dente Riograndense Liso

Derivation of Name. Since there is no established and generally accepted name (although many local names exist), it is proposed to call this race "Dente Riograndense", to indicate its kernel type and its region of adaptation.

Comparison to Previous Studies. This material is identical to Rio Grande Cateto - Dent of Brieger *et al.* (1958).

Plants are medium to early flowering with medium height and rather low ear heights. The race has an average number of long, broad leaves.

Internode Pattern. (Fig. 54). Internodes increase up to the ear-bearing node, then decrease, the last one being the longest.

Tassels are medium to large with many branches.

Ears. (Fig. 55, 56, 57 and 58) are rather large, with an average of 14 rows. The rachilla length is long (3.3 mm), but the kernel covering index is low. Kernels are long and wide. The soft, dented endosperm is yellow.

Distribution. This race is found throughout the states of Rio Grande do Sul and Santa Catarina.

Origin and Relationship. As already mentioned by Brieger *et al.* (1958), this race originated as a result of the many introductions of dent corns from the United States during the last 100 years.

Many samples of Dente Riograndense (especially the Rugoso type), which is yellow, look quite identical to the white ears of Gourdseed and Shoepeg shown by Brown and Anderson (1948). Some references in the Brazilian literature mention introduction from the United States of such dent corn varieties as Golden Dent (introduced in 1913 from Georgia) and Hasting's Prolific (Hunnicutt, 1933). Mendes (1930) refers to the introduction of Golden Dent and Golden Mine.

It is interesting to note that in southern Brazil the dent varieties seem to have been maintained without much introgression from local endemic races. Whether this is true, or whether intensive selection for the dent character has eliminated the effects of any flint introgression, is not known. As pointed out by Brieger *et al.* (1958), farmers of the southern states are predominantly of North European origin, and they seem to have paid more attention to the purity of their varieties than did those of the more central states such as São Paulo.

Sub-races

5.3.1.1. Dente Riograndense Rugoso

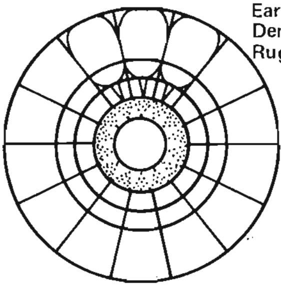
5.3.1.2. Dente Riograndense Liso

Two sub-races can be recognized, differing mainly in the general aspect of the kernels. One of these has rough kernels and is called Dente Riograndense Rugoso (Fig. 55); the other has smooth kernels and is called Dente Riograndense Liso (Fig. 57). These two types are not homogeneous, since both types may present a certain amount of mixture with the other.

Value for Improvement. Dente Riograndense is a good yielding corn, producing large dent kernels of good quality. Its yielding ability is about 20 percent less than the double crosses H6999 and Ag 17 (Table 8). Probably its main weakness is its lodging susceptibility. However, the race possesses sufficient genetic variability for improvement through selection for both yielding ability and for the other necessary agronomic characteristics. Selection among and within half-sib families has been conducted in Dente Riograndense and progress was made with respect to yielding ability [Paterniani (unpublished)].

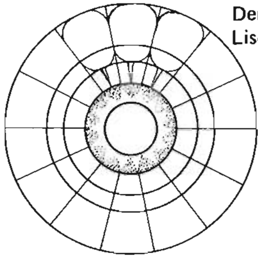
Among a series of diallel crosses (Table 9), Dente Riograndense exhibited considerable heterosis (measured in percent of mid-parent mean) in crosses to Piramex (Tuxpeño germ plasm), Cateto, Piracar (a synthetic variety made up of orange flint lines of Guatemalan origin), and Cristal. Very high yields were obtained when crossed to Piramex. It is interesting to note that this yielding ability persisted into the F_2 generation.

Figure 56.



Ear cross-section
Dente Riograndense
Rugoso.

Figure 58.



Ear cross-section
Dente Riograndense
Liso.

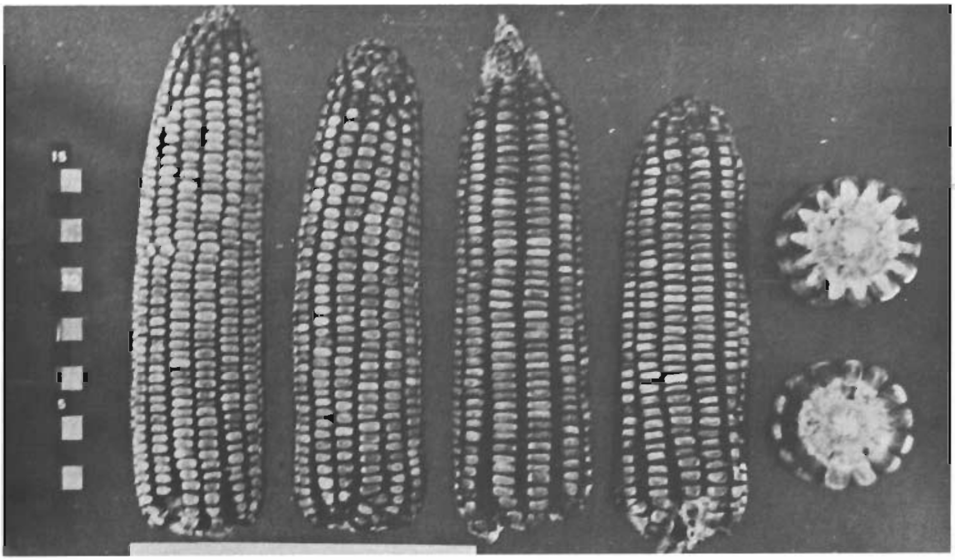


Figure 57. Dente Riograndense Liso.

5.3.2. Dente Paulista

Derivation of Name. Many local names are employed by farmers to characterize one or several varieties of this race. Some of them are Comun, Dente de Cavalo, Armour, Itaici, Caiano, etc. Since all belong to the same group, it is considered that Dente Paulista, a name that has frequently been employed in the technical literature, is an appropriate name for the whole group.

Comparison to Previous Studies. The Paulista Cateto-Dent synthetic of Brieger *et al.* (1958) is identical to Dente Paulista.

Plants. The medium-to-tall plants with relatively high ears and many long, broad leaves are of average maturity.

Internode Pattern. (Fig. 59). Internode lengths increase up to one internode below the ear, then decrease, the last one being the longest, however.

Tassels are rather large with many branches.

Ears. (Figs. 60 and 61). The large ears (14.4 rows of kernels) have relatively large ear cross-section diameters. The rachilla length is 3.5 mm. The indices are of average size. The long kernels are dent to semi-dent type with yellow endosperm. Some less typical samples may have some white kernels.

Distribution. This race is found throughout the states of São Paulo and in some of the neighboring states, mainly Minas Gerais and Paraná.

Origin and Relationship. Dente Paulista undoubtedly originated from natural crosses of dents from the United States, introduced mostly in the last 100 years, with the local Cateto (Brieger *et al.*, 1958). Introduction of U.S. dents to Brazil probably occurred most intensely on two occasions: first around 1860-65 during the American Civil War, when many North Americans settled permanently in Brazil; second, around 1910-1915, when a corn enthusiast, the Secretary of Agriculture of the State of Minas Gerais, Benjamin Hunnicutt, organized the so-called corn shows and introduced North American varieties. To improve varieties and obtain ears with "better appearance", many farmers also obtained North American varieties.

Value for Improvement. Dente Paulista is a highly variable race, perhaps the most variable of all the commercial races described here. The sample used for the yield trials reported in Table 8 was not outstanding, since its yielding ability was similar to that of Cateto. Due to its great variability, its greater yielding ability than the local Cateto, and its widespread acceptance by local farmers, it was decided to carry out a breeding program using this material. A survey of 300 original collections showed great variability and substantial potential for breeding. The yields varied from as low as 1,500 kg/ha to 5,000 hg/ha with an average of 3,440 kg/ha (Paterniani, 1961b). The best samples were utilized in a recurrent selection program for general combining ability. About 30 percent improvement was obtained after one cycle of five years (Paterniani, 1964). Recently the material has been improved using selection among and within half-sib families, with a remarkable improvement of about 13.6 percent per one-year cycle during four cycles (Paterniani, 1967). Dente Paulista had poor standability, but it has been possible to improve its lodging resistance.

Dente Paulista had high heterosis values (above 120 percent relative to the mid-parent mean) in crosses to Cristal, Cateto, Vandeño, Lenha, Zapalote Grande, and Chapalote. High actual yields were obtained in crosses to Morotí, Caingang, Cristal, Carmen (Tuxpeño germ plasm), Cateto, and Vandeño (Paterniani, 1961a). In another set of crosses (Table 9), Dente Paulista gave substantial heterosis in combination with Piracar (Guatemalan flint germ plasm) and Cristal. High yields were obtained in crosses with Piramex (Tuxpeño germ plasm) and Piricar.

Based on the available information, it is evident that Dente Paulista has a great reserve of genetic variability. It seems that the best approach to fully utilize this material for improvement would be first to carry out an extensive, simple selection program, like mass selection, to increase the frequency of the favorable genes. Thereafter, other more precise schemes could be used. There is little doubt that the resulting improved population would be of great value in a practical breeding program. This system would be desirable for many races, but for Dente Paulista it is especially promising.

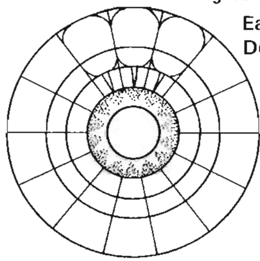


Figure 61.
Ear cross-section
Dente Paulista.

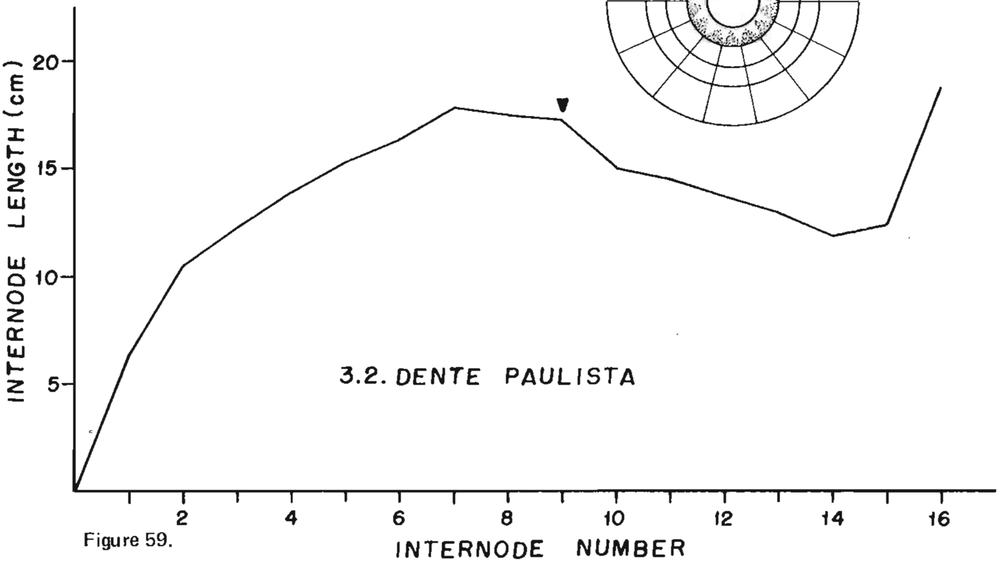


Figure 59.

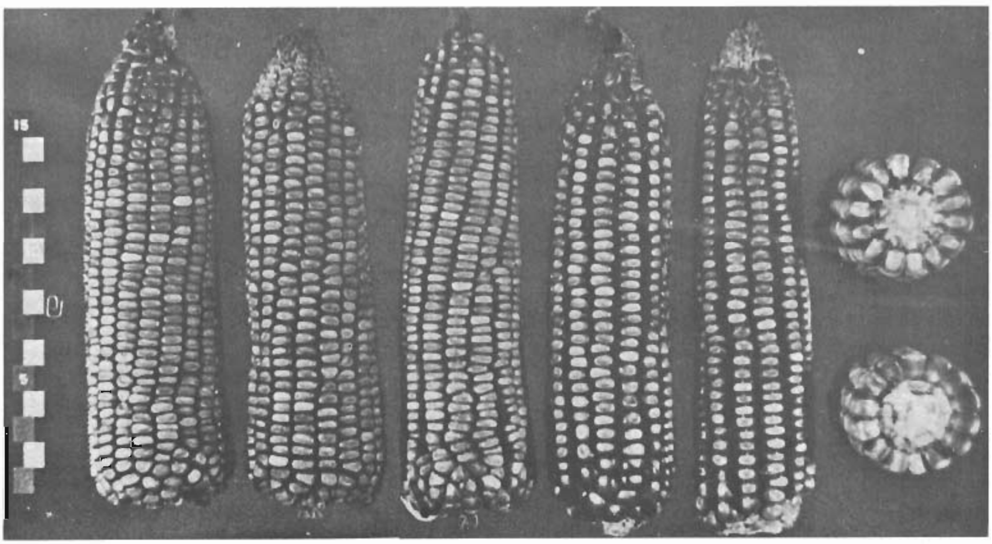


Figure 60. Dente Paulista.

5.3.3. Dente Branco

5.3.3.1. Dente Branco Riograndense
5.3.3.2. Dente Branco Paulista

Derivation of Name. Since no widely used local names are available, the descriptive names "Dente Branco Riograndense" and "Dente Branco Paulista" are hereby proposed.

Comparison to Previous Studies. Dente Branco has not been described previously.

5.3.3.1. Dente Branco Riograndense

Plants. The relatively early flowering, medium to short plants have relatively low ear heights and long wide leaves.

Internode Pattern. (Fig. 62). Internodes increase up to the ear-bearing node, then decrease slightly, the last one being the longest, however.

Tassels have average to large dimensions and an average number of branches.

Ears (Figs. 63 and 64) are rather large with long, white, dented kernels.

5.3.3.2. Dente Branco Paulista

Plants. The rather tall plants have relatively high ear heights, late maturity, and many long, wide leaves.

Internode Pattern. (Fig. 62). Internodes increase up to the ear-bearing node, then decrease slightly, the last one being the longest, however.

Tassels have average to large dimensions with a high number of branches.

Ears. (Figs. 65 and 66). The many rowed ears are rather long, with correspondingly large cross-section diameters. The large kernels have white, dented endosperm.

Distribution. Dente Branco Riograndense is found in the states of Rio Grande do Sul and Santa Catarina, although it is not grown so extensively as its yellow counterpart, Dente Riograndense.

Dente Branco Paulista is also grown on a very limited scale in São Paulo and the neighboring states of Paraná and Minas Gerais.

Origin and Relationship. Dente Branco is treated as a separate race, although the collections from Rio Grande do Sul and from São Paulo have many similarities to Dente Riograndense and Dente Paulista, respectively. This distinction is made because presumably a different germ plasm entered into this group. Dente Branco must also have been introduced from the United States. Apparently both the types from Rio Grande do Sul and from São Paulo have a similar origin. Dente Branco does not show as much evidence of introgression from Cateto as does Dente Paulista. It is probable that some white dents introduced from the United States in the last 100 years have been maintained locally with little introgression from native corns. Some differences (mainly in plant characters) between Dente Branco Riograndense and Dente Branco Paulista must be due to selection for adaptation.

Value for Improvement. Dente Branco Riograndense is similar to Dente Riograndense, but Dente Branco Paulista is more uniform and higher yielding than Dente Paulista (Table 8).

