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RACES OF MAIZE IN PORTUGAL

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ABSTRACT

The study of the possible races of maize in Portugal was done from 163 samples of open pollinate varieties. It was concluded after detailed determination of the characteristics of each variety that these could be grouped in 10 races.

The races were all classified as *Zea Mays* L. convar. *vulgaris* Körn. (*Z. indurata* Sturtev.), race Microsperma (M), race Crossed Microsperma (× M), race Eight Rows (8 r), race Conical Eight Rows Crossing (C × 8), race Small Conico (Cp), race Crossed Conico (× C), race Conico (C), race Big Conico (Cg), race Large Eared (CN), and race Gigantil (A).

INTRODUCTION

Even a first attempt, as this report is, would not have been possible without the full understanding that DeKalb AgResearch, Inc. has always displayed toward all projects in the field of research which may contribute to a better knowledge and improvement of the conditions in which maize breeding may be developed.

It had been a long time ambition to make a full survey of the varieties grown in this country before the introduction of new germplasm from the U. S. cornbelt (Costa-Rodrigues, 1949) but several reasons prevented the accomplishment of such a project.

Fortunately, only under this prism, when in 1965 and 1966 we were able to obtain the present samples through the friendly cooperation of Proselecte Lda., the use of maize hybrids with foreign germplasm could be considered negligible and actually no drastic introgression of this type of material was found in the present samples.

In spite of the size of the country, there is a great variation in maturity, ranging according to the FAO classification from 100 to 1000. This variation is influenced mainly by the temperature distribution, by the possibility of planting maize from February to July under dry-farming or irrigation, and by harvesting from July to late October according to locations and particular conditions of the crop.

This is enough to demonstrate that the number of samples involved in this study, 163, is far fewer than needed to assure a through survey of the present races, and to build the germplasm bank so necessary for future work and preservation of the local gene systems.

We hope with this report to rise the attention of those interested in maize in order to start a joint effort for a complete study of the races of maize in Portugal.

For inherent reasons, this collection was grown in 1967 and 1968 in the U. S. A. at Dekalb, Illinois, and samples of the varieties are available for those interested.

GEOGRAPHY AND CLIMATE

Continental Portugal (Duarte Amaral, 1962) is the most Southwestern part of Europe bordered on the West and South by the Atlantic Ocean and on the North and East by Spain. The total surface area is about 88,852 square kilometers. The longest distance N-S is approximately 561 km, and the widest distance is 218 km.

Orographically, the most important mountain range is part of the central Iberic Meseta and lies North of the Tagus River. This zone has a mean altitude of 370 meters with more than fifty percent of the land above 400 m, and approximately twenty percent above 700 m. The area South of the Tagus River has a mean altitude of 160 meters with only three percent of the land above 400 m.

Two thirds of the total area of the country has very poor soils, thin and with frequent rock outcrops. They are the so-called lithosols, brown podzolic soils, podzolic sands, regosols, acid brown soils, sandy soils, etc.

The best soils are represented by eight percent, primarily by alluviums, Mediterranean red soils, and reddish brown or black clay soils.

The climate characteristics are clearly Mediterranean with two quite different periods of pluviosity — a cold humid period from October to March and a warm dry one from April to September. The Northern part of the country is more distinctly influenced by the Atlantic. However, certain inland areas, being protected by higher mountains, have a continental influence.

Although the regime of rains is the same throughout the entire country, the total precipitation differs quite significantly decreasing from NW to SE.

In the North, the annual mean precipitation is over 800 mm; in the Center it averages around 600 mm, and near the Southern border about 400 mm. In the Fall-Winter period, the rains are very irregular and inconsistent from year to year. The rule is the unexpected, with periods of steady rain providing all the inconveniences for soil conservation and agricultural work, alternating with periods of drought. There is either too much or not enough rain to agree with the needs of the agriculture.

In general, the temperatures are quite favourable, with the isothermic of 15° C dividing the country in about two equal parts, North and South, with some escalation from the coast to the inland.

The variety of climatic influences allied with the irregularity of the topography allows for a diversified agriculture in spite of the small area of the country.

Roughly we can divide the country in the following areas:

Arable land, etc.		3,160,000 ha
Plantations:		
Vineyards	350,000 ha	
Olive trees	420,000 ha	
Fruit trees	200,000 ha	
		970,000 ha
Forest		2,500,000 ha
Others		2,255,200 ha
	Total	8,885,200 ha

The maize crop extends mainly in the Northwest and Central parts of the country with a total area of approximately

450,000 ha. To the North of the Tagus River we find that 92 % of the farms have less than 5 ha and cover 51 % of the area, whereas only 0.5 % of the farms have more than 100 ha, and 7 % of the land area. In the South the number of farms with less than 5 ha is 74 % corresponding to 6 % of the land area. Here the number of farms with more than 100 ha is 2 % but represents 66 % of the area.

About 90 % of the crops are under dry-farming and only 10 % under irrigation.

COLLECTING PROCEDURE

The collections were made directly from farmer's fields at harvest time. An effort was made to obtain a minimum sample of ten ears, includding as many examples as possible of the variation in plant and ear type.

At the time of collection, another effort was also made to obtain pertinent information such as locality, county, and local name of the variety or cultivar. Most of the varieties are known only by the locality and we had to limit ourselves to the registration of the county name for uniformity of data.

The ears collected had to be shelled and the seed shipped to the U. S. A. where the samples were grown in two nine hill rows, two plants per hill, in isolated open pollination to attain full growth and development. Another two rows were used for increase by total sibbing. This seed is in cold storage at De Kalb, Illinois, identified by the numbers referred in the text.

CHARACTERS USED IN CLASSIFICATION

The characters used in classifying the Portuguese races were essentially those used previosly in studies of the races of other countries (Wellhausen *& al.*, 1951 and 1958; Brown, 1953; Hatheway, 1957; Roberts *& al.*, 1957; Brieger *& al.*, 1958; Ramirez *& al.*, 1960; Grobman *& al.*, 1961; Timothy *& al.*, 1961, 1963; Sanchez Monge, 1962), slightly modified by agreement at the meeting on germplasm program held at Minoprio, Italy, in March of 1968 by the European Association for Research in Plant Breeding (EUCARPIA), Maize and Sorghum Section, Southern Committee.

All the measurements of the plant, tassel, and ear characters were made in the same 10 plants of each variety. These ten plants were selected among the possible highest number of thirty-six plants (and if necessary seventy-two plants) by counting the number of leaves above the highest ear of each plant and selecting the group of plants with the highest frequency of the same number of leaves above the ear. The total number of leaves was counted, identifying the 4th, 8th, and 12th leaf by means of a couple of holes made by a common paper punch. Racial means were obtained by averaging the data of the varieties admitted to be included in each race (Table I).

Vegetative plant characteristics

Maturity

Data were taken when 50 % of the plants were at mid-pollination and silking time and they are given as the number of days from planting. With the particular weather conditions of 1968, it is necessary to allow in general 16 days in mean for emergence.

Plants were harvested 65 days after the mid-silking day and determinations were made of the moisture content of the grains of two rows of ten ears but not of the ears of the selected ten plants.

Height of plant

Taken in centimeters from ground level up to the tassel top.

Height of exsertion of highest leaf

Taken in centimeters from ground level.

Height of highest node

Taken in centimeters from ground level.

Height of ear

Taken in centimeters from ground level to the vertex of the angle of insertion of the uppermost developed ear on the stalk.

Total number of leaves and leaves above the ear

Leaf identification starting with the 4th leaf as it is mentioned above allows exact counting.

Length of leaf

Measured in centimeters from the ligule to the tip of the leaf arising at the ear-bearing node.

Width of leaf

Measured in centimeters, it was the maximum width at the longitudinal mid-point of the same leaf used to measure the length.

Plant internode pattern

Diagrams were obtained after measuring all ten plants of each variety and averaging for each race. The upper ears are represented by triangles. The filled triangles mean that that particular position of the ear was the most common in relation to the number of internodes above the ear. If there is a traced triangle, it means that this position runs second in frequency of varieties with that number of internodes above the ear. If the triangle is empty, it just means that it is the least important position in relation to the frequency of varieties with that internode number within each race.

Stem diameters

Measured in millimeters at the middle of the first internode above ground, before harvest.

Color of plant

Observed on the leaf sheath for each variety; 1 is for light green, 2 for medium green, 3 for dark green, *RS* for sun red, *RSD* for diluted sun red, and *P* for purple. The decimal points result from averaging the varieties for each race. There were no plants with red or purple.

Presence of tillers

This was determined in each plant and if present, it was given the one unit value. It is necessary to notice that these tillers were always short, never reaching 50 cm in length, and the plants were in a very low population, maximum of 36,000 per hectare.

E. D. D.

Effective degree days, determined by the formula:

$$\frac{(50 + \textit{min. above } 50^{\circ}) + \textit{max.} - \textit{deg. over } 86^{\circ}}{2} - 50$$

as referred by Gunn & Christensen (1965).

Characters of the tassel

Tassel length

The lenght was measured in centimeters from the point of origin of the lowermost branch to the tip of the central spike.

Peduncle

Taken by difference, it is the distance between the highest node and the point of origin of the lowermost branch of the tassel.

Length of branching space

It is the distance between the point of insertion of the basal and the uppermost branch along the axis of the tassel.

Total number of primary branches

All primary branches were counted independently of their size.

Total number of secondary branches

More than one secondary branch per primary could be found.

Presence of terciary branches

The presence of terciary branches was determined in each plant and given the value of one unit if found.

Presence of branching space

This is the length of the branching space relative to total tassel length, expressed in percentage.

Characters of the ear

Number of husks

Just before harvest.

Length of husks

In relation to the ear, 1 if shorter, 2 covering the ear, 3 exceeding the ear.

Presence of flag-leaves

The presence of flag-leaves was determined in each plant and given the value of one unit if found.

Form of the ear

It was evaluated according to Pavličić & Trifunović (1966) by the Fleischman formula where the difference of the diameters of the base and the top is multiplied by 100 and divided by the length of the ear in centimeters. The authors considered the coefficients as follows: 0-4 cylindrical, 4-6 slightly conical, 6-10 conical, and above 10 very conical ear form. Though the limits for this index are slightly different in the present study, we kept the same classification for the purpose of future comparison among the European races.

Number of rows

This is given as the most frequent number on the central part of the ear in the ears of each variety and averaged for each race.

Number of kernels per row

It is the potential number on two rows of each ear.

Ear length

It is given in centimeters.

Ear diameter

This is taken in millimeters at the ear top, two centimeters from the tip, at mid-ear, and at the bottom of the ear.

Cob diameter

It was measured in millimeters, with calipers, from the upper surface of the upper glumes.

Rachis diameter

It was measured in millimeters at the lower half of the broken ear, with calipers, from the base of the upper glume.

Pith diameter

It was measured in millimeters with calipers on the surface of the lower half of the broken ear, averaging the greatest and smallest diameters.

Color of the glumes

It is given as the range in each race.

Color of the rachis

It is given as the range in each race.

Color of the pith

It is given as the range in each race.

Lower glume pubescence

The relative density and length of hairs was given a visual score from 1 (none) to 3 (very pubescent).

Lower glume texture

It was classified on the basis of relative hardness when punctured with a needle. The score ranged from 1 (soft) to 4 (hard).

Rachis induration

It was scored from 1 (soft) to 4 (hard) when punctured with a needle.

Kernel characteristics

Length

This was measured on ten shelled kernels from the middle of the ear, with calipers in millimeters.

Width

This was measured in the same way as the kernel length.

Thickness

Measurements were taken with calipers on ten consecutive unshelled kernels from the middle of the ear.

Hardness

Visual estimates were based on the texture and resistance to puncture with a needle. It was scored from 1 (hard) to 5 (soft).

Denting

A visual score was used ranging from 0 true flint, 1 flint (soft spot), 2 light dent, 3 normal dent, 4 rough dent, to 5 collapsed.

Rachilla length

Subtracting the diameter of the rachis from the diameter of the ear, dividing by two and subtracting the kernel length, this measure represents the average length of the rachilla. The variation found in the present material ranged from 0.1 to 3.8.

The rachilla is shortened as a result of incorporation of teosinte genes.

Cob/rachis index

This is computed by dividing the diameter of the cob by the diameter of the rachis. The variation in the present varieties ranged from 1.4 to 2.3.

A high index shows the presence of large glumes due to the presence of one of the intermediate alleles of the locus *Tu-tu* as mentioned by Wellhausen *& al.*, 1951.

Glume/kernel index

It is computed by subtracting the diameter of the rachis from the diameter of the cob and dividing the figure obtained by twice the average length of the kernel. The range of variation in the present material went from 0.99 to 0.43.

As referred by Wellhausen *& al.* (1951) this index provides an indication of the alleles at the locus *Tu-tu* (*Tu* tunicate, tu^h half tunicate, tu^w weak tunicate, and *tu* normal).

Rachilla/kernel index

This is the length of the rachilla relative to the length of the kernel. The variation ranged from 0.01 to 0.47.

Pericarp, aleurone, endosperm, and kernel color

A visual classification was given to each of these four characteristics under the form of a range classification.

Weight of 100 kernels

This weight was given in grams.

Specific weight

This value is obviously the weight of the kernels in 100 cc.

RACE DESCRIPTION

The nomenclature of the races described in previous papers on this subject apparently has been based on the name of a variety known in this way throughout the zone of its distribution and the description of the race based on those samples that seemed to fit better the characteristics understood as defining each particular race.

In the present report, common names were not easy to find, and if found, many times the same name was applied to quite different varieties.

An attempt was made to connect Andrade Corvo's classification of 1870, mentioned by Cunha Monteiro & Vilhena (1926), with the present races but only the name 'Gigantil' could be adopted for the last race here discribed.

In an earlier study of the maize crop in the region of Entre-Minho e Douro (Cincinato da Costa, 1924) either the expression «milho amarelo» or expressions merely indicating the place of origin of the maize were commonly used.

Even if common names were found more extensively and a special effort were made in this direction, the multitude of names would force us to consider a greater number of races which will be quite in disagreement with the definition of race given by Anderson & Cutler (1942) as «a group of related individuals with enough characteristics in common to permit their recognition as a group».

On the other hand, the races of maize described in the present study do not arise as extensive ecological races, but more as products of intensive artificial selection which resulted in the maintenance of certain typical characteristics at low levels of variability within each agricultural microclimate as it can be understood by the dispersion of the varieties belonging to the same race.

As we shall try to describe each race, we shall point out those characteristics of one or another sample included in each race that seem to make that sample slightly unique but

that considering all the other characteristics, had to be included in the same group.

All the varieties or cultivars sampled in this study can be classified as *Zea Mays* L. convar. *vulgaris* Körn. (*Z. indurata* Sturtev.).

Race MICROSPERMA (M)

Plant

Early maturity, 68 to 71 days to mid-silking, 133 to 136 days at harvest with 24 % to 34 % moisture content in the

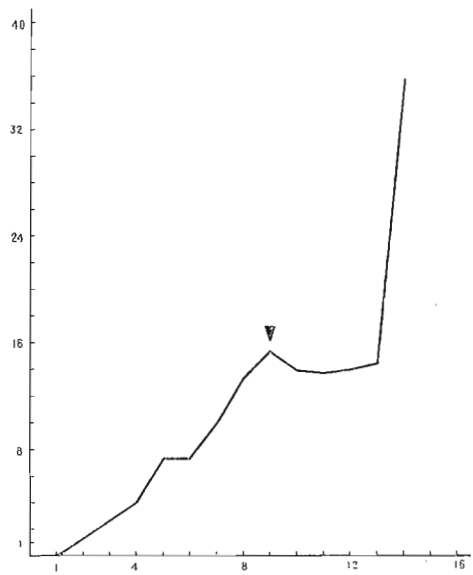

Fig. 1 — Internode pattern of the Microsperma race.
Modelo dos entrenós da raça Microsperma.

grain, 2118 to 2178 E. D. D. units, short plants average height 103 to 124 cm; ear averaging 29 to 60 cm above ground placed always on the 5th node counting from above (Fig. 1); average number of leaves 12 to 14; leaves short and narrow; 40 % of the plants tillering; plant color between medium and dark green.

Tassel

Medium short peduncle, tassel and branching space; 42 % of branching; high number of primary and secondary branches, presence of terciary branches in 10 % of the plants.

Ear

Presence of flag-leaves very common, 10 to 14 husk leaves exceeding the ear; slightly conical ear with 10 to 14 rows of kernels well imbricated (Fig. 2); average ear length 10 to 13 cm;

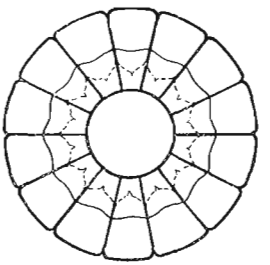

Fig. 2 — Ear cross-section diagram of the Microsperma race.
Diagrama da secção da espiga da raça Microsperma.

mid-diameter of 28.3 to 33.0 mm, mid-cob diameter 20.0 to 22.3 mm; rachis 10.0 to 13.0 mm, pith 5.3 to 7.7 mm; colorless to off white glumes and lemmas, white to pink rachis; white to grey pith; lower glume with slight or no pubescence and medium hard; rather hard rachis (Plate I, 1).

Kernel

Small size kernels (Plate VIII, 2); hard flinty type with no soft spot; clear to pale tan pericarp, white to off white aleurone; light to dark yellow endosperm; pale yellow to yellow tan kernels; 13 to 18 g for the weight of 100 kernels; specific weight 79 to 83.

Distribution

Race Microsperma had a limited distribution, it was found in the counties of Crato (934), Estremoz (1009 and 1010), where the latter is known as Gatanho, Montijo (1055), Setúbal (1073) in dry farming, and Santiago de Cacém (979) here known as Zorrinho (Fig. 3).

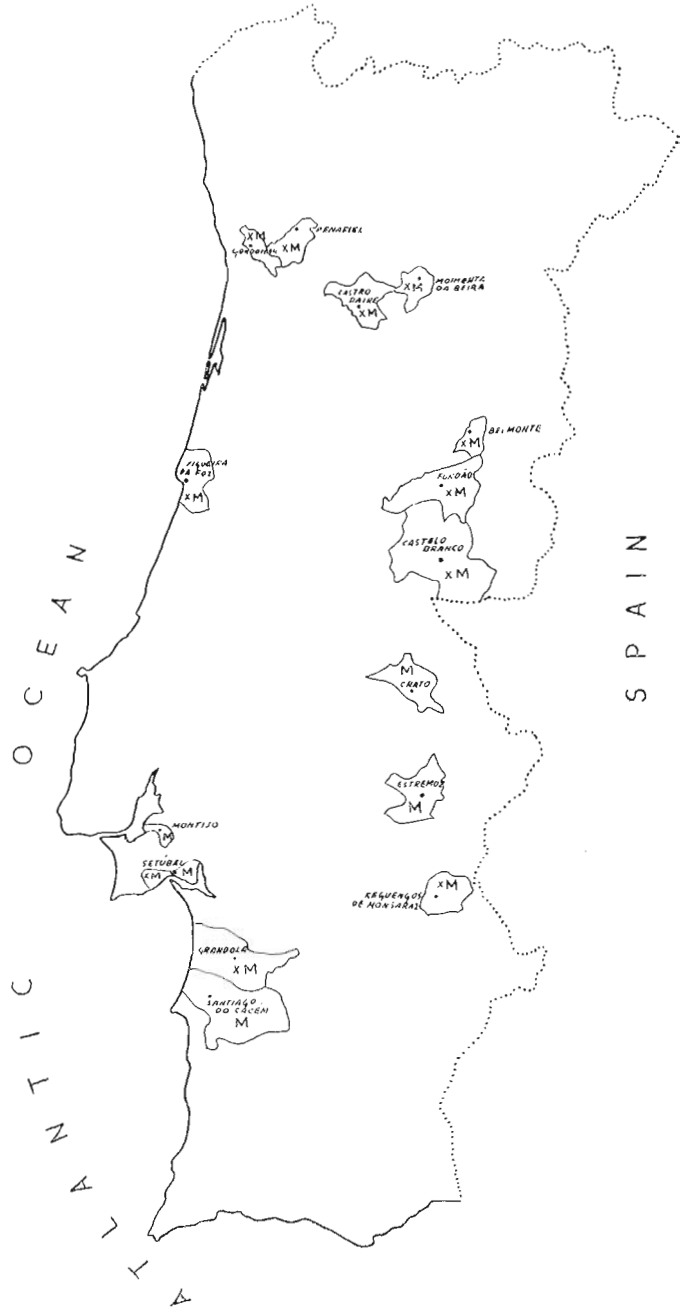

Fig. 3 — The distribution of the Microsperma (M) and Crossed Microsperma (× M) races.
Distribuição das raças Microsperma (M) e Microsperma Cruzada (× M).