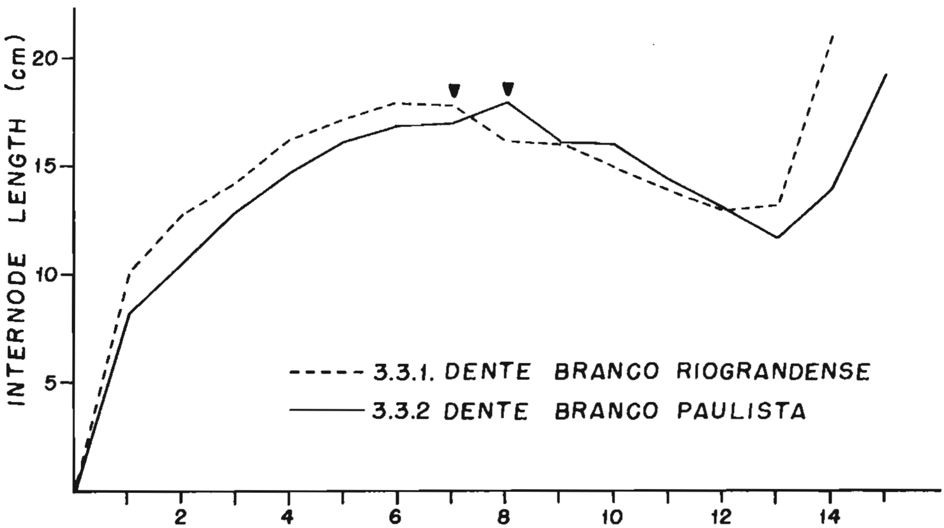

INTERNODE LENGTH (cm)
20
15
10
5
3.3.1. DENTE BRANCO RIOGRANDENSE
3.3.2 DENTE BRANCO PAULISTA
2
4
6
8
10
12
14
INTERNODE NUMBER

Figure 62.

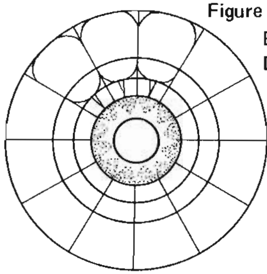


Figure 64.
Ear cross-section
Dente Branco Riograndense.

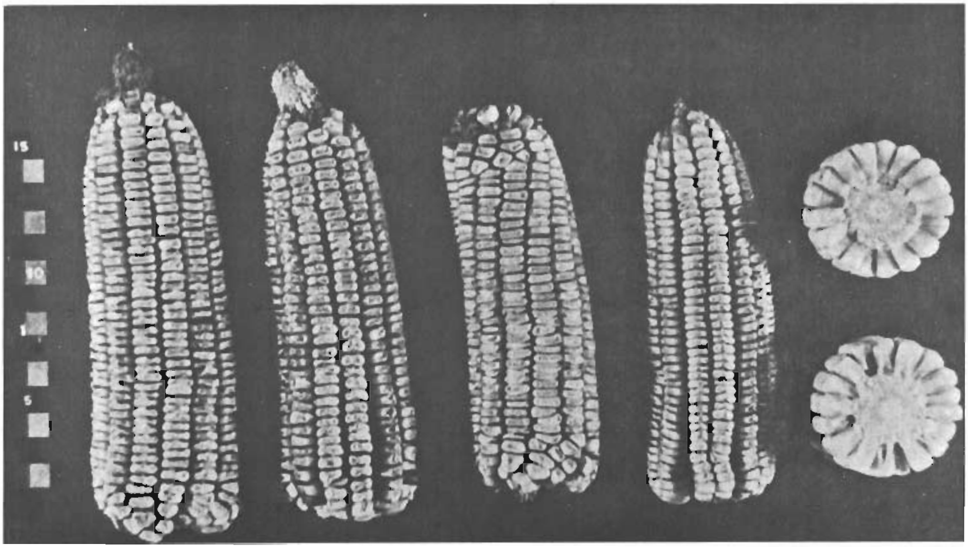


Figure 63. Dente Branco Riograndense.

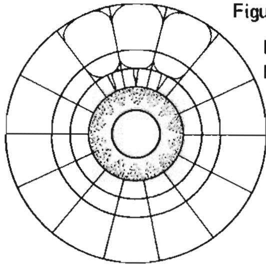


Figure 66.

Ear cross-section
Dente Branco Paulista.

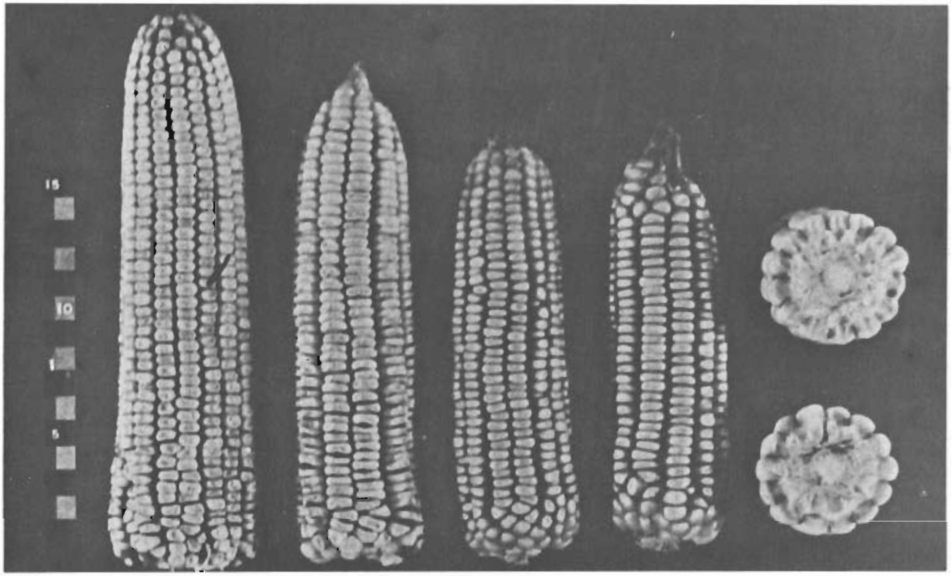


Figure 65. Dente Branco Paulista.

5.3.4. Semi-Dentado

5.3.4.1. Semi-Dentado Riograndense
5.3.4.2. Semi-Dentado Paulista

Derivation of Name. Semi-Dentado Riograndense and Semi-Dentado Paulista are presented simply as descriptive names.

Comparison to Previous Studies. Semi-Dentado has not been described previously.

Plants have average maturity and average plant and ear height with many long, wide leaves.

Internode Pattern. (Fig. 67). Internode lengths increase up to the ear bearing node, decrease slightly, the last one being the longest, however.

Tassels. The large tassels have many branches.

Ears. (Figs. 68, 69, 70 and 71). The rather large ears have an average number of rows of medium sized kernels. The kernels have orange-yellow endosperm color and are of the semi-dent type.

Distribution. Semi-Dentado Riograndense is found in the states of Rio Grande do Sul and Santa Catarina. Semi-Dentado Paulista is grown in São Paulo and the neighboring states of Paraná and Minas Gerais.

Origin and Relationship. Semi-Dentado is clearly a modern type of corn. Most of the samples are probably advanced generations of the semi-dent commercial hybrids distributed by official and private institutions. It can be seen that no great difference exists in plant characters between Semi-Dentado Riograndense and Semi-Dentado Paulista, which suggests a common and recent origin. On the other hand the differences that exist are for earlier and shorter plants in Semi-Dentado Riograndense, suggesting that some selection for adaptation has occurred in the generations available.

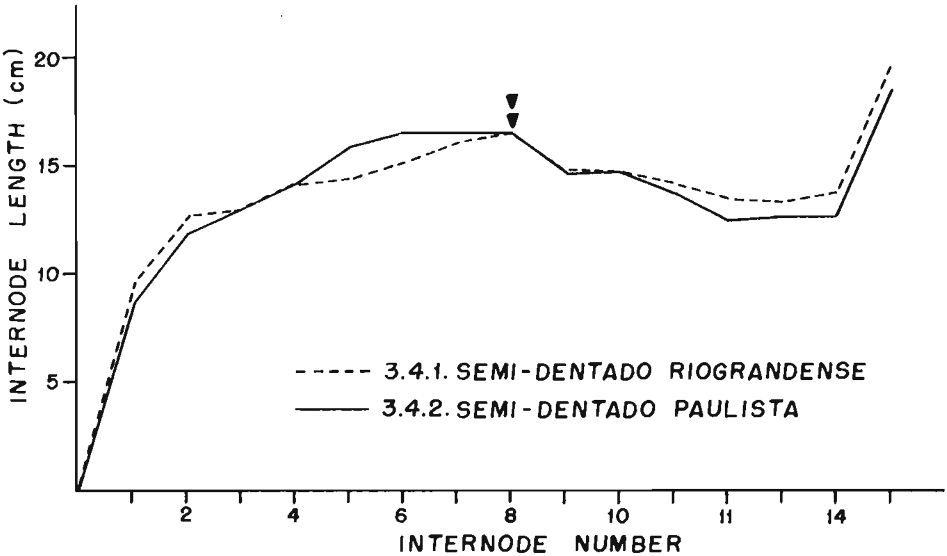
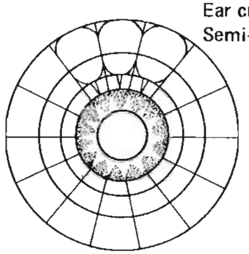

INTERNODE LENGTH (cm)
20
15
10
5
3.4.1. SEMI-DENTADO RIOGRANDENSE
3.4.2. SEMI-DENTADO PAULISTA
2
4
6
8
10
11
14
INTERNODE NUMBER

Figure 67.

Figure 69.

Ear cross-section
Semi-Dentado Riograndense.



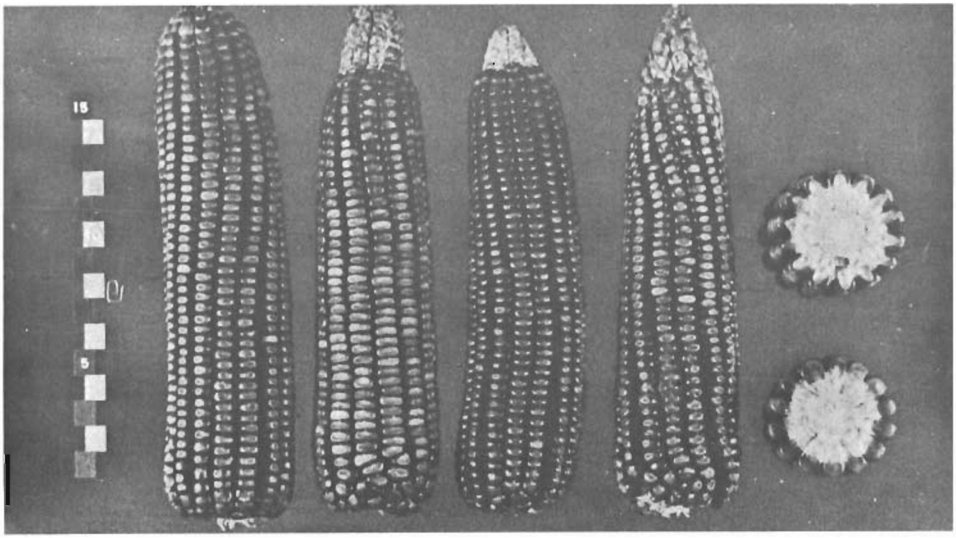


Figure 68. Semi-Dentado Riograndense.

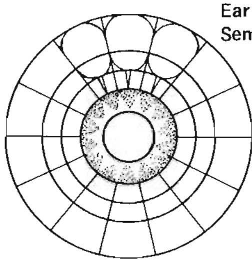


Figure 71.
Ear cross-section
Semi-Dentado Paulista.

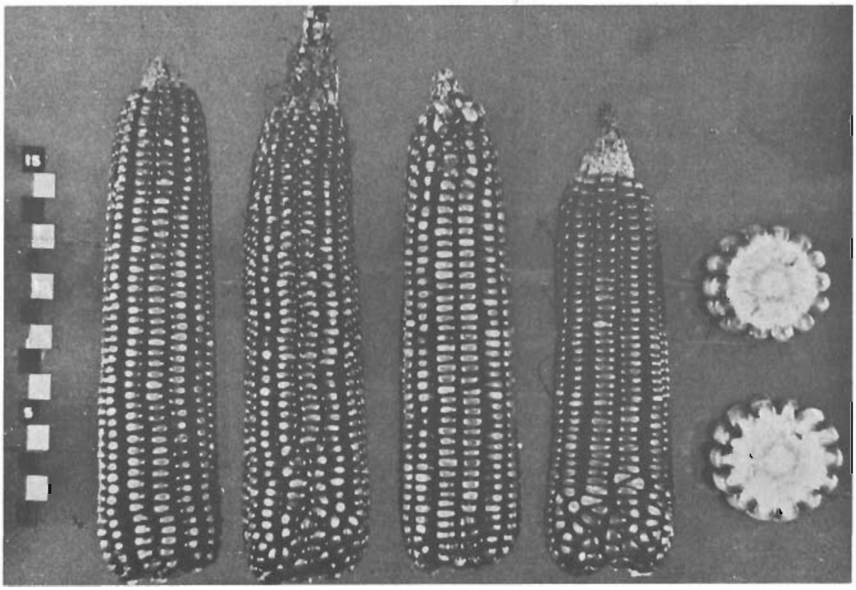


Figure 70. Semi-Dentado Paulista.

5.3.5. Cravo

5.3.5.1. Cravo Riograndense
5.3.5.2. Cravo Paulista

Derivation of Name. Cravo [meaning nail (because of the long and narrow kernels)] is the usual name for this corn. Riograndense and Paulista simply refer to the place of collection.

Comparison to Previous Studies. Cravo has not been described previously.

Plants. The early to medium flowering plants have medium plant height and low to medium ear height with many long, wide leaves.

Internode Pattern. (Fig. 72). Internode lengths increase up to or just below the ear, then decrease a little, the last one being the longest, however.

Tassels are generally of average dimensions with a relatively short branching space and a rather low number of branches.

Ears. (Figs. 73, 74, 75 and 76). The short, thick, many-rowed ears, with correspondingly large ear cross-section diameters, are frequently fasciated. The very long, narrow kernels have very dented yellow endosperm.

Distribution. Cravo was found in the states of São Paulo and Rio Grande do Sul. It is not a commercially important type of corn, and it has not been cultivated extensively. Its presence is due to a few farmers that have maintained this race as a matter of personal preference.

Origin and Relationship. Cravo is a very peculiar corn, characterized mainly by its long, narrow kernels and high row number. The race obviously has also been introduced, probably from the United States in the last 100 years. It is not known from which type it originated, but it most closely resembles types similar to Gourdseed or Shoepeg [described by Brown and Anderson (1948)]. A major difference may be the relatively simpler tassels of Cravo.

Two sub-races are recognized, Cravo Riograndense (Fig. 73) and Cravo Paulista (Fig. 75), with the only notable differences being plant characters relating mainly to adaptation to the two different regions. Cravo Riograndense has shorter plants with lower ear heights.

Value for Improvement. Cravo has limited value for improvement mainly due to its particular type of grain. Its yielding ability is about 25 percent less than the double crosses H6999 and Ag 17 (Table 8).

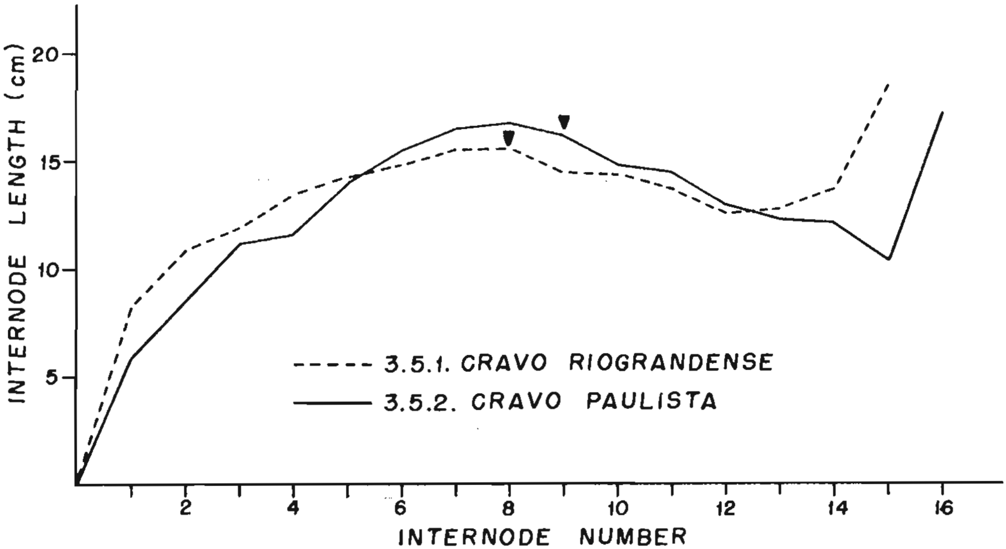

INTERNODE LENGTH (cm)
20
15
10
5
2
4
6
8
10
12
14
16
INTERNODE NUMBER
3.5.1. CRAVO RIOGRANDENSE
3.5.2. CRAVO PAULISTA

Figure 72.

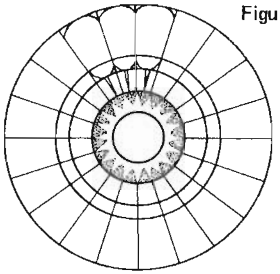


Figure 74.

Ear cross-section Cravo Riograndense.

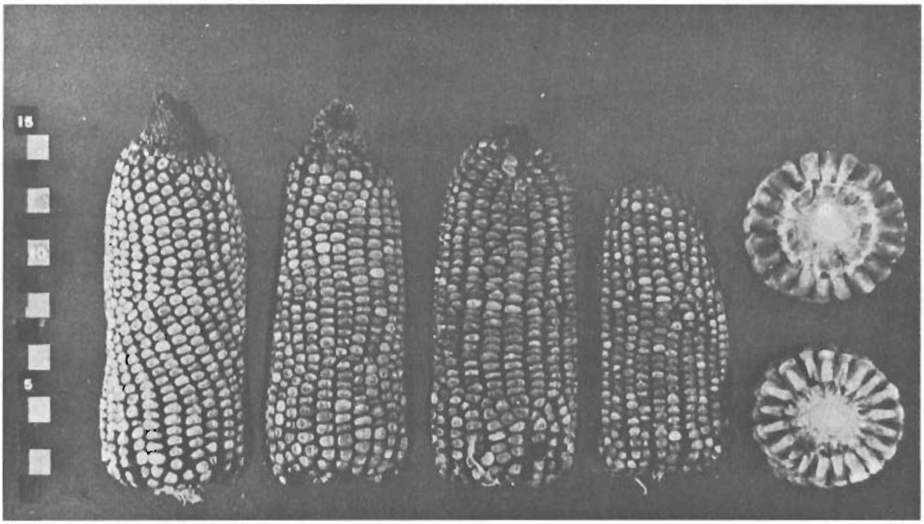


Figure 73. Cravo Riograndense.

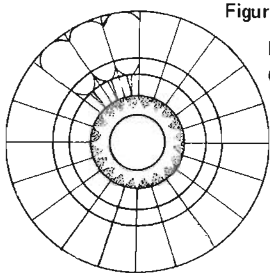


Figure 76.

Ear cross-section Cravo Paulista.

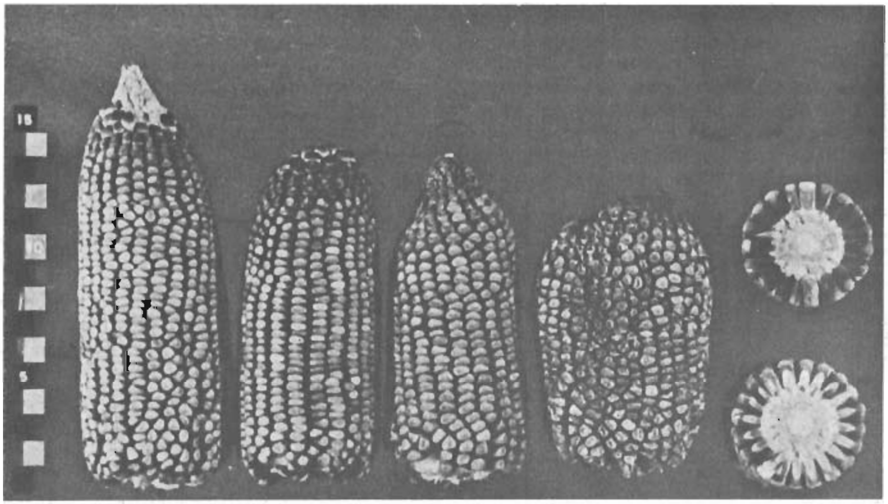


Figure 75. Cravo Paulista.

5.4. Exotic Commercial Races

Exotic commercials are races identical to known foreign races and probably introduced in modern times. Of the two described races, Hickory King may have been grown for many years, while Tusón, found in the state of Bahia, was released by local experiment stations only several years ago.

Other exotic germ plasms have become popular recently. Most of these are synthetic varieties developed and released by official institutions. Some synthetic varieties of Tuxpeño germ plasm such as Asteca and Maia, developed by the Instituto Agronomico de Campinas, and Piramex, developed by the Instituto de Genética of the Escola Superior de Agricultura "Luiz de Queiroz", are becoming popular. Perola Piracicaba, developed by the latter Institute, resulted from the combination of Cateto germ plasm with that of flints from Colombia. More recently in the Instituto de Genética, Centralmex was developed from the combination of Piramex and corns from Central America. This new variety is rapidly gaining wide acceptance. Germ plasms from Colombia are also being utilized as such and in crosses like the intervarietal hybrid Eto x Centralmex.

Notes

5.4.1. Hickory King

Derivation of Name. The U.S. name is used locally, and thus should be maintained.

Comparison to Previous Studies. Unquestionably this is the same race described by Brown and Anderson (1948) as one of the Southern Dents. Hickory King certainly has been introduced into Brazil several times. Some references are available indicating introduction in 1925 (Mendes, 1930), but certainly other introductions have also occurred.

Plants. The early flowering, short plants have low ear heights. There is an average number of rather long, wide leaves.

Internode Pattern. (Fig. 77). Internode lengths increase up to the ear-bearing node, then decrease a little, the last one being the longest.

Tassels are large, with a long peduncle, a long central spike, and few branches.

Ears (Figs. 78 and 79) are long, usually with eight rows of large, nearly square kernels. The cob/rachis index is high and the white endosperm is of dent type.

Distribution. This race is found occasionally in the states of Rio Grande do Sul, Santa Catarina, and, more rarely, in the North.

Origin and Relationship. According to Brown and Anderson (1948), Hickory King is one of the older varieties of the Southern Dents and was derived from the Mexican race Tabloncillo.

Value for Improvement. This is a low yielding race, yielding about 40 percent less than the double crosses H6999 and Ag 17 (Table 8).

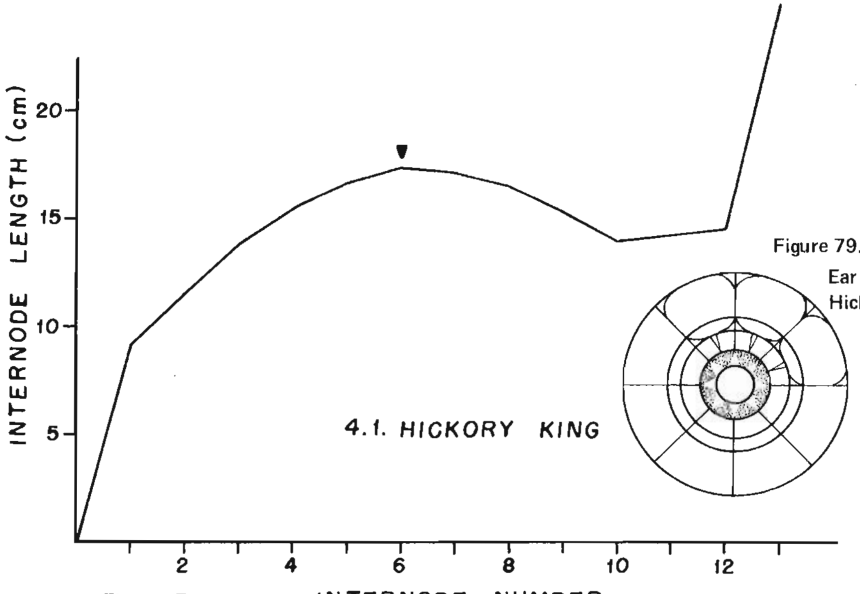


Figure 77.

Figure 79.

Ear cross-section Hickory King.

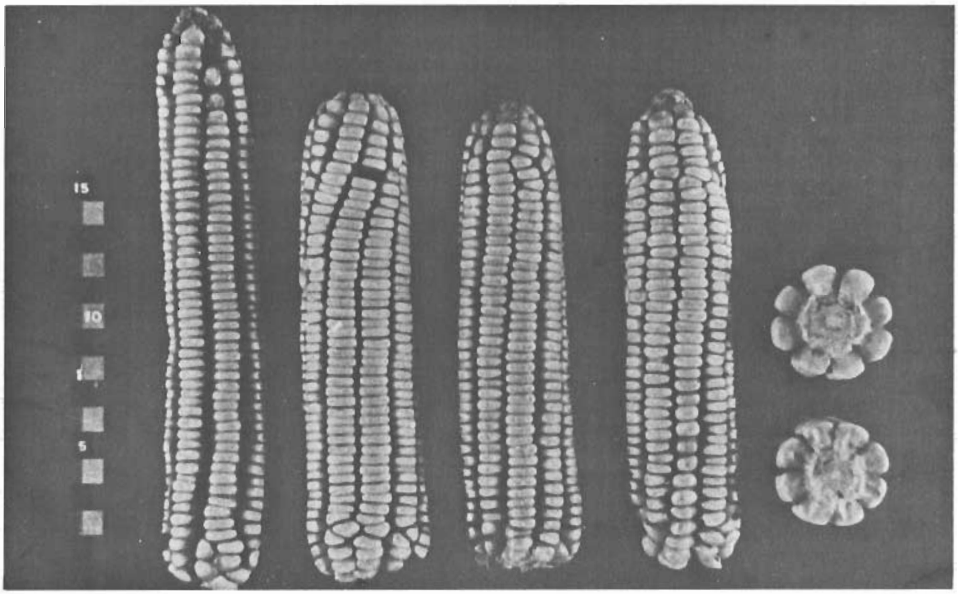


Figure 78. Hickory King.

5.4.2. Tusón

Comparison to Previous Studies. Tusón is the same race described by Hatheway (1957) and Brown (1960). The presence of this race has been reported in Bolivia (Ramirez *et al.*, 1961), in Peru (Grobman *et al.*, 1961), in Ecuador (Timothy *et al.*, 1963), and in Venezuela (Grant *et al.*, 1963).

Plants. The short, low-eared plants (with fewer-than-average long, wide leaves) have medium maturity.

Internode Pattern. (Fig. 80). Except the first and last internodes, which are much longer, all other internodes have about the same length, the ear-bearing node being a little longer.

Tassels are large but have few branches.

Ears: (Figs. 81 and 82). The large, thick ears have correspondingly large cross-section diameters and an average number of rows. Rachilla length is quite long (3.7 mm). The large, dented kernels have yellow endosperm. A reddish pericarp color is frequently found.

Distribution. This race is grown mainly in the state of Bahia near Salvador, due to recent distribution by a nearby experiment station. Due to its adaptation, vigor, and productivity, Tusón was released to farmers almost without selection.

Origin and Relationship. Hatheway (1957), based on the similarity of the distribution of Tusón and the pre-Columbian distribution of the Caribbean Arawak, considered Tusón as having been introduced from South America to the West Indies. However, it seems plausible to agree with Brown, who considered Mexico to be the important center of origin of denting in maize of the Caribbean region. Brown suggested further that Tusón arose as the result of crosses between Coastal Tropical Flint and some unknown dent. It seems that Tusón or Cuban Yellow Dent has a great deal of Tuxpeño germ plasm, judging from its exceedingly high vigor, productivity, and wide range of adaptation.

Value for Improvement. Tusón was the highest yielding race among the ones reported in Table 8. Its yielding ability was about the same as the two double crosses H6999 and Ag 17. Due to its vigor, high productivity, and wide adaptation, this is a race of great value for local programs of maize improvement.

Figure 82.

Ear cross-section Tusón.

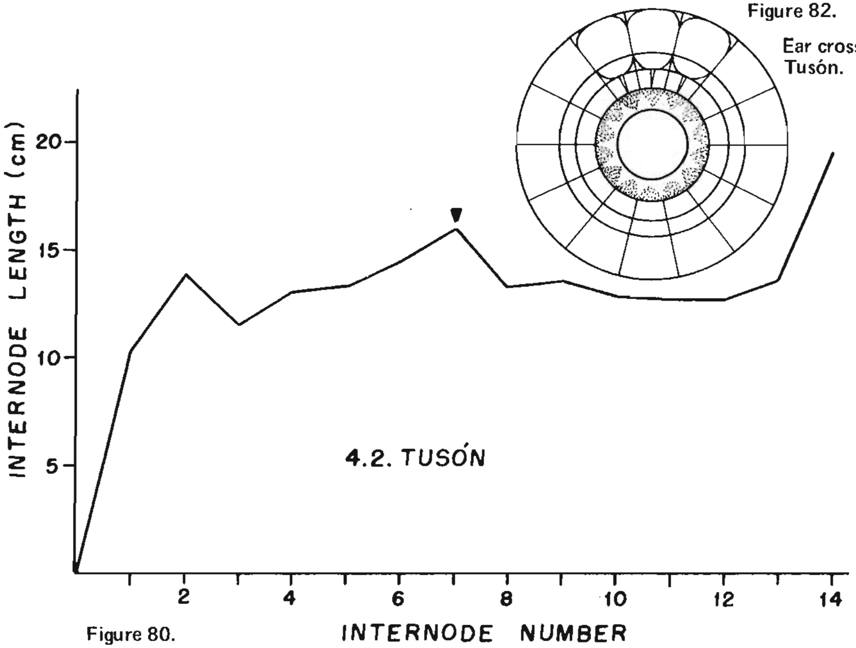


Figure 80.

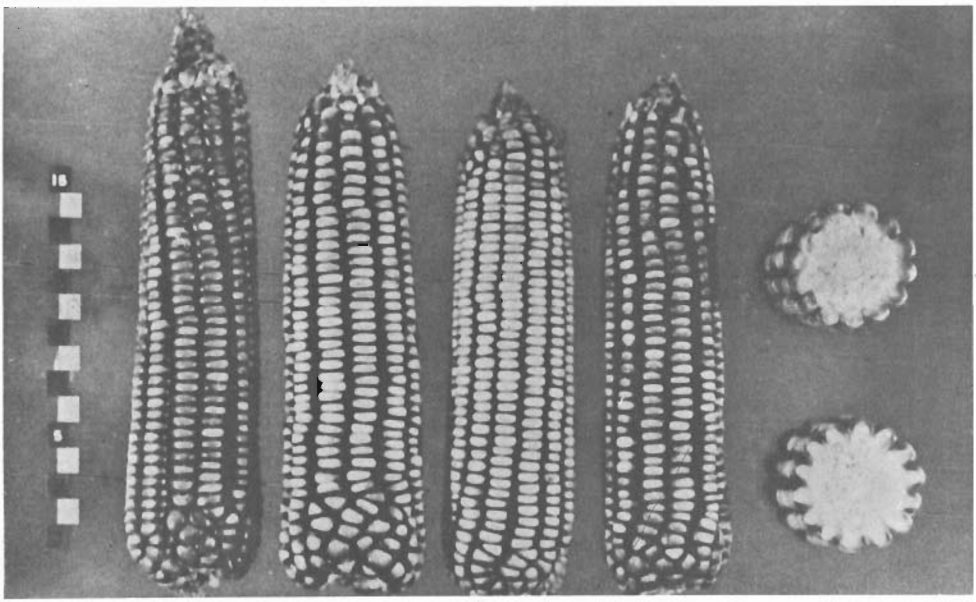


Figure 81. Tusón

6 The problem of the preservation of maize collections

To meet the desired goals, the collected strains must be preserved indefinitely with the least genetic alteration possible. The seeds must be stored in the best storage conditions available. In addition, it is necessary to handle the seeds so as to avoid the condensation of humidity. In any case, the seeds must be periodically planted for maintenance. This maintenance has proved to be a major problem, and there may be no ideal solution. Initially the idea was to propagate each individual collection separately, as some still think should be done. In this way thousands of samples must be propagated periodically by hand pollination. This usually is done by plant-to-plant sib-pollinations or by pollen mixture. In any case, 10 to 30 or more plants are used.