This race seems to fit the «slightly conical» classification for the Fleischman's index, but samples 979 and 1009 show a higher index though close to the upper limit, as if the conical influence was more marked.

We have to consider then, samples 934, 1010, 1055 and 1073 as more typical of this race. Samples 1055 and 1073 only differ in maturity and correlated characters which must not be taken in consideration for racial classification.

Relationships

It seems to be similar in appearance to the Queixalet race from Spain. Perhaps it resembles even more the Pignoletto × Marano of Italy or the Cincantin × Hingănesc race of Roumania.

Race CROSSED MICROSPERMA (× M)

Plant

Early maturity, 66 to 76 days to mid-silking, 133 to 141 days at harvest with 21 % to 30 % moisture content in the grain, 2143 to 2308 E. D. D. units; medium short plants, average height 140 to 243 cm; ear placed mostly on the 5th node counting from above averaging 33 to 119 cm above ground (Fig. 4); average number of leaves 12 to 16; leaves medium short and medium narrow; 50 % of the plants tillering; plant color between medium to dark green.

Tassel

Medium short peduncle, tassel and branching space; 37 % of branching; medium number of primary and secondary branches, presence of terciary branches in 10 % of the plants.

Ear

Presence of flag-leaves very common, 8 to 15 husk leaves exceeding the ear; conical ear with 12 to 18 rows of kernels medium imbricated (Fig. 5); average ear length 11 to 17 cm; mid-diameter 29.7 to 44.7 mm; mid-cob diameter 20.0 to 36.3 mm; rachis 10.0 to 21.7 mm; pith 5.3 to 15.0 mm; colorless to off white glumes and lemmas; white to brown rachis; white to light grey pith; lower glume with slight or no pubescence and medium soft; rather hard rachis (Plate I, 2).

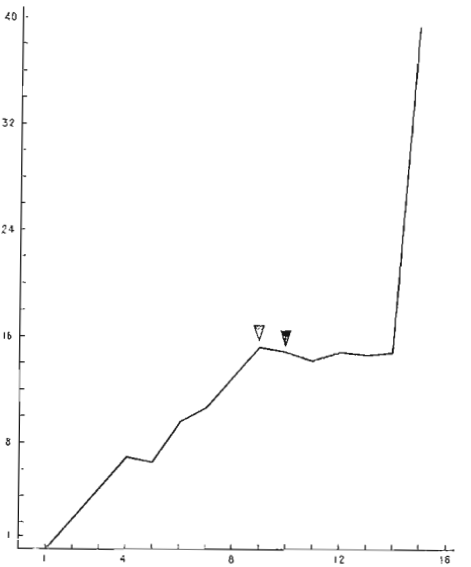

Fig. 4 — Internode pattern of the Crossed Microsperma race.
Modelo dos entrenós da raça Microsperma Cruzada.

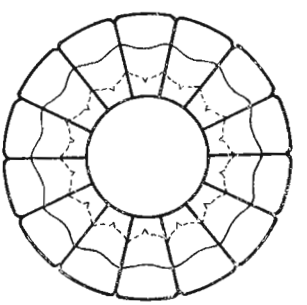

Fig. 5 — Ear cross-section diagram of the Crossed Microsperma race.
Diagrama da secção da espiga da raça Microsperma Cruzada.

Kernel

Next to small size kernels (Plate VIII, 3); very close to hard flinty type with less than 5 % soft spot; clear to very light tan pericarp, white to very light grey aleurone, off white to dark yellow endosperm, white to light tan kernels; 16 to 27 g for the weight of 100 kernels; specific weight 73 to 82.

Distribution

It was found in the counties of Castro Daire (924), Castelo Branco (933) where it is known as Orelha de Lebre, Gondomar (960), Penafiel (968), Grândola (977) where it is called Zorreiro and used in dry-farming, and Figueira da Foz (996) where it is used in dry-farming. These two varieties are white even if the first has yellow introgression and the latter is a tan white. Also found in Fundão (1053) as Milho do Baixo, Belmonte (1057) as Milho Cunha or (1058) as Cedovém, Reguengos (1064) in dry-farming, Setúbal (1072) in dry-farming, and Moimenta da Beira (1076) under irrigation (Fig. 3).

Relationships

This race looks like the result of intercrossing between the Microsperma type and some small form of Conico. The size of the kernels is bigger than in the Microsperma race, but very close, though the 100 kernels weight is higher. There are two exceptions, sample 924 has a low 100 kernel weight and sample 1072 has a 100 kernel weight that is too high. The ears show the influence of Conico in general, but samples 1064, 924, 933, 1074, and 977 have lower Fleischman's indexes than they needed for conical classification. Samples 1072, 1057, and 931 have 5 nodes above the ear-bearing node and they are not the ones in the group with higher E. D. D. units or moisture content in the grain. We have then to consider samples 1052, 1048, 1076, 1058, 968, 960, and 996, as more representative of the race.

Some varieties look similar to the Italian Scagliolo.

Race EIGHT ROWS (8 r)

Plant

Medium early, 68 to 76 days to mid-silking, 133 to 141 days at harvest with 25 % to 36 % moisture content in the grain, 2178 to 2334 E. D. D. units; medium short plants, average

height 138 to 260 cm; ears placed mostly on the 5th node counting from above averaging 33 to 128 cm above the ground (Fig. 6); average number of leaves 12 to 16; medium short

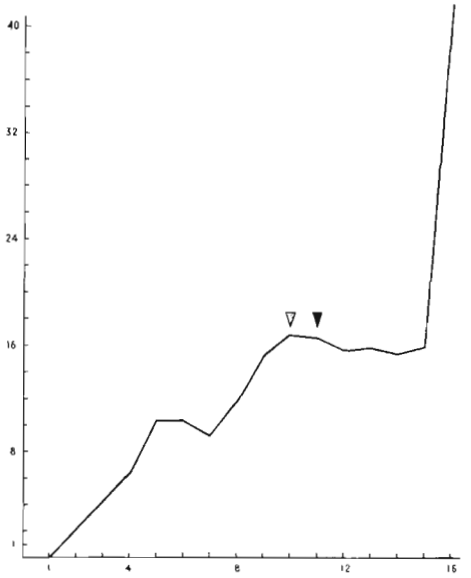

Fig. 6 — Internode pattern of the Eight Rows race.
Modelo dos entrenós da raça Oito Carreiras.

and medium in width; 40 % of the plants tillering; plant color close to dark green.

Tassel

Medium short peduncle and tassel and medium long branching space; 43 % of branching; medium number of primary and secondary branches, presence of terciary branches in 10 % of the plants.

Ear

Presence of flag-leaves very common; 6 to 14 husk leaves exceeding the ear; slightly conical ear with always 8 rows of kernels from slightly imbricated (1038, 993 and 1077) to well defined (1024 and 1045) and varied degrees of interlocking (975, 956, and 1065) (Fig. 7); average ear length 12 to 22 cm;

mid-diameter 29.3 to 33.7 mm, mid-cob diameter 20.3 to 25.3 mm; rachis 9.3 to 14.0 mm; pith 5.0 to 7.0 mm; colorless to tan glumes and lemmas; white to brown rachis; white to pinked

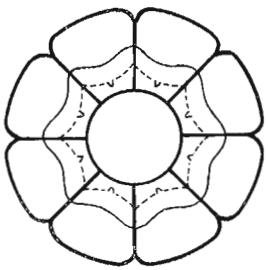

Fig. 7 — Ear cross-section diagram of the Eight Rows race.
Diagrama da secção da espiga da raça Oito Carreiras.

pith; lower glume slightly pubescent and medium hard; hard rachis (Plate II, 1 & 2).

Kernel

Medium round size kernels (Plate VIII, 4), close to hard kernels with less than 5 % soft spot; clear to light brown pericarp; white aleurone; off white to dark yellow endosperm; white to light brown kernels; 22 to 37 g for the weight of 100 kernels; specific weight 70 to 83.

Distribution

Samples were collected in the counties of Estarreja (956, 957, 971) the latter in dry-farming, Albergaria-a-Velha (975) in dry-farming, Cantanhede (985) where it was known as Gatanho and cultivated under irrigation, Montemor-o-Velho (989, 992) also known as Gatanho but under dry-farming, Montijo (1024) under dry-farming, Coruche (1038) under irrigation, Moita (1044, 1045) the first under both forms of cultivation and the latter only under dry-farming, Peniche (1065) in dry-farming, Lourinhã (1069) in dry-farming, and Golegã (1077) in dry-farming (Fig. 8).

Relationships

Since this race is unmistakably defined by the high frequency of the eight row ears found in the samples collected,

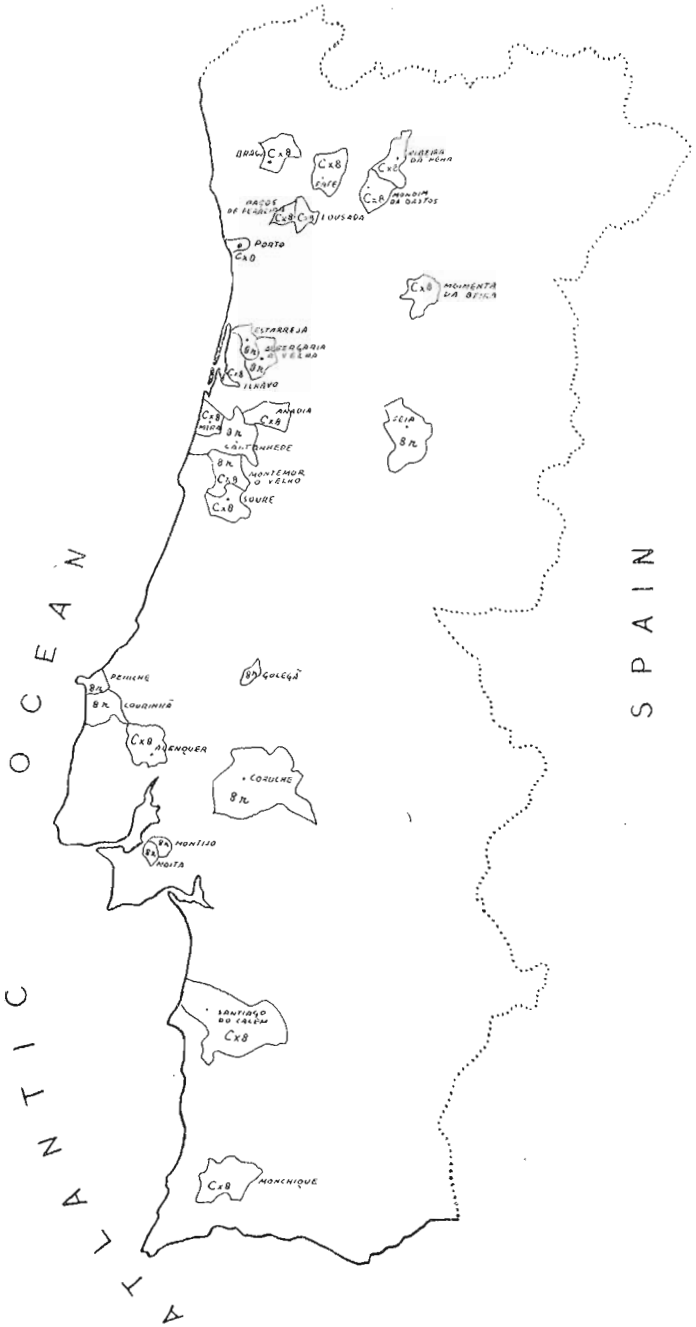

Fig. 8 — The distribution of the Eight Rows (8 r) and Conical Eight Rows Crossing (C × 8) races.
Distribuição das raças Oito Carreiras (8 r) e Cruzamento da Cónico com Oito Carreiras (C × 8).

there is only a reference in relation to sample 1077 which could have been included in the race × M if it weren't for its eight rowed ears.