When the seeds are stored in appropriate storage conditions, they can be kept for a minimum of five years. [Under ideal storage conditions, even sweet corn seeds can be maintained for at least 25 years (Galinat, unpublished)]. Thus, the whole collection may be subdivided in five groups, each one planted in one year. This kind of approach nevertheless raises the following questions:

1. The amount of labor and facilities required is great, making it hazardous for most institutions to guarantee maintenance over a long period of time.
2. The necessarily low number of effective plants used in every propagation certainly leads to a high degree of inbreeding, to loss of genes, and to change of the original genetic variability due to genetic drift.
3. Contamination adds further alteration of the original genetic constitution. This may occur in higher proportion when a pollen mixture is used. A safer approach would be to identify both parents of each sib mating and to mix the kernels resulting from sib matings for which both parents were representative of the collection. This, of course, would further increase the labor and facilities necessary. It may be proper to recall that a major objection against the use of S_1 lines (or other lines with low inbreeding) in hybrids is the great difficulty in maintaining the lines without change. Sometimes S_1 lines maintained by sib-pollinations can change their combining ability without noticeable change in the appearance of the plants as shown by Wellhausen *et al.* (1955).
4. The amount of seed obtained from each sample is necessarily low. The outcome of this is that there is seldom enough seed from a given sample. As a result experiments conducted in different years and by different scientists frequently cannot be properly compared.
5. Some poorly-adapted materials are rapidly lost when propagated in small plantings. On the other hand, by planting a few thousand plants in isolation there is more chance for preservation, although some selection for adaptation does occur.

As a consequence of these problems it was decided that the most practical approach to the preservation was to composite the similar original samples into a smaller number of representative populations, as well as maintaining as many as possible of the individual collections. These representative, composite populations are being maintained at the Instituto de Genética, Escola Superior de Agricultura 'Luiz de Queiroz', Piracicaba, S.P., Brazil and the Centro Internacional de Mejoramiento de Maiz y Trigo, El Batan, Texcoco, México. As many as possible of the original collections are being maintained at the latter germ plasm bank, as well. In addition, following a plan recently adopted by the Maize Germ Plasm Committee [William L. Brown (Pioneer Hi-Bred International, Des Moines, Iowa), chairman] of the Rockefeller Foundation, duplicate samples of each available collection or composite population will be deposited at the National Seed Storage Laboratory, USDA, Fort Collins, Colorado. Requests for samples should be directed to Director, Maize Germ Plasm Bank, CIMMYT, Apartado Postal 6-641, Londres 40, México 6, D.F., México.

7 Typical collections

The procedure involved in making up synthetic populations representative of these races has been described earlier. This procedure evolved for two reasons which were critical although not unique to the Brazilian Germ Plasm Bank [see Timothy (1971) for a more general review]. First, the available storage facilities and manpower dictated that maintenance of all the individual collections would be exceedingly difficult, if not impossible. Second, many of the races described were represented by numerous essentially similar collections. However, for certain purposes individual collections typical of each race are sometimes preferred. [For detailed geographic studies, such as those of Kato and Blumenschein (1967), individual collections are considered essential]. Lists of such collections have been provided in most of the studies of the Latin American races. However, Hatheway (1957), Brieger *et al.* (1958), and Brown (1960) did not include such lists. Since the Catetos or Coastal Tropical Flints are found in the areas covered by these works, use of this particular material has been somewhat hampered.

While most of the individual collections have not been preserved in Piracicaba, duplicate samples originally intended for long-term storage by the USDA were sent to CIMMYT in Mexico and many of them have been increased there. From the composition of the synthetic populations described in this report, a list of individual collections for each race described is available. These are listed in Table 10. The list of typical collections for the races from the Humahuaca Valley (Table 11) was taken from Alleoni (1957). Finally the list of typical collections of the Guaraní popcorns (also Table 11) was compiled by the senior author from records maintained at the Instituto de Genética, Piracicaba, S.P., Brazil.

Summary data on most of the individual collections are available in the reports of the Committee on Preservation of Indigenous Strains of Maize (1954, 1955). The collection numbers used here (Table 10) were assigned at the Brazilian Germ Plasm Bank. They are consecutive over collections from all countries represented and correspond to NAS-NRC numbers 1999-2611, 6988-7156, 8443-9714, and 10,598-10,922 in the reports of the Committee on Preservation of Indigenous Strains of Maize (1954, see especially pages 7 and 14; 1955, see especially pages 2 and 4). Collections beyond No. 2378 have yet to be formally catalogued, but plans have been made to do so by the Maize Germ Plasm Committee of the Rockefeller Foundation.

8 Summary

The races of Brazil and adjacent areas were described by Brieger *et al.* (1958), a publication which marked in many ways the end of the era of racial collection in most of the area (although Amazonas and the Guianas have not been thoroughly collected yet). Since that time the senior author of this report has been mainly concerned with the problems involved with the utilization and maintenance of the racial collections. This report is, in effect, a summary of that material collected and studied at the Instituto de Genética, Piracicaba, S.P., Brazil, and suitable for use in breeding programs. It also includes what is currently known about the history of the materials involved, in as much as the history of material used in breeding programs often dictates the manner in which it might most profitably be used.

Materials which have not shown promise of immediate utility, such as the popcorns and the high altitude races of the Humahuaca Valley of Argentina, have received little attention in this report. However, since typical collections of these races were not listed in Brieger *et al.* (1958), they are included herein. This listing, combined with the preservation of the original collections initiated by the Brazilian Germ Plasm Center and carried on by the Centro Internacional de Mejoramiento de Maiz y Trigo in Mexico should insure that these materials will be available for future studies.

In this report, 91 populations belonging to 19 races and 15 sub-races are described. Ear photographs, ear and plant internode diagrams, and tabular data on ears, plants, and tassels are presented along with yields of interracial crosses when available.

9 Tabular Data

Table 2. Races of Maize of the Brazilian Germ Plasm Bank Compared in Characters of the Plants. Data Collected in Piracicaba, S.P., Brazil.

Races	Days to Flower	Ear Height (cm)	Plant Height (cm)	Ear/Plant Height Index	Leaves: No. Above Ear	Leaves: Total No.	Leaves: Length (cm)	Leaves: Width (cm)	Leaves: Venation Index
1. INDIGENOUS									
1.1. Morotí	74.3	126.4	246.8	0.51	6.0	15.6	92.3	10.5	2.33
1.1.1. Morotí Precoce	61.2	86.0	221.7	0.39	6.0	14.0	83.5	9.4	2.44
1.1.2. Morotí Guapí	68.7	105.6	204.6	0.52	6.1	15.2	87.1	10.7	2.24
1.2. Caingang	74.4	133.4	262.1	0.51	5.9	15.6	90.9	10.1	2.44
1.3. Lenha	68.9	81.6	192.4	0.42	6.0	14.4	71.4	8.9	2.61
1.4. Entrelaçado	87.9	151.6	283.0	0.54	5.8	16.0	91.9	10.9	2.29
2. ANCIENT COMMERCIAL									
2.1. Cristal Sulino	61.8	99.2	200.2	0.50	4.9	12.5	81.2	9.4	2.38
2.2. Cristal	80.7	168.4	300.3	0.56	5.9	16.9	96.9	11.0	2.34
2.2.1. Cristal Semi-Dentado	72.9	122.0	246.8	0.49	5.9	15.5	95.7	11.3	2.23
2.3. Canario de Ocho	59.5	89.7	221.4	0.40	5.2	12.1	83.0	9.8	2.36
2.4. Cateto Sulino Precoce	48.8	18.5	118.8	0.16	3.8	6.9	55.6	5.8	2.42
2.5. Cateto Sulino	61.2	88.7	205.4	0.43	5.0	12.6	82.8	9.6	2.35
2.5.1. Cateto Sulino Escuro	60.6	87.2	194.7	0.45	5.2	11.9	77.0	9.3	2.37
2.6. Cateto Sulino Grosso	57.8	64.4	180.7	0.36	5.3	11.8	74.1	8.9	2.53
2.7. Cateto	74.4	145.2	273.1	0.53	6.2	16.4	90.6	10.7	2.45
2.7.1. Cateto Assis Brasil	69.6	129.7	260.8	0.50	5.7	15.6	88.6	10.4	2.46
2.7.2. Cateto Grande	72.4	127.4	272.1	0.47	5.6	15.3	85.4	10.4	2.52
2.8. Cateto Nortista	80.0	161.5	283.2	0.57	6.3	17.6	95.6	11.3	2.35
2.8.1. Cateto Nortista Precoce	72.1	139.4	266.0	0.52	5.8	17.2	88.1	11.3	2.33
3. RECENT COMMERCIAL									
3.1. Dente Riograndense									
3.1.1. Dente Riograndense Rugoso	69.1	116.4	256.8	0.45	5.7	14.7	92.8	11.0	2.32
3.1.2. Dente Riograndense Liso	71.7	138.2	268.8	0.51	5.7	15.7	97.9	11.0	2.33
3.2. Dente Paulista	76.0	158.0	295.1	0.54	6.1	17.1	100.6	10.9	2.37
3.3. Dente Branco									
3.3.1. Dente Branco Riograndense	67.9	123.6	264.3	0.47	5.9	15.0	94.1	11.1	2.29
3.3.2. Dente Branco Paulista	78.7	164.8	302.0	0.55	6.1	17.2	94.7	10.9	2.41
3.4. Semi-Dentado									
3.4.1. Semi-Dentado Riograndense	71.2	121.2	251.0	0.48	5.8	15.4	90.3	10.9	2.37
3.4.2. Semi-Dentado Paulista	76.1	152.9	289.0	0.53	6.5	17.1	95.8	11.0	2.40
3.5. Cravo									
3.5.1. Cravo Riograndense	68.2	119.0	249.0	0.48	5.8	15.4	91.5	11.0	2.42
3.5.2. Cravo Paulista	76.0	141.0	273.2	0.52	6.0	16.4	91.0	10.7	2.38
4. EXOTIC COMMERCIAL									
4.1. Hickory King	66.6	109.7	246.2	0.45	5.6	14.4	90.2	10.7	2.29
4.2. Tusón	72.4	108.8	238.8	0.46	6.2	14.6	90.0	10.5	2.45

Table 3. Races of Maize of the Brazilian Germ Plasm Bank Compared in Characters of the Tassels. Data collected in Piracicaba, S.P., Brazil.

Races	Length (cm)						Number of Branches		
	Sheath	Peduncle	Tassel	Branching Space	Terminal Spike	Peduncle Covering Index	Primary	Secondary	Tertiary
1. INDIGENOUS									
1.1 Morotí	12.7	16.6	40.2	16.3	23.9	1.31	24.4	5.8	0.18
1.1.1. Morotí Precoce	12.8	17.2	42.1	15.9	26.2	1.34	19.8	5.6	–
1.1.2. Morotí Guapí	12.0	15.0	34.1	15.4	18.7	1.25	20.9	5.6	0.10
1.2. Caingang	13.5	18.7	42.6	14.4	28.2	1.38	18.7	4.0	0.13
1.3. Lenha	12.4	16.0	40.6	11.7	28.9	1.29	20.2	2.6	–
1.4. Entrelaçado	12.8	17.2	44.4	19.2	25.2	1.34	26.3	5.8	0.20
2. ANCIENT COMMERCIAL									
2.1. Cristal Sulino	13.4	20.8	37.7	14.8	22.9	1.55	20.3	4.2	0.07
2.2. Cristal	14.7	18.5	43.0	17.3	25.7	1.26	22.3	5.0	0.06
2.2.1. Cristal Semi-Dentado	13.2	17.6	42.1	15.9	26.2	1.34	22.9	4.6	0.08
2.3. Canario de Ocho	14.6	22.0	39.5	13.8	25.7	1.51	15.0	3.9	0.07
2.4. Cateto Sulino Precoce	13.2	20.6	39.4	15.2	24.2	1.56	21.5	4.5	–
2.5. Cateto Sulino	13.6	22.1	39.3	14.3	25.0	1.62	18.7	3.9	0.02
2.5.1. Cateto Sulino Escuro	12.6	17.0	38.6	14.0	24.6	1.35	20.0	4.5	0.10
2.6. Cateto Sulino Grosso	13.3	21.7	39.0	12.7	26.3	1.63	18.5	3.2	–
2.7. Cateto	13.1	19.2	39.4	15.3	24.1	1.46	24.0	5.3	0.09
2.7.1. Cateto Assis Brasil	13.1	19.6	39.5	14.8	24.7	1.50	22.0	4.2	0.30
2.7.2. Cateto Grande	14.6	19.2	39.9	16.6	23.3	1.32	16.0	5.1	0.50
2.8. Cateto Nortista	12.6	17.3	38.7	16.1	22.6	1.37	23.8	6.0	0.33
2.8.1. Cateto Nortista Precoce	13.4	20.0	38.7	17.2	21.5	1.49	25.2	7.3	0.30
3. RECENT COMMERCIAL									
3.1. Dente Riograndense									
3.1.1. Dente Riograndense Rugoso	14.6	20.3	40.7	14.8	25.9	1.39	19.4	4.1	0.10
3.1.2. Dente Riograndense Liso	14.5	20.9	42.2	16.1	26.1	1.44	21.4	4.1	0.05
3.2. Dente Paulista	15.1	20.8	43.1	15.9	27.2	1.37	20.6	4.5	0.08
3.3. Dente Branco									
3.3.1. Dente Branco Riograndense	14.8	21.2	41.6	15.1	26.5	1.43	19.2	4.3	0.09
3.3.2. Dente Branco Paulista	15.0	19.8	43.4	16.5	26.9	1.32	23.6	4.7	0.30
3.4. Semi-Dentado									
3.4.1. Semi-Dentado Riograndense	14.6	19.7	42.7	15.2	27.5	1.35	20.5	4.1	0.20
3.4.2. Semi-Dentado Paulista	14.3	19.6	43.2	16.9	26.3	1.37	25.1	5.1	0.05
3.5. Cravo									
3.5.1. Cravo Riograndense	13.0	18.5	40.6	13.0	27.6	1.42	20.8	3.0	–
3.5.2. Cravo Paulista	14.0	20.6	39.8	13.4	26.4	1.47	19.4	3.8	–
4. EXOTIC COMMERCIAL									
4.1. Hickory King	15.4	23.6	43.9	15.4	28.5	1.53	15.7	4.2	0.10
4.2. Tusón	13.1	19.2	41.4	14.2	27.2	1.46	14.0	3.6	–

Table 4. Races of Maize of the Brazilian Germ Plasm Bank Compared in Characters of the Ears. Data Collected in Piracicaba, S.P., Brazil.

Races	Ear Length (cm)	Row No.	Ear Cross-Section Diameters (mm): Ear	Cob	Kernel Base	Rachis	Pith	Indices: Cob/Rachis	Glume/Kernel	Rachilla/Kernel	Kernel Covering	Kernels (mm): Width	Thickness	Length
1. INDIGENOUS														
1.1. Morotí	18.7	13.4	39.2	27.8	20.9	14.8	7.6	1.88	0.65	0.31	0.34	8.7	4.6	10.0
1.1.1. Morotí Precoce	17.2	13.8	40.1	26.6	20.3	14.0	7.3	1.90	0.64	0.32	0.32	8.3	5.0	9.8
1.1.2. Morotí Guapí	12.1	19.8	49.9	34.6	28.9	23.4	13.5	1.48	0.55	0.27	0.28	9.1	4.2	10.1
1.2. Caingang	18.7	12.4	39.8	26.7	20.8	15.1	7.4	1.77	0.53	0.26	0.27	9.5	4.3	10.8
1.3. Lenha	14.9	22.1	52.2	39.4	32.9	24.7	14.8	1.59	0.72	0.40	0.32	7.7	4.0	10.1
1.4. Entrelaçado	29.2	13.0	38.6	29.9	22.5	15.6	7.4	1.92	0.77	0.37	0.40	8.5	5.7	9.3
2. ANCIENT COMMERCIAL														
2.1. Cristal Sulino	16.4	14.4	38.4	26.3	20.2	15.3	7.9	1.72	0.59	0.26	0.33	7.5	3.8	9.4
2.2. Cristal	18.8	12.7	41.2	29.2	22.0	15.6	7.8	1.88	0.65	0.30	0.34	9.0	4.4	10.5
2.2.1. Cristal Semi-Dentado	18.9	13.3	41.3	29.1	22.7	16.0	8.6	1.82	0.62	0.32	0.30	9.0	4.2	10.5
2.3. Canario de Ocho	19.4	9.8	36.6	25.4	19.3	14.4	7.5	1.78	0.56	0.25	0.31	9.9	4.2	9.8
2.4. Cateto Sulino Precoce	13.6	10.5	33.2	24.5	18.5	13.6	10.6	1.80	0.60	0.28	0.34	7.4	3.8	8.8
2.5. Cateto Sulino	17.6	12.5	39.2	27.0	21.3	15.4	8.5	1.81	0.64	0.30	0.34	8.6	4.0	9.7
2.5.1. Cateto Sulino Escuro	16.5	16.7	40.0	28.4	21.6	16.0	9.1	1.78	0.64	0.29	0.35	7.0	3.6	9.6
2.6. Cateto Sulino Grosso	14.5	19.4	44.1	32.7	25.7	19.0	11.7	1.72	0.70	0.35	0.36	6.9	3.5	9.7
2.7. Cateto	18.4	13.7	37.3	26.4	19.7	13.8	7.8	1.91	0.64	0.30	0.34	7.8	4.0	9.9
2.7.1. Cateto Assis Brasil	18.7	12.9	39.4	26.9	20.3	14.2	8.1	1.89	0.61	0.29	0.32	8.7	4.2	10.4
2.7.2. Cateto Grande	20.3	10.4	37.4	27.6	20.8	14.1	8.6	1.96	0.73	0.37	0.36	9.6	4.5	9.2
2.8. Cateto Nortista	16.1	16.3	46.0	34.1	27.3	19.9	12.0	1.73	0.68	0.36	0.33	8.1	3.9	10.4
2.8.1. Cateto Nortista Precoce	16.0	13.8	41.3	29.6	22.7	17.4	9.9	1.70	0.60	0.34	0.34	8.2	3.6	10.1
3. RECENT COMMERCIAL														
3.1. Dente Riograndense														
3.1.1. Dente Riograndense Rugoso	17.8	14.3	50.4	31.3	24.4	17.9	9.2	1.75	0.47	0.23	0.24	9.2	3.6	14.3
3.1.2. Dente Riograndense Liso	18.9	13.8	47.0	31.4	24.4	17.8	9.8	1.77	0.56	0.27	0.29	9.2	3.9	12.2
3.2. Dente Paulista	19.0	14.4	46.4	31.2	24.2	17.1	9.1	1.83	0.59	0.30	0.29	8.8	4.0	12.0
3.3. Dente Branco														
3.3.1. Dente Branco Riograndense	17.8	12.8	48.5	30.3	23.2	16.6	8.6	1.83	0.49	0.24	0.25	9.9	3.7	14.1
3.3.2. Dente Branco Paulista	17.5	14.4	48.5	31.9	24.7	17.6	8.9	1.81	0.57	0.28	0.29	9.1	3.8	12.5
3.4. Semi-Dentado														
3.4.1. Semi-Dentado Riograndense	19.1	13.3	43.3	30.2	22.1	16.9	9.2	1.78	0.60	0.23	0.37	9.2	4.0	11.1
3.4.2. Semi-Dentado Paulista	18.3	14.6	45.8	32.1	24.9	18.0	9.8	1.78	0.63	0.31	0.32	8.8	4.0	11.2
3.5. Cravo														
3.5.1. Cravo Riograndense	15.5	19.4	48.2	31.4	25.1	17.8	9.7	1.76	0.50	0.27	0.23	7.0	3.4	13.6
3.5.2. Cravo Paulista	15.2	20.7	49.3	31.6	24.8	17.7	10.1	1.79	0.52	0.27	0.26	6.9	3.3	13.3
4. EXOTIC COMMERCIAL														
4.1. Hickory King	19.7	8.5	41.8	25.4	19.2	12.9	6.5	1.97	0.48	0.24	0.24	12.5	4.0	13.0
4.2. Tusón	20.0	14.4	50.3	34.1	28.5	21.1	12.3	1.62	0.55	0.31	0.24	9.4	4.1	11.8

Table 5. Populations of the Races of the Brazilian Germ Plasm Bank Compared in Characters of the Plants. Data Collected in Piracicaba, S.P., Brazil. (Average of four years: 1960, 1963, 1964, 1965).

Races	Days to Flower	Ear Height (cm)	Plant Height (cm)	Ear/Plant Height Index	Leaves: No. Above Ear	Leaves: Total No.	Leaves: Length (cm)*2	Leaves: Width (cm)*2	Leaves: Venation Index *2
1. INDIGENOUS									
1.1. Morotí									
RGS XIX *1	65.4	93.4	202.6	0.46	5.2	13.8	84.0	10.4	2.35
Pr I	66.5	102.8	212.6	0.48	5.6	13.7	86.6	9.1	2.47
Pr II*1	68.2	111.0	203.9	0.54	5.2	14.8	76.0	9.9	1.86
Pe I	78.6	135.0	263.7	0.51	5.6	15.6	91.7	11.0	2.41
Mt II	74.0	132.2	281.0	0.47	6.7	15.6	94.9	10.4	2.41
Mt III	75.8	143.6	271.8	0.53	5.9	15.7	97.6	10.4	2.39
Mt IV	77.4	131.6	277.8	0.47	6.4	15.5	97.4	10.8	2.40
Mt V	77.8	143.0	278.0	0.51	6.5	16.4	98.7	10.6	2.37
Pag V	76.0	137.8	248.6	0.55	6.0	16.0	95.9	10.8	2.24
Pag VI	79.3	122.9	221.1	0.56	6.2	16.4	89.2	11.0	2.30
Pag VII	79.9	127.6	249.2	0.51	6.6	17.2	99.0	11.3	2.32
Bol II	77.1	139.4	261.6	0.53	6.1	16.1	98.1	10.5	2.42
Bol III	69.5	123.0	237.2	0.52	5.9	15.4	91.2	10.4	2.34
Means	74.3	126.4	246.8	0.51	6.0	15.6	92.3	10.5	2.33
1.1.1. Morotí Precoce									
Bol I*2	61.2	86.0	221.7	0.39	6.0	14.0	83.5	9.4	2.44
1.1.2. Morotí Guapí									
Pag VI-A*1	68.7	105.6	204.6	0.52	6.1	15.2	87.1	10.7	2.24
1.2. Caingang									
Pr III	68.2	114.9	241.9	0.47	5.8	14.8	87.0	9.9	2.37
SP XIII	73.6	122.2	267.6	0.46	6.0	15.0	88.0	10.0	2.53
SP XIV*1	81.5	163.2	276.8	0.59	6.0	16.9	97.7	10.5	2.43
Means	74.4	133.4	262.1	0.51	5.9	15.6	90.9	10.1	2.44
1.3. Lenha									
RGS XX*1	68.9	81.6	192.4	0.42	6.0	14.4	71.4	8.9	2.61
1.4. Entrelaçado									
Mt VI	87.9	151.6	283.0	0.54	5.8	16.0	91.9	10.9	2.29
2. ANCIENT COMMERCIAL									
2.1. Cristal Sulino									
Arg I	58.1	88.2	200.3	0.44	4.8	12.0	80.3	9.5	2.33
Arg VIII*1	60.4	98.9	178.2	0.55	4.8	11.9	78.7	9.0	2.42
Urg VIII*1	66.9	110.5	222.0	0.50	5.2	13.6	84.6	9.6	2.39
Means	61.8	99.2	200.2	0.50	4.9	12.5	81.2	9.4	2.38
2.2. *Cristal*									
SP X	79.0	170.4	304.8	0.56	6.2	17.4	97.0	11.5	2.26
SP XI	76.1	166.5	302.1	0.55	6.0	16.8	98.8	10.9	2.38
SP XII	85.1	187.0	311.9	0.60	5.9	17.9	98.3	11.5	2.32
MG III	83.0	175.6	309.8	0.57	6.1	17.0	97.0	11.1	2.24
Ba II	80.1	142.6	272.9	0.52	5.5	15.3	93.5	10.3	2.51
Means	80.7	168.4	300.3	0.56	5.9	16.9	96.9	11.0	2.34
2.2.1. Cristal Semi-Dentado									
Pag II	78.0	127.8	251.8	0.51	6.0	15.8	97.7	11.3	2.20
Pag III	67.8	116.3	241.8	0.48	5.8	15.2	93.6	11.2	2.26
Means	72.9	122.0	246.8	0.49	5.9	15.5	95.7	11.3	2.23
2.3. Canario de Ocho									
Arg IV	55.8	70.0	193.8	0.36	5.1	11.7	78.2	8.7	2.37
Arg VI	60.1	94.0	222.2	0.42	5.4	12.3	78.0	9.8	2.42
Urg VI*2,*3	62.5	105.4	248.2	0.42	5.0	12.4	93.0	11.0	2.28
Means	59.5	89.7	221.4	0.40	5.2	12.1	83.0	9.8	2.36
2.4. Cateto Sulino Precoce									
Arg VII*2	48.8	18.5	118.8	0.16	3.8	6.9	55.6	5.8	2.42

(Continued on page 82)

Table 5. cont.

Races	Days to Flower	Ear Height (cm)	Plant Height (cm)	Ear/Plant Height Index	Leaves: No. Above Ear	Leaves: Total No.	Leaves: Length (cm)*2	Leaves: Width (cm)*2	Leaves: Venation Index *2
2.5. Cateto Sulino									
Arg II *2	62.4	89.8	215.0	0.42	5.1	12.1	91.0	9.6	2.29
Arg III	57.8	96.8	217.8	0.44	4.9	12.3	81.3	9.7	2.30
Arg V	59.0	89.2	204.8	0.44	4.9	12.9	80.0	9.6	2.38
Urg I*1	70.2	104.4	212.2	0.49	5.2	14.2	88.4	10.3	2.34
Urg II	60.0	84.0	196.0	0.43	4.6	12.2	78.4	9.4	2.36
Urg IV *3	58.0	68.1	186.5	0.37	5.2	12.1	78.0	9.1	2.44
Means	61.2	88.7	205.4	0.43	5.0	12.6	82.8	9.6	2.35
2.5.1. Cateto Sulino Escuro									
Urg V	58.4	78.0	186.6	0.42	5.2	11.0	74.7	8.8	2.52
Urg V-A*1	62.9	96.3	202.8	0.48	5.2	12.8	79.5	9.9	2.22
Means	60.6	87.2	194.7	0.45	5.2	11.9	77.0	9.3	2.37
2.6. Cateto Sulino Grosso									
Urg III	57.8	64.4	180.7	0.36	5.3	11.8	74.1	8.9	2.53
2.7. Cateto									
SP VII	72.8	146.4	288.0	0.51	6.2	16.7	93.5	10.7	2.34
SP VIII	72.7	151.5	294.2	0.52	6.4	16.4	96.3	11.0	2.35
MG II	74.2	154.1	285.4	0.54	6.1	16.7	93.9	11.3	2.42
Ba I*1	75.5	144.4	261.8	0.55	6.0	16.0	94.8	10.7	2.45
Ma I	82.8	152.5	271.2	0.56	6.4	17.1	93.5	11.0	2.40
Desc I	73.8	134.8	252.1	0.54	6.6	17.4	83.9	10.1	2.57
Ce I*1	70.4	149.5	271.6	0.55	5.8	16.0	93.4	10.7	2.34
Pontinha*2,*3,*4	73.0	128.0	260.5	0.49	5.8	16.2	75.8	9.8	2.76
Means	74.4	145.2	273.1	0.53	6.2	16.4	90.6	10.7	2.45
2.7.1. Cateto Assis Brasil									
RGS XIV	69.6	129.7	260.8	0.50	5.7	15.6	88.6	10.4	2.46
2.7.2. Cateto Grande									
Mt I	72.4	127.4	272.1	0.47	5.6	15.3	85.4	10.4	2.52
2.8. Cateto Nortista									
GFr I*3	77.8	165.0	301.2	0.55	6.2	17.3	97.2	10.7	2.40
GFr II	74.6	152.2	273.3	0.57	6.5	17.9	92.6	11.8	2.30
GFr III	76.8	161.4	285.0	0.57	6.2	17.4	94.5	11.1	2.22
GFr IV*2,*3,*4	88.5	227.0	359.5	0.63	8.3	19.6	97.6	11.8	2.42
Sur II	79.4	167.4	295.0	0.57	6.0	17.6	99.1	11.7	2.22
GFr VI	79.2	154.8	265.0	0.58	6.1	17.7	94.9	11.2	2.37
Sur III	77.8	158.0	279.4	0.57	6.2	17.7	94.7	11.6	2.36
Gln I	81.2	141.2	260.0	0.54	5.6	16.4	93.9	10.7	2.46
Gln II	82.1	154.0	264.2	0.58	5.8	16.9	98.2	11.5	2.35
Gln III	83.0	133.6	249.6	0.54	5.8	17.2	93.5	10.6	2.43
Means	80.0	161.5	283.2	0.57	6.3	17.6	95.6	11.3	2.35
2.8.1. Cateto Nortista Precoce									
Sur I	72.1	139.4	266.0	0.52	5.8	17.2	88.1	11.3	2.33
3. RECENT COMMERCIAL									
3.1. Dente Riograndense									
3.1.1. Dente Riograndense Rugoso									
RGS I	66.8	118.9	248.1	0.48	5.8	15.2	89.4	10.6	2.31
RGS II	68.0	116.4	249.8	0.47	5.8	15.2	94.3	11.4	2.24
RGS III*2,*3,*4	73.5	109.0	263.0	0.41	5.5	13.0	92.4	11.1	2.38
RGS IV	68.0	121.2	266.2	0.46	5.8	15.5	95.0	10.9	2.35
Means	69.1	116.4	256.8	0.45	5.7	14.7	92.8	11.0	2.32
3.1.2. Dente Riograndense Liso									
RGS V	68.8	127.2	262.4	0.48	5.6	15.2	94.4	11.3	2.33
RGS VI	73.2	145.3	270.1	0.54	5.8	16.2	100.4	10.5	2.40
SC I	73.0	142.2	274.0	0.52	5.8	15.7	98.8	11.2	2.26
Means	71.7	138.2	268.8	0.51	5.7	15.7	97.9	11.0	2.33

(Continued on page 83)

Table 5. cont.

Races	Days to Flower	Ear Height (cm)	Plant Height (cm)	Ear/Plant Height Index	Leaves No. Above Ear	Leaves Total No.	Leaves Length (cm)*2	Leaves Width (cm)*2	Leaves Venation Index *2
3.2. Dente Paulista									
SP III	75.6	150.0	285.0	0.53	6.0	16.8	98.3	11.0	2.30
SP IV	77.7	157.2	287.0	0.55	6.2	17.0	101.3	10.6	2.44
MG I	74.8	166.8	313.4	0.53	6.2	17.4	102.1	11.1	2.38
Means	76.0	158.0	295.1	0.54	6.1	17.1	100.6	10.9	2.37
3.3. Dente Branco									
3.3.1. Dente Branco Riograndense									
RGS X	67.5	130.2	270.8	0.48	6.2	15.8	102.8	11.5	2.28
RGS XI	66.2	120.4	254.0	0.47	5.8	15.1	92.8	10.9	2.29
RGS XII	68.1	110.2	257.2	0.43	5.9	13.9	91.9	11.3	2.15
RGS XIII	67.8	128.6	267.0	0.48	5.8	15.0	86.3	10.7	2.36
SC II	70.1	128.8	272.3	0.47	5.8	15.2	96.7	11.0	2.35
Means	67.9	123.6	264.3	0.47	5.9	15.0	94.1	11.1	2.29
3.3.2. Dente Branco Paulista									
SP V	78.7	164.8	302.0	0.55	6.1	17.2	94.7	10.9	2.41
3.4. Semi-Dentado									
3.4.1. Semi-Dentado Riograndense									
RGS XV	71.4	125.8	253.9	0.49	5.9	16.1	92.9	10.9	2.42
RGS XVI	71.0	116.6	248.2	0.47	5.7	14.8	87.7	10.9	2.32
Means	71.2	121.2	251.0	0.48	5.8	15.4	90.3	10.9	2.37
3.4.2. Semi-Dentado Paulista									
SP IX	73.8	144.8	282.2	0.51	6.4	16.4	95.0	10.8	2.42
Mt VII	79.8	164.9	297.2	0.56	6.4	17.6	92.3	11.1	2.42
Pag I	74.6	148.9	287.6	0.52	6.8	17.4	100.2	11.2	2.37
Means	76.1	152.9	289.0	0.53	6.5	17.1	95.8	11.0	2.40
3.5. Cravo									
3.5.1. Cravo Riograndense									
RGS VII	68.4	117.3	249.4	0.47	5.9	15.7	91.9	11.1	2.40
RGS VIII	68.0	120.8	248.7	0.49	5.8	15.2	90.9	10.9	2.45
Means	68.2	119.0	249.0	0.48	5.8	15.4	91.5	11.0	2.42
3.5.2. Cravo Paulista									
SP I	73.4	131.8	265.0	0.50	6.0	16.0	86.2	10.1	2.42
SP II	78.6	150.3	281.5	0.53	6.0	16.8	95.8	11.2	2.34
Means	76.0	141.0	273.2	0.52	6.0	16.4	91.0	10.7	2.38
4. EXOTIC COMMERCIAL									
4.1. Hickory King									
RGS IX	66.6	109.7	246.2	0.45	5.6	14.4	90.2	10.7	2.29
4.2. Tusón									
Ba III	72.4	108.8	238.8	0.46	6.2	14.6	90.0	10.5	2.45

*1 Data for 1960 missing
*2 Data for 1963 missing
*3 Data for 1964 missing
*4 Data for 1965 missing

Table 6. Populations of the Races of the Brazilian Germ Plasm Bank Compared in Characters of the Tassels. Data Collected in Piracicaba, S.P., Brazil. (Average of three years: 1960, 1964, 1965).