Fleischman's index of samples 1077, 992, 1065 are all above 6, thus defining these samples as conical, whereas samples 956 and 971 show an index below 4 which will classify them as cylindrical. Actually the classifications resulting from the application of these limits and of the index itself do not seem to fit the apparent morphological shape of these ears.

There are clear differences in the morphology of the ears of this race and the fact that there are eight rows is not enough to relate them only to the NE flints of the USA. The Northern and Midwestern flints have to be considered as well as the primitive types from which they were derived.

Race CONICAL EIGHT ROWS CROSSING (C × 8)

Plant

Medium, 67 to 84 days to mid-silking, 132 to 149 days at harvest with 22 % to 47 % moisture content in the grain, 2192 to 2372 E. D. D. units; medium high plants, average height 142 to 277 cm; ear placed almost equally between the 5th and 6th node counting from above (Fig. 9); averaging 33 to 146 cm above ground; average number of leaves 12 to 18; leaves medium in length and width; 30 % of the plants tillering; plant color very close to dark green.

Tassel

Medium long peduncle, tassel and branching space; 39 % of branching; medium number of primary and secondary branches, presence of terciary branches in less than 10 % of the plants.

Ear

Presence of flag-leaves almost common; 8 to 15 husk leaves exceeding the ear; practically conical ear with 10 to 12 rows of kernels most of the times well imbricated (Fig. 10); averaging ear length 13 to 19 cm; mid-diameter 31.3 to 40.7 mm; mid-cob diameter 25.0 to 32.3 mm; rachis 11.3 to 18.3 mm; pith 6.0 to 11.0 mm; colorless to white glumes and lemmas; white to grey rachis; white to light grey pith; lower glume

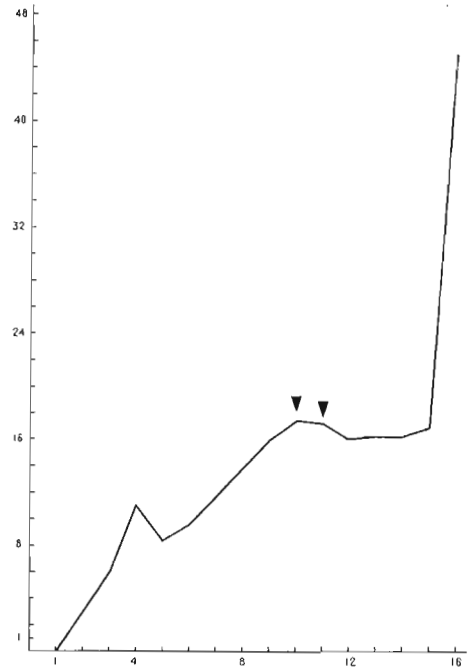

Fig. 9 — Internode pattern of the Conical Eight Rows Crossing race.
Modelo dos entrenós da raça Cruzamento da Cónico com Oito Carreiras.

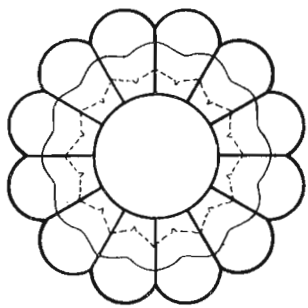

Fig. 10 — Ear cross-section diagram of the Conical Eight Rows Crossing race.
Diagrama da secção da espiga da raça Cruzamento da Cónico com Oito Carreiras.

slightly or not pubescent and medium hard; hard rachis (Plate III, 1 & 2).

Kernel

Medium size kernels (Plate VIII, 5), close to hard kernels with less than 5% soft spot; clear to tan pericarp; white to very pale yellow aleurone; white to dark yellow endosperm; white to brown kernels; 21 to 34 g for the weight of 100 kernels; specific weight 76 to 83.

Distribution

Samples were collected in the counties of Santiago de Cacém (976 and 978) in dry-farming, Mira (987) where it is called Gatanho or Sete à Cova, both in dry-farming and under irrigation, Porto (1961), Ílhavo (970), Anadia (990) under the name of Sete à Cova and in irrigation, Alenquer (1056) in dry-farming, Braga (935, 938, 939, 945, 946, 953, 941 and 949) the latter two under the names of Temporão and Da Sombra respectively, Moimenta da Beira (1034) under irrigation, Lousada (974), Monchique (1016), Mondim de Basto (955) known as Verdial Pequeno under irrigation, Paços de Ferreira (962), Montemor-o-Velho (998) named Gatanho under dry-farming, Fafe (952), Soure (981) under irrigation, Ribeira de Pena (1028), and Figueiró dos Vinhos (1039) under irrigation (Fig. 8).

Relationships

The intercrossing of conical types with eight-rowed gave to the elements of this race the appearance of an eight-rowed maize but with the number of rows slightly increased. At the same time quite a variable race was created as is demonstrated by the variation in form of the ear. Samples 976 and 1056 are cylindrical and samples 961, 1037, 934, 998, 945, 952, 981 and 946 are only slightly conical.

On the other hand, samples 990, 1056, 962, 998, 945, 952, 981, 1028, 935, 941, 946 and 1039 have the ear attached to the 6th node, introducing in this way more variation in the characteristics of the race.

Race SMALL CONICO (Cp)

Plant

Medium early, 68 to 80 days to mid-silking, 133 to 145 days at harvest with 23 % to 36 % moisture content in the grain, 2178 to 2373 E. D. D. units; medium size plants, average

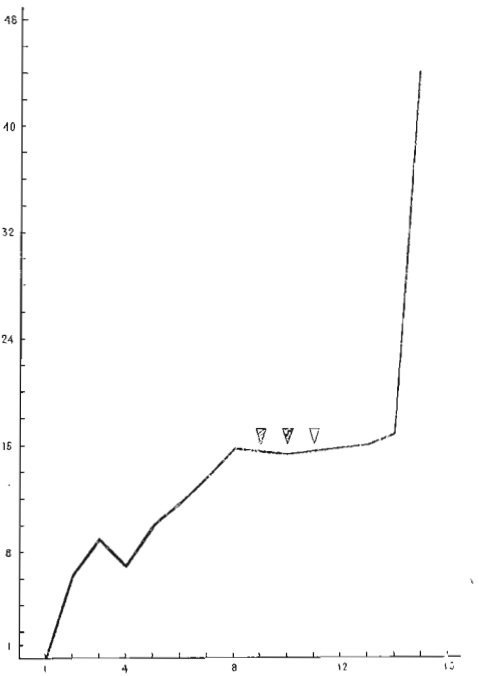

Fig. 11 — Internode pattern of the Small Conico race.
Modelo dos entrenós da raça Cónico Pequeno.

height 133 to 287 cm; ear placed mostly on the 5th node counting from above (Fig. 11); averaging 38 to 142 cm above ground; average number of leaves 12 to 17; leaves short and medium narrow; 40 % of the plants tillering; plant color close to dark green.

Tassel

Medium long peduncle and tassel, medium short branching space; 36 % of branching; medium low number of primary

branches and medium number of secondary branches; presence of terciary branches in less than 10 % of the plants.

Ear

Common presence of flag-leaves, 10 to 14 husk leaves exceeding the ear; conical ear with 10 to 14 rows of kernels most of the times well imbricated (Fig. 12); averaging ear length 12 to 16 cm; mid-diameter 32.3 to 49.0 mm; mid-cob diameter 24.7 to 36.0 mm; rachis 10.7 to 24.3 mm; pith 4.0

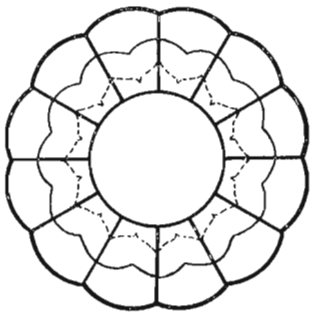

Fig. 12 — Ear cross-section diagram of the Small Conico race.
Diagrama da secção da espiga da raça Cónico Pequeno.

to 13.3 mm; colorless to off white glumes and lemmas; white to brown rachis; white to tan pith; lower glume glabrous or slightly pubescent, medium hard; hard rachis (Plate IV, 1 & 2).

Kernel

Medium size kernels (Plate IX, 1), very close to hard kernels with less than 5 % soft spot; clear to light tan pericarp; white aleurone; white to dark yellow endosperm; white to tan yellow kernels; 23 to 38 g for the weight of 100 kernels; specific weight 74 to 82.