Races	Length (cm)					Peduncle Covering Index	Number of Branches		
	Sheath	Peduncle	Tassel	Branching Space	Terminal Spike		Primary	Secondary	Tertiary
1. INDIGENOUS									
1.1. Morotí									
RGS XIX*	13.8	17.4	39.8	14.6	25.2	1.26	21.3	5.1	–
Pr I	12.6	16.6	40.2	15.2	25.0	1.32	19.0	5.4	0.40
Pr II*	10.3	15.0	35.4	13.4	22.0	1.46	19.5	3.4	–
Pc I	10.8	16.0	36.2	17.7	18.5	1.48	27.3	7.2	0.90
Mt II	13.4	16.8	39.5	15.0	24.5	1.25	22.7	5.2	0.05
Mt III	13.0	16.3	41.8	16.6	25.2	1.25	25.8	5.4	–
Mt IV	13.7	17.8	43.4	16.2	27.2	1.30	21.4	5.0	–
Mt V	14.6	17.9	41.1	15.6	25.5	1.23	25.2	6.9	–
Pag V	12.8	17.4	43.8	17.5	26.3	1.36	27.5	6.6	0.10
Pag VI	12.8	16.2	39.6	17.4	22.2	1.26	24.9	5.8	0.54
Pag VII	12.5	15.4	40.5	17.6	22.9	1.23	29.0	6.4	0.10
Bol II	13.2	16.4	41.6	17.6	24.0	1.24	26.9	6.2	0.10
Bol III	11.5	16.5	39.8	17.2	22.6	1.43	27.3	7.2	0.15
Means	12.7	16.6	40.2	16.3	23.9	1.31	24.4	5.8	0.18
1.1.1. Morotí Precoce									
Bol I	12.8	17.2	42.1	15.9	26.2	1.34	19.8	5.6	–
1.1.2. Morotí Guapí									
Pag VI-A*	12.0	15.0	34.1	15.4	18.7	1.25	20.9	5.6	0.10
1.2. Caingang									
Pr III	13.4	18.6	43.2	13.2	30.0	1.39	15.7	3.8	–
SP XIII	13.4	20.4	42.7	16.0	26.7	1.52	20.5	4.3	0.10
SP XIV*	13.7	17.2	41.8	14.0	27.8	1.26	20.0	3.8	0.30
Means	13.5	18.7	42.6	14.4	28.2	1.38	18.7	4.0	0.13
1.3. Lenha									
RGS XX*	12.4	16.0	40.6	11.7	28.9	1.29	20.2	2.6	–
1.4. Entrelaçado									
Mt VI	12.8	17.2	44.4	19.2	25.2	1.34	26.3	5.8	0.20
2. ANCIENT COMMERCIAL									
2.1. Cristal Sulino									
Arg I	12.7	22.0	37.1	14.4	22.7	1.73	21.6	4.6	–
Arg VIII*	13.2	20.6	39.4	15.2	24.2	1.56	21.5	4.5	–
Urg VIII*	14.2	19.8	36.7	14.8	21.9	1.39	17.8	3.6	0.20
Means	13.4	20.8	37.7	14.8	22.9	1.55	20.3	4.2	0.07
2.2. Cristal									
SP X	15.2	20.4	44.4	17.0	27.4	1.34	21.6	4.2	–
SP XI	13.9	18.3	42.5	17.4	25.1	1.32	23.0	5.6	0.05
SP XII	14.8	18.4	43.4	18.4	25.0	1.24	24.2	5.7	0.25
MG III	15.7	19.7	42.5	17.0	25.5	1.25	21.2	4.7	–
Ba II	13.7	15.8	42.0	16.6	25.4	1.15	21.6	4.7	–
Means	14.7	18.5	43.0	17.3	25.7	1.26	22.3	5.0	0.06
2.2.1. Cristal Semi-Dentado									
Pag II	12.8	17.4	42.6	16.6	26.0	1.36	24.8	4.8	0.10
Pag III	13.5	17.9	41.5	15.2	26.3	1.32	21.0	4.4	0.05
Means	13.2	17.6	42.1	15.9	26.2	1.34	22.9	4.6	0.08
2.3. Canario de Ocho									
Arg IV	15.6	23.6	39.6	10.8	28.8	1.51	12.5	2.8	–
Arg VI	16.0	24.8	41.2	14.0	27.2	1.55	14.3	3.9	–
Urg VI **	12.2	17.6	37.6	16.5	21.1	1.44	18.1	5.1	0.20
Means	14.6	22.0	39.5	13.8	25.7	1.51	15.0	3.9	0.07
2.4. Cateto Sulino Precoce									
Arg VII	13.2	20.6	39.4	15.2	24.2	1.56	21.5	4.5	–
2.5. Cateto Sulino									
Arg II	14.6	22.4	41.8	16.0	25.8	1.53	20.0	4.7	0.10
Arg III	13.3	21.7	39.0	12.7	26.3	1.63	18.5	3.2	–
Arg V	14.0	26.6	37.4	13.9	23.5	1.90	17.0	3.4	–
Urg I*	14.0	19.6	40.0	15.2	24.8	1.40	19.1	4.7	–
Urg II	13.4	22.0	38.1	14.0	24.1	1.64	16.2	4.0	–
Urg IV **	12.4	20.4	39.7	14.0	25.7	1.64	21.5	3.4	–
Means	13.6	22.1	39.3	14.3	25.0	1.62	18.7	3.9	0.02

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Table 6. cont.

Races	Length (cm)					Peduncle Covering Index	Number of Branches		
	Sheath	Peduncle	Tassel	Branching Space	Terminal Spike		Primary	Secondary	Tertiary
2.5.1. Cateto Sulino Escuro									
Urg V	12.8	18.7	36.5	12.4	24.1	1.46	17.8	3.2	–
Urg V-A*	12.4	15.4	40.6	15.6	25.0	1.24	22.2	5.8	0.20
Means	12.6	17.0	38.6	14.0	24.6	1.35	20.0	4.5	0.10
2.6. Cateto Sulino Grosso									
Urg III	13.3	21.7	39.0	12.7	26.3	1.63	18.5	3.2	–
2.7. Cateto									
SP VII	14.0	20.2	39.2	16.2	23.0	1.44	24.3	4.8	0.10
SP VIII	13.8	19.6	40.8	15.7	25.1	1.42	24.0	5.1	–
MG II	13.3	21.0	39.6	15.4	24.2	1.58	23.0	6.1	0.10
Ba I*	11.9	21.2	38.0	12.4	25.6	1.78	21.2	3.1	–
Ma I	13.0	16.2	38.8	15.1	23.7	1.25	27.0	5.8	0.25
Dese I **	12.2	16.0	40.6	16.9	23.7	1.31	27.2	6.6	–
Ce I*	13.2	19.4	39.6	16.1	23.5	1.47	24.2	5.9	0.10
Pontinha** ***	13.4	19.7	38.2	14.4	23.8	1.47	21.0	5.0	0.20
Means	13.1	19.2	39.4	15.3	24.1	1.46	24.0	5.3	0.09
2.7.1. Cateto Assis Brasil									
RGS XIV	13.1	19.6	39.5	14.8	24.7	1.50	22.0	4.2	0.30
2.7.2. Cateto Grande									
Mt I	14.6	19.2	39.9	16.6	23.3	1.32	16.0	5.1	0.50
2.8. Cateto Nortista									
GFr I **	12.6	18.2	42.6	18.1	24.5	1.44	26.4	5.9	0.30
GFr II	11.6	15.0	38.2	15.6	22.6	1.29	19.9	5.6	0.35
GFr III	13.5	17.6	41.2	18.1	23.1	1.30	26.4	7.0	0.45
GFr IV** ***	11.2	14.4	33.3	15.2	18.1	1.28	19.0	5.0	–
Sur II	13.4	18.0	42.6	18.5	24.1	1.34	27.0	7.0	0.75
GFr VI	11.2	16.5	39.3	16.2	23.1	1.47	20.6	4.6	0.35
Sur III	13.0	18.2	35.7	15.8	19.9	1.40	24.9	6.6	0.05
Gln I	11.9	18.8	36.8	15.1	21.7	1.58	24.2	6.8	0.55
Gln II	14.3	18.4	39.0	14.7	24.3	1.29	24.6	5.7	0.30
Gln III	13.2	17.7	38.3	13.9	24.4	1.34	25.2	5.9	0.20
Means	12.6	17.3	38.7	16.1	22.6	1.37	23.8	6.0	0.33
2.8.1. Cateto Nortista Precoce									
Sur I	13.4	20.0	38.7	17.2	21.5	1.49	25.2	7.3	0.30
3. RECENT COMMERCIAL									
3.1. Dente Riograndense									
3.1.1. Dente Riograndense Rugoso									
RGS I	13.8	18.8	37.8	15.7	22.1	1.36	21.1	5.4	0.40
RGS II	14.7	18.6	42.0	14.2	27.8	1.26	19.2	3.4	–
RGS III** ***	15.0	20.6	38.7	13.8	24.9	1.37	18.0	4.2	–
RGS IV	14.9	23.2	44.1	15.4	28.7	1.56	19.2	3.4	–
Means	14.6	20.3	40.7	14.8	25.9	1.39	19.4	4.1	0.10
3.1.2. Dente Riograndense Liso									
RGS V	15.1	20.6	45.3	17.8	27.5	1.36	24.6	3.6	–
RGS VI	13.6	18.8	41.2	14.2	27.0	1.38	20.4	4.8	0.15
SC I	14.9	23.2	39.9	16.2	23.7	1.56	19.1	3.8	–
Means	14.5	20.9	42.2	16.1	26.1	1.44	21.4	4.1	0.05
3.2. Dente Paulista									
SP III	15.5	21.0	40.7	15.4	25.3	1.35	19.6	4.0	0.25
SP IV	14.2	19.8	43.0	15.6	27.4	1.39	21.4	4.3	–
MG I	15.6	21.5	45.7	16.8	28.9	1.38	20.8	5.2	–
Means	15.1	20.8	43.1	15.9	27.2	1.37	20.6	4.5	0.08
3.3. Dente Branco									
3.3.1. Dente Branco Riograndense									
RGS X	14.8	20.7	41.7	15.8	25.9	1.40	21.8	5.0	0.10
RGS XI	14.2	21.0	41.2	15.0	26.2	1.48	21.0	3.8	0.15
RGS XII	14.5	19.9	41.3	14.4	26.9	1.37	18.4	3.8	–
RGS XIII	14.0	22.8	40.9	13.9	27.0	1.63	17.3	4.2	–
SC II	16.4	21.4	43.0	16.6	26.4	1.30	17.6	4.6	0.20
Means	14.8	21.2	41.6	15.1	26.5	1.43	19.2	4.3	0.09
3.3.2. Dente Branco Paulista									
SP V	15.0	19.8	43.4	16.5	26.9	1.32	23.6	4.7	0.30

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Table 6. cont.

Races	Length (cm)					Peduncle Covering Index	Number of Branches		
	Sheath	Peduncle	Tassel	Branching Space	Terminal Spike		Primary	Secondary	Tertiary
3.4. Semi-Dentado									
3.4.1. Semi-Dentado Riograndense									
RGS XV	14.6	19.8	42.7	16.0	26.7	1.36	21.8	3.6	0.2
RGS XVI	14.7	19.6	42.6	14.3	28.3	1.33	19.2	4.6	0.2
Means	14.6	19.7	42.7	15.2	27.5	1.35	20.5	4.1	0.2
3.4.2. Semi-Dentado Paulista									
SP IX	14.1	19.2	41.4	15.6	25.8	1.36	25.2	4.6	–
Mt VII	14.2	18.0	42.4	16.8	25.6	1.27	26.8	5.6	0.05
Pag I	14.5	21.6	45.6	18.2	27.4	1.49	23.2	5.0	0.1
Means	14.3	19.6	43.2	16.9	26.3	1.37	25.1	5.1	0.05
3.5. Cravo									
3.5.1. Cravo Riograndense									
RGS VII	12.4	17.8	40.4	11.9	28.5	1.44	20.1	2.7	–
RGS VIII	13.6	19.2	40.7	14.0	26.7	1.41	21.4	3.4	–
Means	13.0	18.5	40.6	13.0	27.6	1.42	20.8	3.0	–
3.5.2. Cravo Paulista									
SP I	14.0	21.3	39.6	12.7	26.9	1.52	16.8	3.1	–
SP II	13.9	19.8	40.2	14.2	26.0	1.42	22.0	4.4	–
Means	14.0	20.6	39.8	13.4	26.4	1.47	19.4	3.8	–
4. EXOTIC COMMERCIAL									
4.1. Hickory King									
RGS IX	15.4	23.6	43.9	15.4	28.5	1.53	15.7	4.2	0.10
4.2. Tusón									
Ba III	13.1	19.2	41.4	14.2	27.2	1.46	14.0	3.6	–

* Data for 1960 missing
** Data for 1964 missing
*** Data for 1965 missing

Table 7. Populations of the Races of the Brazilian Germ Plasm Bank Compared in Character of the Ears. Data collected in Piracicaba, S.P., Brazil. (Average of three years: 1960, 1963, 1965).