Distribution

Samples of this race were collected in the counties of Montemor-o-Velho (991) under the name of Gatões cultivated both under dry and irrigated farming, Condeixa (993) with the name of Milho Grado in dry and irrigated farming, Viseu (1070) under irrigation, Abrantes (1051) under dry-farming,

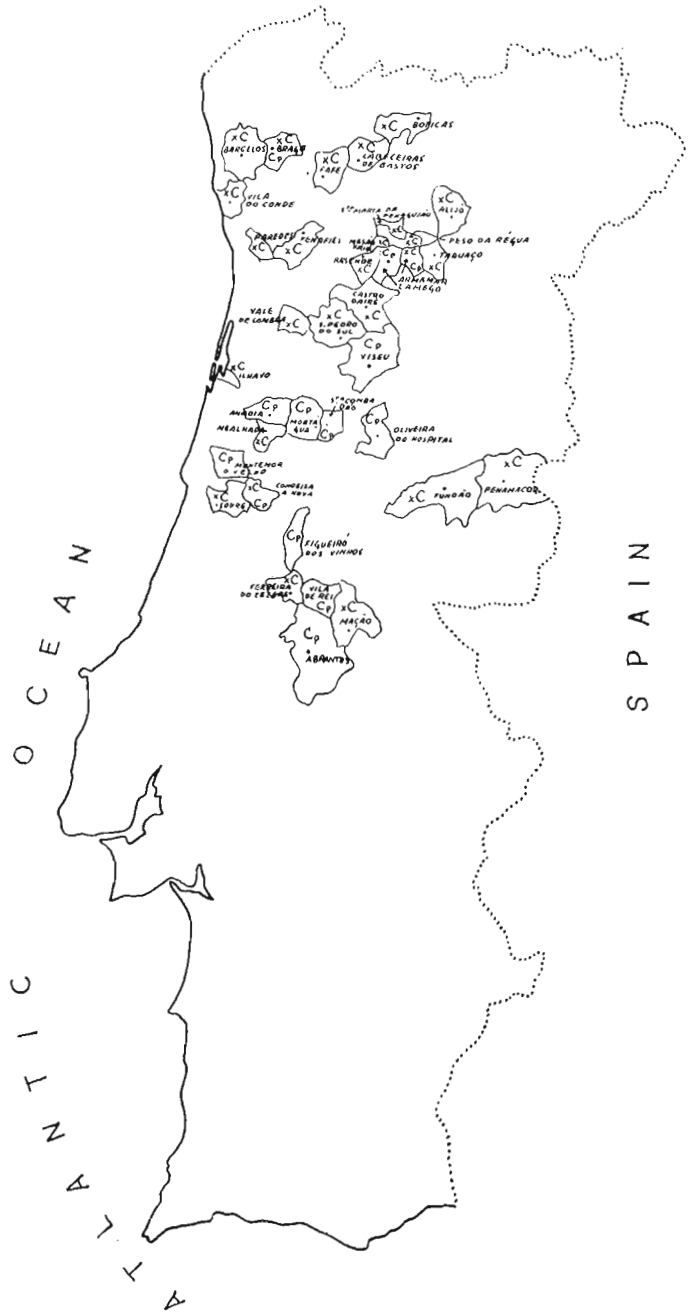

Fig. 13 — The distribution of the Small Conico (Cp) and Crossed Conico (× C) races.
Distribuição das raças Cónico Pequeno (Cp) e Cónico Cruzado (C).

Oliveira do Hospital (992 and 1063) the latter under irrigation, Mortágua (1046) under irrigation, Vila de Rei (1040) with the name of Gatanho in dry-farming, Santa Comba-Dão (929), Pedrógão Grande (1031) under irrigation, Armamar (1042) under irrigation, Lamego (1043) under irrigation, Anadia (984) with the name Sete à Cova and under irrigation, and Braga (940) with the name of Milho Serôdio (Fig. 13).

Relationships

This race must have a very light influence of the eight row but not enough to place some samples under the last title, as it can be observed with samples, 991, 1019, and 1070 which are only slightly conical. The size of the ears and some ear types must have some transitional elements (sample 940) that become more clear in the crossed conico race. Whereas other samples like 1029 with the ear placed at the 4th node could have been included in the × M race.

Some samples came very close to the Gallego race from Spain, the Conico × Polieta from Italy, or the Moldovenesc race from Roumania.

Race CROSSED CONICO (× C)

Plant

Medium, 68 to 84 days to mid-silking, 133 to 149 days at harvest with 24 % to 35 % moisture content in the grain, 2178 to 2388 E. D. D. units; medium high plants, average height 161 to 280 cm; ears placed mostly on the 6th node, counting from above (Fig. 14); averaging 40 to 142 cm above ground; average number of leaves 13 to 18; leaves medium in length and width; 20 % of the plants tillering; plant color very close to dark green.

Tassel

Medium long peduncle, tassel and branching space; 38 % of branching; medium number of primary and secondary branches; presence of terciary branches in less than 5 % of the plants.

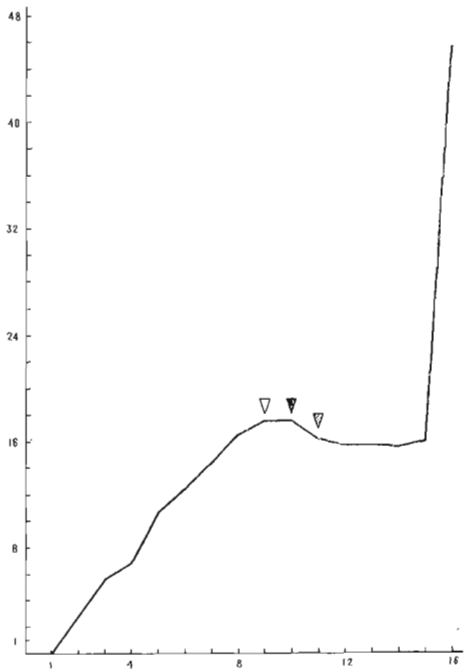

Fig. 14 — Internode pattern of the Crossed Conico race.
Modelo dos entrenós da raça Cónico Cruzado.

Ear

Presence of flag-leaves common; 8 to 15 husk leaves exceeding the ear; conical ear with 12 to 20 rows of kernels well imbricated (Fig. 15); averaging ear lenght 13 to 20 cm; mid-diameter 36.0 to 49.0 mm; mid-cob diameter 28.0 to 39.3 mm; rachis 15.3 to 27.3 mm; pith 7.3 to 17.0 mm; colorless to grey glumes and lemmas; white to dark red rachis; white to yellow grey pith; lower glume glabrous or slightly pubescent, medium soft; hard rachis (Plate V, 1 & 2).

Kernel

Medium size rounder kernels (Plate IX, 2), close to hard kernels with less than 5 % soft spot; clear to tan pericarp, white to off white aleurone, white to dark yellow endosperm,

white to light brown kernels; 20 to 35 g for the weight of 100 kernels; specific weight 70 84.

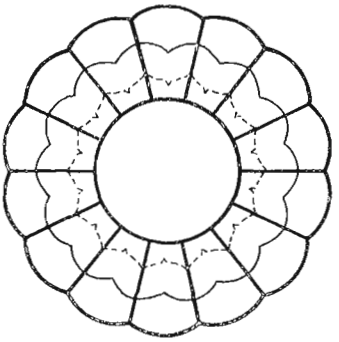

Fig. 15 — Ear cross-section diagram of the Crossed Conico race.
Diagrama da secção da espiga da raça Cónico Cruzado.

Distribution

There is a wider distribution of this race. Samples were colected in the counties of Alijó (1027 and 1071) both in dry-farming, Penamacor (1085) where it is known as Milhão, Armamar (1079) under irrigation, Fundão (1054) under irrigation, Boticas (1075), Mação (1062 and 1074) under irrigation and dry-farming respectively, Tabuaço (1066) in dry-farming, Beja (1008), Cabeceiras de Basto (954) where it is known as Verdial and is under irrigation, Braga (936, 943, and 944) the middle one known as Milho de Trepar, Santa Marta de Penagião (1026 and 1047) under irrigation, Mealhada (994) known as Sete à Cova and under irrigation, Ílhavo (973) under irrigation, Gondomar (969), Castro Daire (928), Vale de Cambra (963), Vila do Conde (964), Ferreira do Zézere (1041) under irrigation, S. Pedro do Sul (926), Barcelos (947 and 948) the latter known as Cem Dias da Beira-mar, Resende (1021) in dry-farming and under irrigation, Mesão Frio (1025) in dry-farming and under irrigation, Penafiel (966), Condeixa (997) known as Milho Grado and under irrigation, Fafe (950 and 951), Soure (980) known as Milho de Palha Alta and under irrigation (Fig. 13).

Relationships

We called this race Crossed Conico because we find some variation in ear type. Thus sample 973 is cylindrical, samples 1054, 951, 944, and 1047 are slightly conical, and sample 1074 has a very conical ear form. Obviously the samples of this race showed enough distinct differences to exclude them from the race Conical Eight Rows Crossing or the races Conico and Big Conico.

Only the race Românesc from Roumania seems to be similar to this one.

Race CONICO (C)

Plant

Medium early, 68 to 82 days to mid-silking, 133 to 147 days at harvest with 23 % to 35 % moisture content in the grain, 2178 to 2402 E. D. D. units; medium plants, average height 168 to 249 cm; ears placed on the 5th and 6th node, counting from above (Fig. 16); averaging 45 to 111 cm above ground; average number of leaves 13 to 17; leaves medium in length and width; 30 % of the plants tillering; plant color close to dark green.

Tassel

Medium long peduncle and tassel, medium short branching space; 36 % of branching; medium number of primary and secondary branches; presence of terciary branches in 10 % of the plants.

Ear

Presence of flag-leaves common; 9 to 15 husk leaves exceeding the ear; conical ear with 12 to 18 rows of kernels (Fig. 17); averaging ear length 13 to 17 cm; mid-diameter 40.3 to 48.0 mm; mid-cob diameter 33.0 to 39.3 mm; rachis 19.3 to 26.0 mm; pith 11.7 to 15.3 mm; colorless to off white glumes and lemmas; white to light tan rachis; white to off white pith; lower glume with no pubescence, medium hard; rather hard rachis (Plate VI, 1 & 2).

Kernel

Medium size rounder kernels (Plate IX, 3); very close to hard kernels with less than 5 % soft spot; clear to light tan

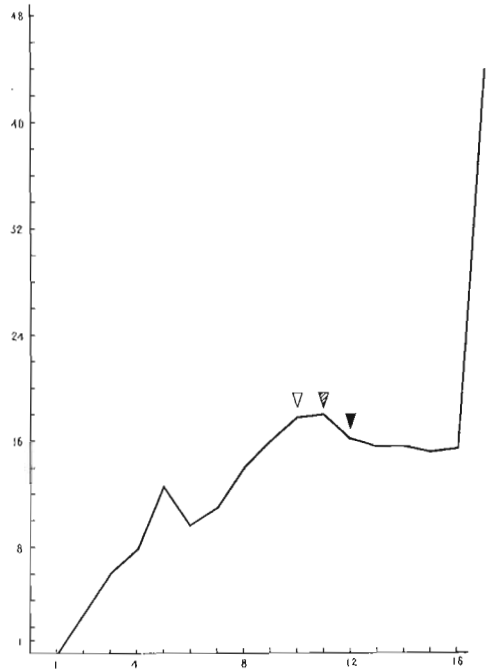

Fig. 16 — Internode pattern of the Conico race.
Modelo dos entrenós da raça Cónico.