Populations			Ear Cross-Section Diameters (mm)					Indices				Kernels (mm)		
	Ear Length (cm)	Row No.	Ear	Cob	Kernel Base	Rachis	Pith	Cob/Rachis	Glume/Kernel	Rachilla/Kernel	Kernel Covering	Width	Thickness	Length
1. INDIGENOUS														
1.1. Morotí														
RGS XIX*	19.0	11.2	40.8	27.8	19.9	15.1	8.4	1.84	0.60	0.23	0.37	9.8	4.3	10.6
PR I	18.0	12.1	35.8	24.7	17.9	12.3	5.9	2.01	0.64	0.29	0.35	8.5	4.6	9.7
PR II*	17.1	13.1	39.6	27.5	21.2	14.8	7.8	1.86	0.64	0.32	0.32	9.6	4.1	9.9
Pe I	19.4	13.2	36.6	25.6	19.6	13.1	6.6	1.95	0.66	0.34	0.31	8.4	5.4	9.5
Mt II	20.3	13.3	39.0	28.6	22.3	15.1	7.3	1.89	0.71	0.38	0.34	8.0	4.4	9.4
Mt III *3	17.2	13.4	39.2	29.1	22.2	16.0	8.6	1.82	0.67	0.32	0.35	8.7	4.6	9.8
Mt IV	19.7	14.0	40.5	29.1	21.7	15.3	8.1	1.90	0.70	0.32	0.37	8.6	4.3	9.9
Mt V	19.6	14.1	39.4	27.2	20.4	15.1	8.7	1.80	0.57	0.25	0.32	8.4	4.5	10.5
Pag V	19.5	13.9	39.1	27.8	21.1	14.5	7.1	1.92	0.63	0.31	0.32	8.7	4.6	10.5
Pag VI	19.6	13.0	39.2	27.7	20.7	14.7	7.4	1.89	0.65	0.30	0.35	8.7	4.5	10.0
Pag VII	18.4	13.8	40.4	28.3	21.3	14.6	7.2	1.93	0.65	0.32	0.33	8.7	4.2	10.5
Bol II	18.1	15.4	39.2	28.7	21.7	15.5	8.6	1.85	0.68	0.32	0.36	8.3	5.2	9.7
Bol III	17.1	14.1	40.4	29.1	22.4	16.2	7.8	1.79	0.67	0.32	0.35	8.6	4.9	9.6
Means	18.7	13.4	39.2	27.8	20.9	14.8	7.6	1.88	0.65	0.31	0.34	8.7	4.6	10.0
1.1.1. Morotí Precoce														
Bol I*2	17.2	13.8	40.1	26.6	20.3	14.0	7.3	1.90	0.64	0.32	0.32	8.3	5.0	9.8
1.1.2. Morotí Guapí														
Pag VI-A*	12.1	19.8	49.9	34.6	28.9	23.4	13.5	1.48	0.55	0.27	0.28	9.1	4.2	10.1
1.2. Caingang														
Pr III	18.8	12.7	42.0	27.2	21.7	15.6	7.4	1.75	0.52	0.27	0.24	9.8	4.4	11.3
SP XIII	19.2	13.2	39.5	27.5	21.1	15.7	8.3	1.75	0.52	0.24	0.28	9.6	4.5	11.2
SP XIV*	17.9	11.2	37.8	25.3	19.4	14.0	6.4	1.80	0.57	0.27	0.30	9.1	3.9	9.9
Means	18.7	12.4	39.8	26.7	20.8	15.1	7.4	1.77	0.53	0.26	0.27	9.5	4.3	10.8
1.3. Lenha														
RGS XX*	14.9	22.1	52.2	39.4	32.9	24.7	14.8	1.59	0.72	0.40	0.32	7.7	4.0	10.1
1.4. Entrelaçado														
Mt VI *,*2	29.2	13.0	38.6	29.9	22.5	15.6	7.4	1.92	0.77	0.37	0.40	8.5	5.7	9.3
2. ANCIENT COMMERCIAL														
2.1. Cristal Sulino														
Arg I	16.2	14.5	37.1	25.5	19.1	14.5	7.8	1.76	0.57	0.24	0.33	7.1	3.6	9.6
Arg VIII*,*2	15.9	14.0	36.8	24.8	18.0	15.0	6.7	1.65	0.49	0.15	0.34	7.3	3.8	10.0
Urg VIII*	17.2	14.6	41.2	28.6	23.4	16.3	9.2	1.76	0.71	0.41	0.30	8.2	3.9	8.7
Means	16.4	14.4	38.4	26.3	20.2	15.3	7.9	1.72	0.59	0.26	0.33	7.5	3.8	9.4
2.2. Cristal														
SP X	19.8	13.6	39.7	28.2	21.4	15.0	8.1	1.88	0.65	0.32	0.33	8.2	4.1	10.2
SP XI*3	18.9	13.0	41.3	29.1	22.2	15.3	7.8	1.90	0.66	0.33	0.33	8.6	4.4	10.5
SP XII	19.6	12.3	42.5	30.7	23.3	16.2	7.7	1.90	0.67	0.33	0.34	9.7	4.3	10.8
MG III	19.1	11.6	41.9	30.4	22.6	16.3	7.1	1.87	0.67	0.30	0.37	9.9	4.8	10.5
Ba II	16.8	13.2	40.5	27.6	20.4	15.1	8.5	1.83	0.58	0.25	0.34	8.6	4.3	10.7
Means	18.8	12.7	41.2	29.2	22.0	15.6	7.8	1.88	0.65	0.30	0.34	9.0	4.4	10.5
2.2.1. Cristal Semi-Dentado														
Pag II	18.9	13.8	40.3	29.6	22.8	16.5	9.0	1.79	0.66	0.32	0.34	8.9	4.3	9.9
Pag III	18.9	12.7	42.3	28.6	22.6	15.4	8.1	1.85	0.59	0.32	0.27	9.1	4.0	11.1
Means	18.9	13.3	41.3	29.1	22.7	16.0	8.6	1.82	0.62	0.32	0.30	9.0	4.2	10.5
2.3. Canario de Ocho														
Arg IV	20.8	8.4	33.6	22.4	17.0	11.8	6.3	1.90	0.56	0.28	0.28	10.2	3.8	9.4
Arg VI	19.0	10.4	35.4	24.5	18.4	14.2	7.9	1.73	0.51	0.21	0.30	9.4	4.1	10.1
Urg VI*2	18.4	10.4	40.7	29.4	22.6	17.2	8.4	1.71	0.61	0.27	0.34	10.2	4.6	10.0
Means	19.4	9.8	36.6	25.4	19.3	14.4	7.5	1.78	0.56	0.25	0.31	9.9	4.2	9.8
2.4. Cateto Sulino Precoce														
Arg VII*	13.6	10.5	33.2	24.5	18.5	13.6	10.6	1.80	0.60	0.28	0.34	7.4	3.8	8.8
2.5. Cateto Sulino														
Arg II	17.4	13.0	38.2	27.3	20.7	15.1	7.8	1.81	0.61	0.28	0.33	8.0	3.9	10.0
Arg III	16.9	12.5	38.3	27.4	20.7	16.1	9.5	1.70	0.59	0.24	0.35	8.6	3.9	9.6
Arg V	18.2	13.1	39.9	27.7	20.6	15.2	8.1	1.83	0.62	0.27	0.35	8.4	4.1	10.1
Urg I*	18.6	12.5	39.0	28.5	23.0	15.8	8.2	1.81	0.68	0.39	0.30	8.6	4.1	9.3
Urg II*2	17.6	11.6	39.6	27.0	20.4	15.1	8.2	1.79	0.63	0.28	0.35	8.9	4.0	9.5
Urg IV	16.7	12.4	40.0	29.4	22.6	15.4	9.4	1.90	0.73	0.38	0.35	8.9	3.8	9.6
Means	17.6	12.5	39.2	27.0	21.3	15.4	8.5	1.81	0.64	0.30	0.34	8.6	4.0	9.7
2.5.1. Cateto Sulino Escuro														
Urg V	16.3	16.4	37.9	26.9	20.6	15.2	9.0	1.77	0.66	0.30	0.36	6.9	3.4	8.9
Urg V-A*	16.8	17.0	42.0	29.8	22.7	16.8	9.1	1.78	0.63	0.29	0.34	7.1	3.7	10.3
Means	16.5	16.7	40.0	28.4	21.6	16.0	9.1	1.78	0.64	0.29	0.35	7.0	3.6	9.6
2.6. Cateto Sulino Grosso														
Urg III	14.5	19.4	44.1	32.7	25.7	19.0	11.7	1.72	0.70	0.35	0.36	6.9	3.5	9.7
2.7. Cateto														
SP VII	18.8	14.4	38.8	26.7	20.5	14.0	8.1	1.91	0.62	0.32	0.30	7.8	4.0	10.2
SP VIII	19.8	14.2	41.2	28.1	21.7	14.8	8.5	1.89	0.61	0.32	0.30	8.2	4.0	10.8
MG II	20.4	13.0	36.9	25.8	19.3	13.5	7.4	1.92	0.62	0.29	0.33	8.1	4.1	9.9
Ba I*	17.7	13.5	34.8	25.2	18.7	12.7	6.8	1.99	0.69	0.33	0.36	7.6	4.0	9.1
Ma I	17.5	14.3	33.7	24.9	18.3	13.0	7.3	1.92	0.68	0.31	0.38	7.1	4.1	8.7
Desc I	17.3	14.0	40.2	29.3	22.4	16.0	9.1	1.83	0.65	0.32	0.34	8.2	4.4	10.2
Ce I*	19.4	13.1	35.0	25.3	19.2	13.4	8.0	1.89	0.62	0.30	0.32	7.7	3.9	9.6
Pontinha*2,*3	16.4	13.2	38.0	26.0	18.0	13.2	7.4	1.97	0.59	0.22	0.37	7.8	4.0	10.8
Means	18.4	13.7	37.3	26.4	19.7	13.8	7.8	1.91	0.64	0.30	0.34	7.8	4.0	9.9
2.7.1. Cateto Assis Brasil														
RGS XIV	18.7	12.9	39.4	26.9	20.3	14.2	8.1	1.89	0.61	0.29	0.32	8.7	4.2	10.4
2.7.2. Cateto Grande														
Mt I	20.3	10.4	37.4	27.6	20.8	14.1	8.6	1.96	0.73	0.37	0.36	9.6	4.5	9.2

(Continued on page 88)

Table 7, cont.

Populations	Ear Length (cm)	Row No.	Ear Cross-Section Diameters (mm): Ear	Cob	Kernel Base	Rachis	Pith	Indices: Cob/Rachis	Glume/Kernel	Rachilla/Kernel	Kernel Covering	Kernels (mm): Width	Thickness	Length
2.8. Cateto Nortista														
GFr I *2	16.5	16.4	47.1	32.9	26.6	18.8	12.1	1.75	0.66	0.36	0.29	8.3	4.2	10.7
GFr II	17.4	17.3	50.3	38.7	31.5	24.1	15.4	1.60	0.74	0.37	0.36	8.2	4.1	9.9
GFr III	20.9	16.9	49.5	37.8	31.8	24.1	14.6	1.57	0.67	0.38	0.29	8.4	4.4	10.2
GFr IV *2,*3	13.0	14.8	40.4	32.0	24.6	18.0	10.4	1.78	0.74	0.35	0.39	8.0	3.6	9.4
Sur II	17.1	14.9	44.9	31.7	23.9	17.9	10.1	1.77	0.59	0.26	0.33	8.6	3.8	11.6
GFr VI	15.0	15.9	44.0	33.2	26.3	19.6	11.9	1.69	0.72	0.35	0.36	7.9	3.7	9.5
Sur III	16.4	14.7	45.5	31.8	25.6	18.6	11.7	1.71	0.60	0.32	0.28	8.5	3.7	11.0
Gln I	14.4	18.4	45.2	32.9	25.7	17.8	10.7	1.85	0.67	0.35	0.32	7.2	3.8	11.2
Gln II	17.5	16.6	48.6	36.5	29.4	20.1	11.9	1.82	0.73	0.42	0.32	8.3	4.0	11.2
Gln III	13.3	17.0	44.4	34.0	27.6	19.7	11.1	1.72	0.77	0.43	0.34	7.8	3.9	9.2
Means	16.1	16.3	46.0	34.1	27.3	19.9	12.0	1.73	0.68	0.36	0.33	8.1	3.9	10.4
2.8.1. Cateto Nortista Precoce														
Sur I	16.0	13.8	41.3	29.6	22.7	17.4	9.9	1.70	0.60	0.34	0.34	8.2	3.6	10.1
3. RECENT COMMERCIAL														
3.1. Dente Riograndense														
3.1.1. Dente Riograndense Rugoso														
RGS I	17.3	14.8	52.7	31.5	25.0	18.2	9.0	1.73	0.44	0.22	0.22	9.4	3.6	15.1
RGS II	18.0	14.7	52.2	32.1	25.7	18.3	9.3	1.76	0.49	0.26	0.23	8.8	3.5	14.1
RGS III*3	16.6	14.0	45.9	29.6	22.3	16.6	10.3	1.78	0.45	0.23	0.25	9.2	3.6	14.4
RGS IV	19.2	13.7	50.7	31.8	24.8	18.4	8.2	1.73	0.50	0.24	0.26	9.6	3.8	13.5
Means	17.8	14.3	50.4	31.3	24.4	17.9	9.2	1.75	0.47	0.23	0.24	9.2	3.6	14.3
3.1.2. Dente Riograndense Liso														
RGS V	18.9	14.6	48.7	31.4	24.3	17.9	9.9	1.76	0.54	0.26	0.28	9.1	3.8	12.5
RGS VI	20.2	13.7	46.2	33.1	26.1	19.0	10.7	1.74	0.62	0.31	0.31	9.1	4.2	11.5
SC I	17.7	13.0	46.2	29.7	22.7	16.4	8.8	1.80	0.52	0.25	0.27	9.5	3.8	12.8
Means	18.9	13.8	47.0	31.4	24.4	17.8	9.8	1.77	0.56	0.27	0.29	9.2	3.9	12.2
3.2. Dente Paulista														
SP III	19.5	14.8	45.2	30.3	23.9	17.3	9.3	1.75	0.54	0.28	0.27	8.7	4.1	12.0
SP IV	17.9	13.7	46.2	30.3	23.6	16.6	9.1	1.83	0.57	0.29	0.28	8.6	3.7	12.1
MG I	19.6	14.6	47.9	33.0	25.2	17.4	8.8	1.90	0.66	0.33	0.33	9.1	4.3	11.8
Means	19.0	14.4	46.4	31.2	24.2	17.1	9.1	1.83	0.59	0.30	0.29	8.8	4.0	12.0
3.3. Dente Branco														
3.3.1. Dente Branco Riograndense														
RGS X	17.9	12.7	49.9	30.6	23.8	17.0	9.1	1.80	0.47	0.23	0.23	10.2	3.5	14.5
RGS XI	19.0	13.4	46.6	29.7	22.0	16.3	8.0	1.82	0.52	0.22	0.30	9.2	3.8	12.9
RGS XII	17.1	14.0	51.2	31.9	25.7	17.9	9.6	1.78	0.44	0.24	0.19	9.7	3.8	15.9
RGS XIII	16.9	13.3	50.9	31.4	23.4	16.3	8.5	1.93	0.52	0.25	0.27	9.8	3.6	14.5
SC II	18.0	10.6	43.7	28.2	21.3	15.5	8.1	1.82	0.50	0.23	0.27	10.7	3.9	12.6
Means	17.8	12.8	48.5	30.3	23.2	16.6	8.6	1.83	0.49	0.24	0.25	9.9	3.7	14.1
3.3.2. Dente Branco Paulista														
SP V	17.5	14.4	48.5	31.9	24.7	17.6	8.9	1.81	0.57	0.28	0.29	9.1	3.8	12.5
3.4. Semi-Dentado														
3.4.1. Semi-Dentado Riograndense														
RGS XV	18.9	13.6	43.9	30.0	21.5	17.1	9.5	1.76	0.56	0.19	0.37	8.9	4.0	11.5
RGS XVI	19.3	13.1	42.6	30.4	22.7	16.8	8.8	1.81	0.64	0.28	0.37	9.4	4.1	10.6
Means	19.1	13.3	43.3	30.2	22.1	16.9	9.2	1.78	0.60	0.23	0.37	9.2	4.0	11.1
3.4.2. Semi-Dentado Paulista														
SP IX	19.4	14.5	43.7	30.4	23.4	16.8	9.8	1.81	0.60	0.29	0.31	8.4	4.0	11.2
Mt VII	17.4	14.7	44.6	30.5	24.5	17.4	8.7	1.75	0.60	0.32	0.27	8.8	4.0	11.0
Pag I	18.2	14.5	49.3	35.3	26.9	19.8	11.0	1.78	0.67	0.31	0.36	9.3	4.0	11.5
Means	18.3	14.6	45.8	32.1	24.9	18.0	9.8	1.78	0.63	0.31	0.32	8.8	4.0	11.2
3.5. Cravo														
3.5.1. Cravo Riograndense														
RGS VII	15.2	20.2	47.7	31.8	25.5	18.2	10.2	1.75	0.51	0.28	0.23	7.1	3.5	13.4
RGS VIII	15.7	18.6	48.7	31.0	24.6	17.4	9.3	1.78	0.49	0.26	0.23	7.0	3.4	13.9
Means	15.5	19.4	48.2	31.4	25.1	17.8	9.7	1.76	0.50	0.27	0.23	7.0	3.4	13.6
3.5.2. Cravo Paulista														
SP I	14.2	22.3	50.0	31.5	24.7	17.3	9.9	1.82	0.53	0.27	0.25	6.4	3.3	13.5
SP II	16.1	19.1	48.6	31.8	24.9	18.1	10.3	1.76	0.52	0.26	0.26	7.4	3.3	13.1
Means	15.2	20.7	49.3	31.6	24.8	17.7	10.1	1.79	0.52	0.27	0.26	6.9	3.3	13.3
4. EXOTIC COMMERCIAL														
4.1. Hickory King														
RGS IX	19.7	8.5	41.8	25.4	19.2	12.9	6.5	1.97	0.48	0.24	0.24	12.5	4.0	13.0
4.2. Tusón														
Ba III	20.0	14.4	50.3	34.1	28.5	21.1	12.3	1.62	0.55	0.31	0.24	9.4	4.1	11.8

* Data for 1960 missing
*2 Data for 1963 missing
*3 Data for 1965 missing

Table 8. Yields of Some Races of the Brazilian Germ Plasm Bank.