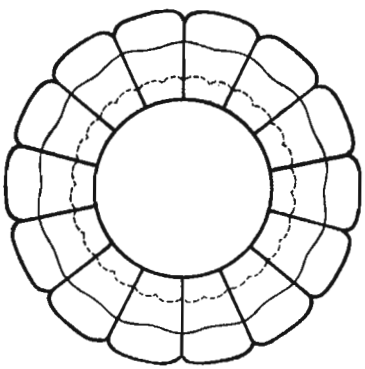

Fig. 17 — Ear cross-section diagram of the Conico race.
Diagrama da secção da espiga da raça Cónico.

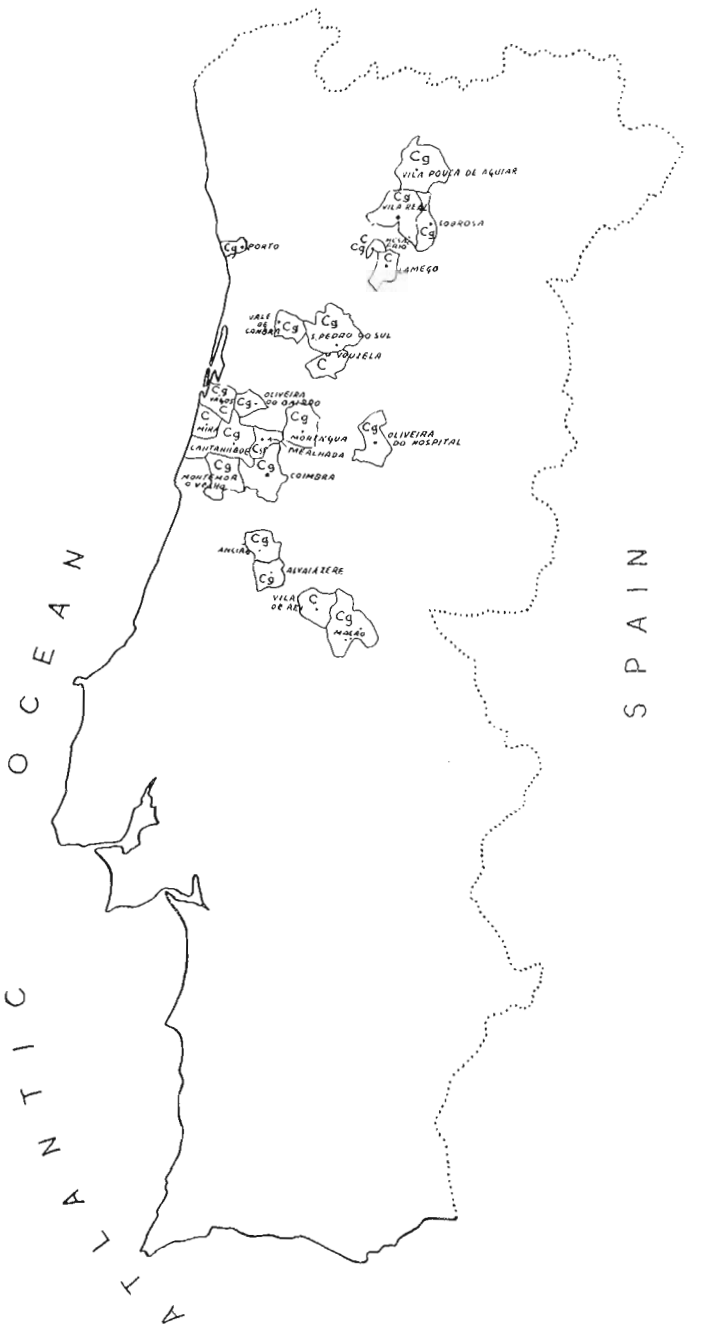

Fig. 18 — The distribution of the Conico (C) and Big Conico (Cg) races.
Distribuição das raças Cónico (C) e Cónico Grande (Cg).

pericarp; white aleurone; white to dark yellow endosperm; white to dark yellow kernels; 23 to 35 g for the weight of 100 kernels; specific weight 70 to 81.

Distribution

Samples collected in the counties of Vouzela (932) known as Pé de Porco, Vagos (935) named Galego, Mira (1004) under dry-farming and irrigation, Vouzela (1086) under irrigation, Lamego (1049) under irrigation, Vila de Rei (1059 and 1060) the first called Milho de Meia Cana and in dry-farming, the other under irrigation, Mesão Frio (1050) in dry-farming and under irrigation (Fig. 18).

Relationships

This race seems to be a true conico, looking quite similar to the Italian types classified «spiga conica».

Race BIG CONICO (Cg)

Plant

Medium late, 69 to 82 days to mid-silking, 134 to 147 days at harvest with 24 % to 43 % moisture content in the grain, 2218 to 2402 E. D. D. units; medium high plants, average height 156 to 285 cm; ears placed in the 6th and 5th node, counting from above (Fig. 19); averaging 38 to 149 cm above ground; average number of leaves 13 to 19; leaves medium in length and width; 30 % of the plants tillering; plant color quite dark green.

Tassel

Medium long peduncle, tassel and branching space; 37 % of branching; medium number of primary and secondary branches; presence of terciary branches in less than 5 % of the plants.

Ear

Presence of flag-leaves almost common; 8 to 16 husk leaves exceeding the ear; conical ear with 12 to 16 rows of kernels well imbricated (Fig. 20); average ear length 14 to 20 cm; mid-diameter 37.3 to 46.7 mm; mid-cob diameter 27.3 to 36.0 mm; rachis 15.3 to 24.3 mm; pith 7.3 to 12.7 mm; color-

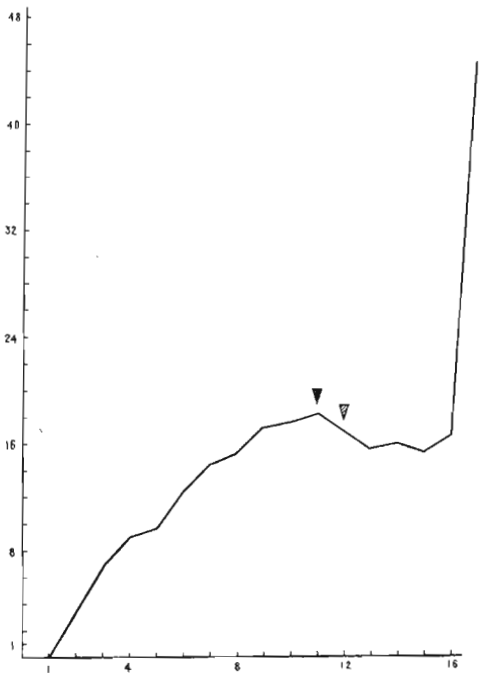

Fig. 19 — Internode pattern of the Big Conico race.
Modelo dos entrenós da raça Cónico Grande.

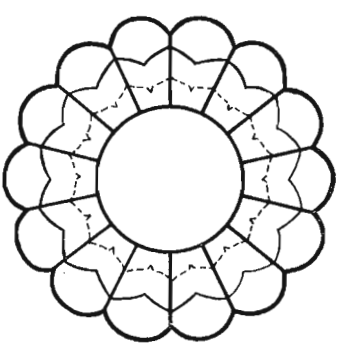

Fig. 20 — Ear cross-section diagram of the Big Conico race.
Diagrama da secção da espiga da raça Cónico Grande.

less to pinked glumes and lemmas; white to light brown rachis, white to grey pith; lower glume not or slightly pubescent, medium soft; hard rachis (Plate VII, 1).

Kernel

Big size kernels (Plate IX, 4); close to hard with less than 5 % soft spot; clear to light tan pericarp; white aleurone; white to dark yellow endosperm; white to dark yellow kernels; 21 to 40 g for the weight of 100 kernels; specific weight 76 to 83.

Distribution

This is a widely distributed race and samples were collected in the counties of Montemor-o-Velho (983, 1001, and 1005) where it is called Cem Dias, Meia Palha and Palhudo respectively, the latter under irrigation; Mortágua (930), Oliveira do Hospital (923 and 1036) the latter under irrigation, Porto (972), Coimbra (982) — called Americano, the only sample which bears a slight denting — under irrigation, Ílhavo (959), Ansião (999 and 1002) the first under irrigation and the second in dry-farming, Cantanhede (986 and 988) the first called Gatanho under irrigation and the second called Verdial, Vale de Cambra (965), Oliveira do Bairro (1003 and 1007) both named Verdial and under irrigation and the second is also under dry-farming, Fundão (1052) called Milho Grande, Alvaiázere (1032), Vagos (1000) known as Verdial under irrigation, Vila Real (1020) under irrigation, Vila Pouca de Aguiar (1022), Sabrosa (1023) under irrigation, Mação (1035) under irrigation, Mealhada (1006) called Verdial and under irrigation, and S. Pedro do Sul (925) (Fig. 18).

Relationships

This race has only two samples that may be considered exceptions — 1006 which is slightly conical and 1032 with a very conical ear form.

This race seems to be similar to the Alb Moldovenesc race from Roumania.

Race LARGE EARED (CN)

Plant

Medium late, 76 to 84 days to mid-silking, 141 to 149 days at harvest with 25 % to 36 % moisture content in the grain, 2206 to 2422 E. D. D. units; tall plants, average height 215 to 303 cm; ears placed mostly in the 6th and 7th nodes, counting from above (Fig. 21); averaging 69 to 152 cm above ground;

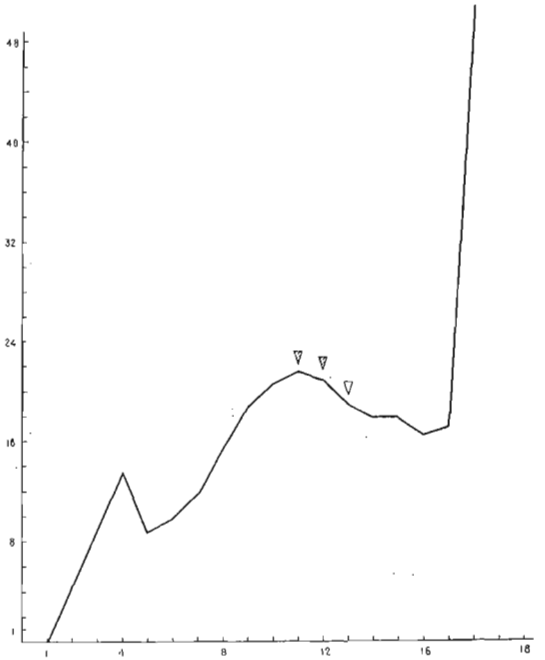

Fig. 21 — Internode pattern of the Large Eared race.
Modelo dos entrenós da raça Espiga Grande.

average number of leaves 14 to 19; leaves long and medium in width; 20 % of the plants tillering; plant color almost dark green.

Tassel

Medium long peduncle, tassel and branching space; 36 % of branching; medium number of primary branches, medium low number of secondary branches; presence of terciary branches in less than 5 % of the plants.

Ear

Presence of flag-leaves almost common; 8 to 14 husk leaves exceeding the ear; slightly conical ear with 12 rows of kernels (Fig. 22); average ear length 19 to 21 cm; mid-diameter 38.0 to 40.3 mm; mid-cob diameter 27.7 to 32.0 mm; rachis 15.3 to

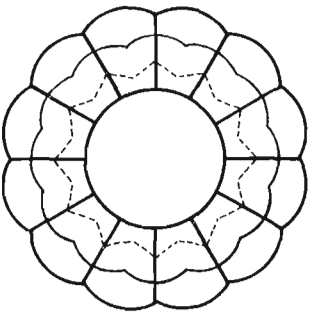

Fig. 22 — Ear cross-section diagram of the Large Eared race.
Diagrama da secção da espiga da raça Espiga Grande.

20.3 mm; pith 6.3 to 10.3 mm; colorless to red glumes and lemmas; white to brown rachis; white pith; lower glume slightly or not pubescent, almost hard; hard rachis (Plate VII, 2).

Kernel

Big rounder kernels (Plate IX, 5); close to hard with 20 % of soft spot; clear to very pale yellow pericarp; white aleurone; off white to dark yellow endosperm; off white to tan kernels; 25 to 36 g for the weight of 100 kernels; specific weight 74 to 80.

Distribution

This race has a limited distribution. Samples did come from the counties of Braga (937 and 942) known as Cem Dias and Da Beira-mar respectively, Albergaria-a-Velha (958 and 967), Golegã (1078) under irrigation, and Vila Real (1082) under irrigation (Fig. 23).

Relationships

This race like the derived flint types of Italy, must be the result of crossing between conico and a long ear type not yet defined for lack of samples with those characteristics.

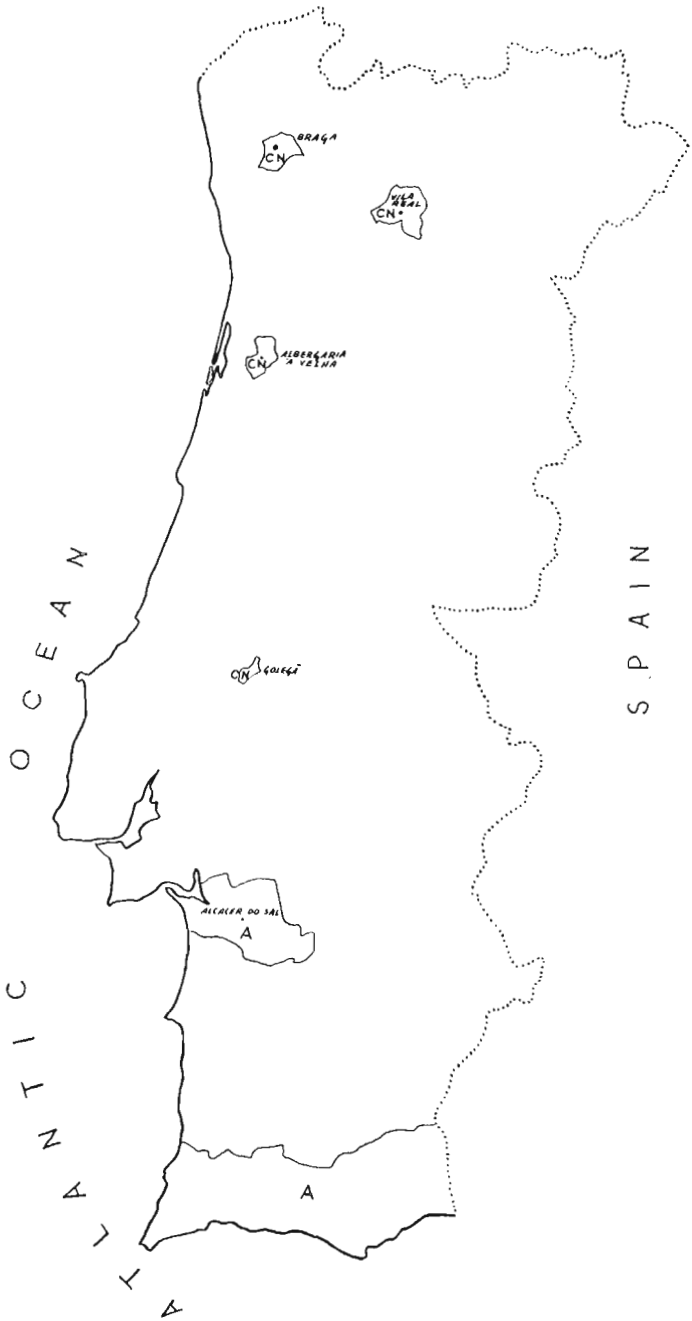

Fig. 23 — The distribution of the Large Eared (CN) and Gigantil (A) races.
Distribuição das raças Espiga Grande (CN) e Gigantil (A).

Race GIGANTIL (A)

Plant

Medium late, 74 to 85 days to mid-silking, 139 to 150 days at harvest with 32 % to 44 % moisture content in the grain, 2284 to 2422 E. D. D. units; tall plants, average height 185 to 318 cm; ears placed in the 6th, 7th, or 8th node, counting from

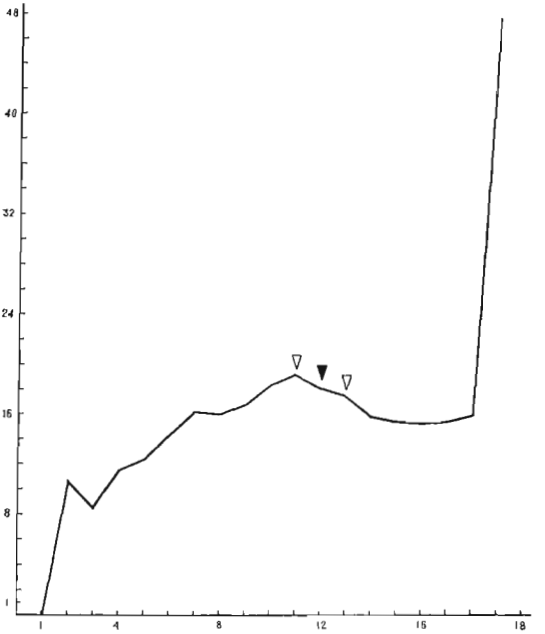

Fig. 24 — Internode pattern of the Gigantil race.
Modelo dos entrenós da raça Gigantil.

above (Fig. 24); averaging 58 to 163 cm above ground; average number of leaves 15 to 22; leaves long and wide; less than 10 % of plants tillering; plant color almost dark green.

Tassel

Medium long peduncle, tassel and branching space; 35 % of branching; medium number of primary and secondary branches, presence of terciary branches in 20 % of the plants.

Ear

Presence of flag-leaves in only 50 % of the plants; 10 to 14 husk-leaves mostly exceeding the ear; conical ear with 10

to 14 rows of kernels not imbricated in the most characteristic samples (Fig. 25); average ear length 17 to 23 cm; mid-diameter 40.3 to 51.7 mm; mid-cob diameter 29.0 to 40.7 mm; rachis 17.7 to 27.7 mm; pith 9.3 to 17.3 mm; colorless to red glumes and

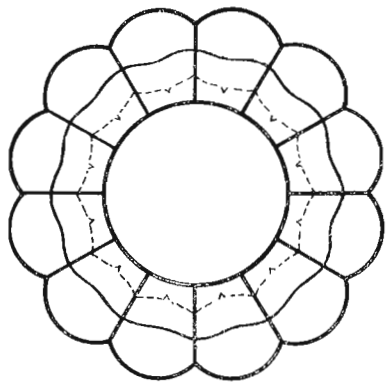

Fig. 25 — Ear cross-section diagram of the Gigantil race.
Diagrama da secção da espiga da raça Gigantil.

lemmas; white to pinked rachis; white pith; lower glume not or slightly pubescent, medium hard; rather hard rachis (Plate VIII, 1).

Kernel

Big round kernels (Plate IX, 6); medium hardness with 50 % of soft spot; clear to tan pericarp; white aleurone; yellow to dark yellow endosperm; light yellow to yellow orange kernels; 32 to 44 g for the weight of 100 kernels; specific weight 74 to 79.

Disbribution

The samples of this race were mainly collected in the South province of Algarve (1011, 1012, 1013, 1014, 1015, and 1018) where they were known respectively as Zorrinho, Gigante, Chichorro, Bordeira, Infantil, and the last with no name. Samples were gathered in the county of Alcácer do Sal (1067 and 1068) the first both in dry-farming and under irrigation, the second in dry-farming (Fig. 23).

Relationships

This race is quite distinct in its characteristics from all the others even in clearly outcrossed samples like 1014 or 1068. It looks very similar to the race Andaluz from Spain, only this has smaller ears, what can be well justified if in spite of being neighboring regions, the one in Spain is mostly under dry-farming and in Algarve mainly under irrigation.

CONCLUSIONS

The first introduction of maize in Portugal was believed to have been made by the Portuguese sailors who were with Columbus on his second trip. Coutinho (1917) refers to a Mr. Paulo Braga who brought some kernels of maize from Cadiz and gave them to a farmer in the region of Coimbra. He places this fact between 1515 and 1525 but believes that the crop was well established in 1533 by the relative position of the prices of wheat and maize then quite different from earlier list prices when the Portuguese name «milho» was given to millet instead of to maize.