Races	Yields in percent of double crosses H6999 and Ag 17
Moroti	68.2 (4)
Caingang	68.0 (4)
Lenha	51.0 (5)
Cristal	67.9 (1)
Canario de Ocho	33.7 (5)
Cateto	76.0 (1)
Cateto Assis Brasil	78.7 (2)
Cateto Nortista	63.7 (5)
Dente Riograndense	78.3 (1)
Dente Paulista	76.4 (1)
Dente Branco Riograndense	75.2 (3)
Dente Branco Paulista	83.2 (4)
Semi-Dentado	84.2 (4)
Cravo	74.2 (3)
Hickory King	62.5 (2)
Tusón	97.0 (4)

(1) Average of 14 yield trials, 5 years.
(2) Average of 4 yield trials, 4 years.
(3) Average of 3 yield trials, 2 years.
(4) Average of 2 yield trials, 2 years.
(5) Average of 1 yield trial, 1 year.

Table 9. Grain Yields (kg/ha) for Parents (Diagonal), F_1 Crosses (Upper Figures in Upper Diagonal), F_2's (Lower Figures in Upper Diagonal), BC_A (Upper figures in Lower Diagonal) and BC_B (Lower Figures in Lower Diagonals), Together with Means of F_1's and F_2's (Last Column) and Means of BC's (Lower Row). Averages of Two Years 1960 and 1961. Piracicaba, S. P., Brazil. (Paterniani unpublished).

Parents P_A \ P_B	Piramex	Piracar	Dente Rio-grandense	Dente Paulista	Cateto	Cristal	Averages of F_1's and F_2's
		6852	6514	5824	5660	5756	6121
Piramex	5890	6110	6552	5361	5622	5683	5866
	5834		5640	5811	5928	5654	5977
Piracar	6026	4992	5938	5412	5222	5314	5599
Dente	5796	5872		5214	5664	5142	5635
Riograndense	5592	5578	4686	5062	5082	4838	5494
Dente	5520	5498	4992		5074	4847	5354
Paulista	6498	5938	4944	4624	5152	4746	5147
	5876	5470	5480	4760		4316	5328
Cateto	6128	5561	5570	4849	4830	4746	5165
	4538	4790	4364	4718	3909		5143
Cristal	5782	5938	4745	5214	4980	3276	5065
Averages of backcrosses	5759	5650	5293	5293	5258	4898	

BC_A = backcross to parent P_A

BC_B = backcross to parent P_B

Table 10. Collections * Composited to Form Each Representative Population.

1.1. Morotí – RGS XIX: 741, 1444; Pr I: 34-35, 72-73, 198, 200, 755, 2062; Pr II: 774; Pe I: 235; Mt II: 63-64; Mt III: 71, 208; Mt IV: 50, 65-69, 207, 759, 765; Mt V: 51-59; Pag V: 40-41, 44, 90, 97-98, 100-104, 105, 108, 111, 112, 113, 118, 120-121, 330, 767; Pag VI: 43, 95, 99, 109, 114, 117, 119, 766; Pag VII: 124-125, 127; Bol II: 91-93; Bol III: 86, 88-89.

1.1.1. Morotí Precoce – Bol I: 47, 49, 77-85, 87.

1.1.2. Morotí Guapí – Pag VI-A: 114.

1.2. Caingang – Pr III: 1, 4-22, 23, 29-30, 33, 94, 190, 758; SP XIII: 188, 192, 194, 756, 761; SP XIV: 191, 206.

1.3. Lenha – RGS XX: 556, 558, 560.

1.4. Entrelaçado – Mt VI: 2364-66, 2368, 2372, 2374-75, 2376-77, 2479-80.

2.1. Cristal Sulino – Arg I: 2420; Arg VIII: 570, 572, 575-76, 578-80, 581, 605-06; Urg VIII: 739.

2.2. Cristal – SP X: 1829, 2033, 2100, 2197, 2255, 2534, 2651, 2666, 2698; SP XI: 1738, 1797, 1838, 1919, 1994, 2017, 2024, 2053, 2092, 2163, 2214, 2249, 2274, 2277; SP XII: 2193; MG III: 2307, 2321, 2659-60, 2674, 2681, 2696; Ba II: 2390.

2.2.1. Cristal Semi-Dentado – Pag II: 129, 131, 134-35, 138, 144, 146, 149, 152; Pag III: 150-51.

2.3. Canario de Ocho – Arg. IV: 2419; Arg VI: 2448; Urg VI: 743.

2.4. Cateto Sulino Precoce – Arg VII: 2424.

2.5. Cateto Sulino – Arg II: 2401, 2407, 2431, 2444; Arg III: 2399, 2400, 2403-06, 2408-10, 2412-15, 2417, 2422-23, 2425-26, 2428-33, 2434, 2435-36, 2437-38, 2439-41, 2443, 2445-46, 2449-50; Arg V: 2398, 2402; Urg I: 596, 600; Urg II: 618-20, 621-23, 624, 625, 626, 627-30, 632-33, 634, 635, 636, 637, 638-44, 645, 646-50, 652, 654, 730; Urg IV: 655, 661, 662-63, 664, 665, 666-669, 670, 671-72, 673-74, 675, 677, 678, 680, 690, 701-02, 703, 704-06, 707, 731, 734, 746-47.

2.5.1. Cateto Sulino Escuro – Urg V: 679, 682, 698-99; Urg V-A: 779.

2.6. Cateto Sulino Grosso – Urg III: 683, 684, 693, 700, 710, 727.

2.7. Cateto – SP VII: 1646, 1729, 1741, 1744, 1851, 1879, 1901, 2008, 2026, 2032, 2035, 2067, 2078, 2152, 2173, 2284, 2317, 2332, 2344; SP VIII: 197, 214, 352, 368, 374, 392, 405, 419, 422, 1745, 1747, 1752, 1760, 1771, 1792, 1836, 1842, 1843-44, 1884, 1910, 1915, 1917, 1927, 1929, 1985, 1986, 2000, 2028, 2089, 2126, 2132, 2140, 2168, 2180, 2182, 2191, 2202, 2206, 2208, 2240, 2242, 2251-52, 2263, 2265, 2270, 2273, 2291, 2293, 2304; MG II: 2485, 2478, 2487, 2503, 2509-10, 2515, 2527, 2533, 2708, 2742; 2743; Ba I: 2351, 2473; Ma I: 2339; Desc I: 75, 76; Ce I: 448; Pontinha.

2.7.1. Cateto Assis Brasil – RGS XIV: 1524, 1534, 1543, 1544, 1546, 1549, 1560, 1562, 1567, 1574.

2.7.2. Cateto Grande – Mt I: 60, 61.

2.8. Cateto Nortista – GFr I: 784; GFr II: 786; GFr III: 788; GFr IV: 790, 791; Sur II: 792; GFr VI: 785; Sur III: 797, 799, 801, 803, 804; Gln I: 808-09; Gln II: 813-17; Gln III: 810.

2.8.1. Cateto Nortista Precoce – Sur I: 802.

3.1.1. Dente Riograndense Rugoso – RGS I: 910, 919, 933, 941, 994; RGS II: 820-22, 823-25, 826, 828, 838, 846, 853, 855, 857, 860, 862, 869-70, 874, 877-78, 879, 881-82, 883, 885, 887, 894-95, 896, 900, 902, 931, 937, 938, 945-46, 949, 951, 953, 964, 975, 976, 982-83, 988, 990, 1009-10, 1011, 1015, 1017, 1021, 1024, 1025-26, 1028-29, 1032, 1037, 1040, 1042, 1043, 1048, 1051, 1089, 1098, 1099, 1117, 1138, 1139, 1145-46, 1164-65, 1170, 1175, 1198; RGS III: 829, 940, 1033; RGS IV: 310, 827, 830, 835, 836-37, 839-40, 842, 843-44, 847, 848, 849-50, 851, 854, 856, 858-59, 861, 863-64, 866-67, 868, 875, 884, 886, 888, 890, 891-92, 893, 897, 899, 901, 903, 905, 910-11, 912, 913, 918, 923-24, 927, 929, 934-35, 936, 944, 952, 960, 962-63, 968, 970, 972, 978, 979, 984-85, 995, 996, 998, 1000, 1003, 1005, 1013-14, 1019-20, 1023, 1027, 1031, 1036, 1038, 1044, 1060, 1061, 1062-63, 1064, 1065, 1066, 1067-72, 1074, 1076, 1077, 1079, 1080-81, 1082-84, 1086-87, 1090, 1093-94, 1095, 1097, 1100, 1102, 1105,

(Continued on page 91)

Table 10. cont.

1106-07, 1108, 1109-10, 1112, 1113, 1115-16, 1118-20, 1121, 1124-26, 1128, 1129, 1130, 1131, 1133, 1134, 1135, 1136, 1142, 1143, 1144, 1149, 1150, 1152, 1153, 1154-55, 1156, 1157-59, 1160, 1161-62, 1163, 1165-66, 1168, 1172-73, 1174, 1180, 1182, 1185-87, 1189, 1192, 1193, 1195, 1196, 1208, 1233, 1238-39, 1242, 1244, 1258, 1270, 1279-80, 1306-07, 1310, 1323, 1327, 1674, 1721.

3.1.2. Dente Riograndense Liso – RGS V: 889, 917, 921, 928, 943, 956, 958-59, 981, 993, 1006, 1034, 1058-59, 1114, 1151, 1169, 1176, 1177, 1181, 1188, 1301, 1717, 1720; RGS VI: 948, 980, 1052, 1171; SC I: 1632, 1644-45, 1648-52, 1663-64, 1666, 1668-69, 1673, 1675-76, 1682, 1685, 1696, 1704.

3.2. Dente Paulista – SP III: 1789, 1805, 1858, 1903, 1906, 1926, 1973, 1988-89, 2002, 2042, 2138, 2143, 2190, 2238, 2239, 2246, 2258, 2260, 2280; SP IV: 1725-26, 1727, 1733-34, 1739, 1746, 1762, 1764-65, 1767, 1768, 1770, 1772-76, 1778, 1784, 1789, 1801, 1804-06, 1808-09, 1815, 1820-21, 1833, 1844-45, 1847, 1849, 1858, 1859, 1861-63, 1867-68, 1871-72, 1878, 1880, 1885, 1889, 1895-96, 1898, 1903, 1906-08, 1921, 1923-24, 1926, 1930, 1931, 1935, 1936, 1942, 1943-44, 1951-52, 1954, 1958, 1960, 1961, 1962, 1963, 1966, 1969, 1972-73, 1976, 1977, 1979, 1988-89, 1999, 2002, 2004, 2006-07, 2010, 2013, 2022-23, 2034, 2036, 2037, 2040-42, 2044-45, 2058, 2065, 2070-71, 2075, 2077, 2080, 2083-84, 2088, 2093-94, 2096, 2097, 2101, 2103-04, 2108-09, 2120, 2121-22, 2127-29, 2134-35, 2131, 2137-38, 2143, 2145, 2148, 2151, 2153-57, 2159, 2166, 2175, 2176, 2183, 2185, 2190, 2199, 2200, 2215, 2219, 2221-22, 2224, 2229-31, 2234-35, 2236, 2237-38, 2239, 2243, 2246, 2248, 2250, 2258, 2260, 2261, 2269, 2272, 2275, 2280-82, 2286, 2289-90, 2297, 2301, 2303, 2305, 2309-11, 2313, 2316, 2318, 2320, 2322, 2324, 2325-27, 2482-84; MG I: 2493, 2499, 2505, 2507, 2516, 2522, 2526, 2529, 2668, 2704, 2711, 2717, 2719, 2722, 2725, 2730, 2735-41.

3.3.1. Dente Branco Riograndense – RGS X: 1345, 1353, 1355, 1358, 1368, 1371, 1373, 1375, 1382-83, 1384, 1387, 1401, 1410, 1412, 1418-19, 1429, 1432, 1441, 1443, 1447, 1450, 1453-54, 1456, 1464, 1470, 1473, 1477, 1481, 1486, 1491, 1500-01, 1508, 1510; RGS XI: 1319, 1391, 1430-31, 1442, 1460, 1505, 1513; RGS XII: 1578, 1583, 1587, 1602; RGS XIII: 1582, 1591, 1604; SC II: 1455, 1701, 1703, 1705, 1707, 2232.

3.3.2. Dente Branco Paulista – SP V: 222, 1620, 2054-55, 2079, 2105, 2179, 2264, 2276, 2321.

3.4.1. Semi-Dentado Riograndense – RGS XV: 1537, 1555, 1559, 1565, 1570, 1571; RGS XVI: 1520-21, 1522, 1523, 1525-31, 1533, 1535-36, 1539, 1541-42, 1545, 1547-48, 1550-52, 1553, 1554, 1556-58, 1561, 1563, 1564, 1566, 1568-69, 1572, 1573, 1575-77.

3.4.2. Semi-Dentado Paulista – SP IX: 1824, 1996, 2024, 2672, 2716; Mt VII: 2353, 2355, 2360; Pag I: 154, 162, 164-65, 186.

3.5.1. Cravo Riograndense – RGS VII: 1209, 1219, 1224, 1251, 1261, 1262, 1265, 1290, 1325, 1332-33, 1337; RGS VIII: 1078, 1197, 1207, 1211, 1212-14, 1216, 1217, 1220, 1222-23, 1229-30, 1232, 1235-37, 1245, 1247, 1254, 1255, 1266-67, 1269, 1272-74, 1283, 1289, 1291, 1296-97, 1300, 1302, 1303, 1312, 1322, 1326, 1334, 1338, 1340-41, 1607-08, 1733.

3.5.2. Cravo Paulista – SP I: 1945, 2142; SP II: 1761, 1807, 1856, 1971, 2082, 2111, 2118, 2124, 2144, 2158, 2160, 2223, 2268.

4.1. Hickory King – RGS IX: 1346, 1352, 1364, 1389, 1403, 1433, 1439, 1445, 1455, 1483, 1492-93, 1495, 1499, 1517, 1719.

4.2. Tusón – Ba III: 2745.

* The collection numbers given were assigned at the Brazilian Germ Plasm Bank. They are consecutive over collections from all countries represented and correspond to NAS-NRC numbers 1999-2611, 6988-7156, 8443-9714, and 10,598-10,922 in the reports of the Committee on Preservation of Indigenous Strains of Maize (1954, see especially pages 7 and 14; 1955, see especially pages 2 and 4). Collections beyond No. 2378 have yet to be formally catalogued, but plans have been made to do so by the Maize Germ Plasm Committee of the Rockefeller Foundation. Underlined collections are currently available from CIMMYT.

Table 11. Typical Collections of the Races from the Humahuaca Valley of Argentina and Typical Collections of the Guaraní Popcorns.

Capia Blanco: Arg. *462, 463, 499.*
Rosada: Arg. *460, 489*
Carapata: Arg. 459
Amarillo: Arg. 461*
Varriegata: Arg. 458*, 497*

Capia — Amarillo de Ocho: Arg. *454, 455,* 457
Achilli: Arg. *469, 538.*
Chulpi: Arg. *484*
Amarillo de Ocho: Arg. 509
Culli: Arg. *471*
Marron: Arg. *468*
Morocho: Arg. *467,* 536
Altiplano: Arg. *472, 533*
Oke: Arg. *473, 539*
Bola Blanca: Arg. *470, 532*
Pisincho: Arg. *481, 482, 541*

Avatí Pichingá — A: 2508, *2760, 2784-85, 2799,* 2453*, *2463**, 2467*, *2773*, 2776*, 2798*, 2801*, 2804*, 2823**

Avatí Pichingá — B: *2778,* 522*, *2460*, 2767*, 2786**

Avatí Pichingá Ihú: *169,* 180-81, 184, *2766, 2827, 2830,* 166*, 170*, 178*, 185*, 2331*, 2452*, 2455*, *2459**, 2470*, 2474*, *2758*, 2762-63*, 2781*, 2793*, 2807*, 2816*, 2824-25*, 2829**

*Less typical samples
Italicized collections are available from CIMMYT.

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