This means that maize has been in this country for five centuries under several selection pressures due to the differentiated ecological patterns and subjected to man's will in the heavy populated areas with divided property. In the Southern part of the country, the crop was restricted to isolation and selection.

The conditions under which the crop was domesticated gave origin to an array of maturities from identical varieties and from intercrossing of different varieties at several maturities.

If the calculated values of rachilla length or the index rachilla/kernel show for all races intermediate numbers, there are for one or other race extreme values in the component varieties. Similar situation is found when the cob-rachis index and glume/kernel index are considered, which only confirms the intercrossing pattern of the present races.

The internode pattern of the possible ten races described here reflect these assumptions. The irregularity shown in the curve correspondent to the basal internodes expresses varia-

tion in maturity. Intercrossing is understood from the similar pattern of each race when compared two by two in the order in which they were described.

Races Microsperma, Crossed Microsperma, Eight Rows, Conical Eight Rows Crossing, Crossed Conico, Conico and Big Conico can be related to the Early Caribbean; races Large Eared and Gigantil can be related to the Coastal Tropical Flint or Cuban Flint races as defined by Brown (1953) for some of the maizes of the West Indies.

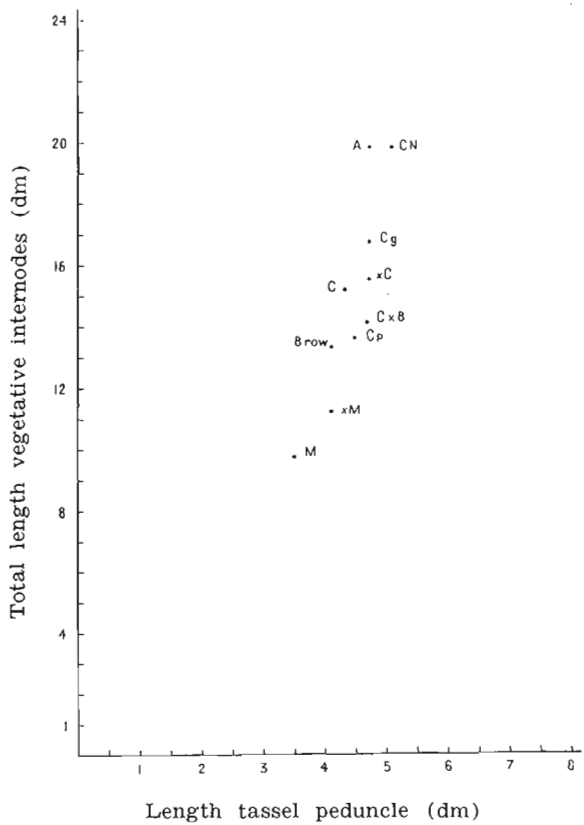

Fig. 26 — The ratio of the lengths of the peduncles of the tassels and the total lengths of the vegetative internodes of the ten races.
Proporção relativa dos comprimentos dos pedúnculos das panículas e do total dos comprimentos dos entrenós vegetativos das dez raças.

Observing the diagram of distribution of mean racial values of tassel peduncle length and total internode length (Fig. 26), it is possible to conclude that the present races of maize in Portugal did originate from a restricted number of races of the Western hemisphere and only by selection for earliness have they evolved in new races to fit the microclimatic conditions of the country.

This conclusion seems to be in agreement with Edwards & Leng (1965) when they say that the majority of the Spanish and Southeastern European collections show very little similarity, but it also broadens this pattern when it is observed almost fortuitous similitude between only two races of the two Peninsular countries, an observation whose roots may lie on historical past.

RESUMO

Fez-se o estudo das raças de milho eventualmente existentes em Portugal a partir de 163 amostras de cultivares em polinização livre. Conclui-se, depois de estudar pormenorizadamente as características de cada uma delas, que estas podiam agrupar-se em 10 raças de *Zea Mays* L. convar. *vulgaris* Körn. (*Z. indurata* Sturtev.): raça Microsperma (M), raça Microsperma Cruzada (× M), raça Oito Carreiras (8 r), raça Cruzamento da Cónico e Oito Carreiras (C × 8), raça Cónico Pequeno (Cp), raça Cónico Cruzado (× C), raça Cónico (C), raça Cónico Grande (Cg), raça Espiga Grande (CN) e raça Gigantil (A).

As oito primeiras podem relacionar-se com a raça Caraíba Precoce e as duas últimas com o Flint Tropical Costeiro ou com o Flint Cubano.

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EXPLANATION OF THE PLATES

PLATE I

1 — Ears of the Microsperma race.
Espigas da raça Microsperma.
2 — Ears of the Crossed Microsperma race.
Espigas da raça Microsperma Cruzada.

PLATE II

Ears of the Eight Rows race.
Espigas da raça Oito Carreiras.

PLATE III

Ears of the Conical Eight Rows Crossing race.
Espigas da raça Cruzamento da Cónico e Oito Carreiras.

PLATE IV

Ears of the Small Conico race.
Espigas da raça Cónico Pequeno.

PLATE V

Ears of the Crossed Conico race.
Espigas da raça Cónico Cruzado.

PLATE VI

Ears of the Conico race.
Espigas da raça Cónico.

PLATE VII

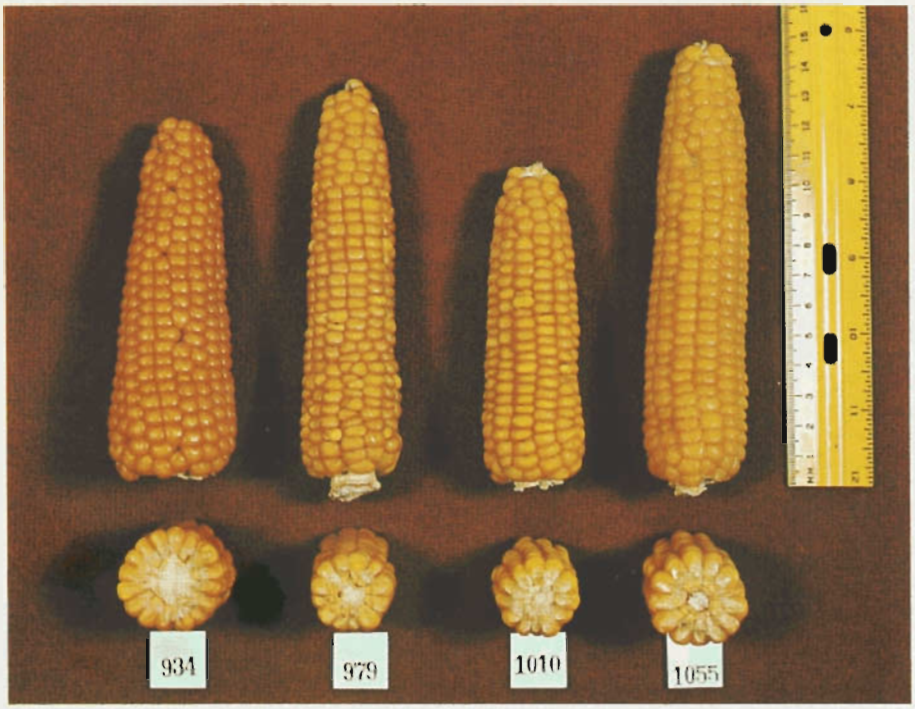
1 — Ears of the Big Conico race.
Espigas da raça Cónico Grande.
2 — Ears of the Large Eared race.
Espigas da raça Espiga Grande.

PLATE VIII

1 — Ears of the Gigantil race.
Espigas da raça Gigantil.
2 — Kernels of the Microsperma race.
Grãos da raça Microsperma.
3 — Kernels of the Crossed Microsperma race.
Grãos da raça Microsperma Cruzada.
4 — Kernels of the Eight Rows race.
Grãos da raça Oito Carreiras.
5 — Kernels of the Conical Eight Rows Crossing race.
Grãos da raça Cruzamento da Cónico e Oito Carreiras.

PLATE IX

1 — Kernels of the Small Conico race.
Grãos da raça Cónico Pequeno.
2 — Kernels of the Crossed Conico race.
Grãos da raça Cónico Cruzado.
3 — Kernels of the Conico race.
Grãos da raça Cónico.
4 — Kernels of the Big Conico race.
Grãos da raça Cónico Grande.
5 — Kernels of the Large Eared race.
Grãos da raça Espiga Grande.
6 — Kernels of the Gigantil race.
Grãos da raça Gigantil.



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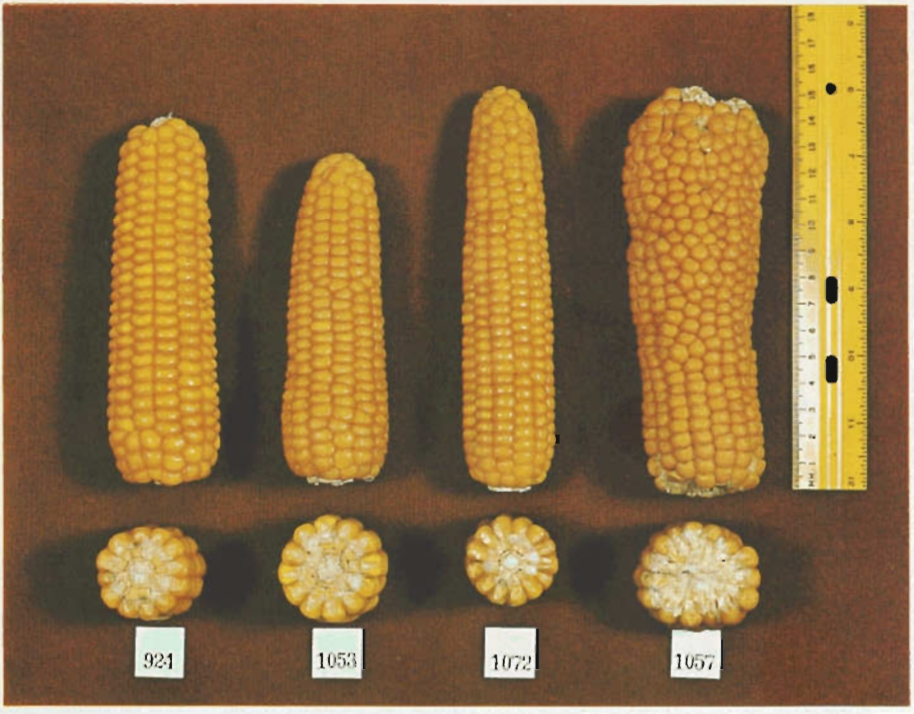

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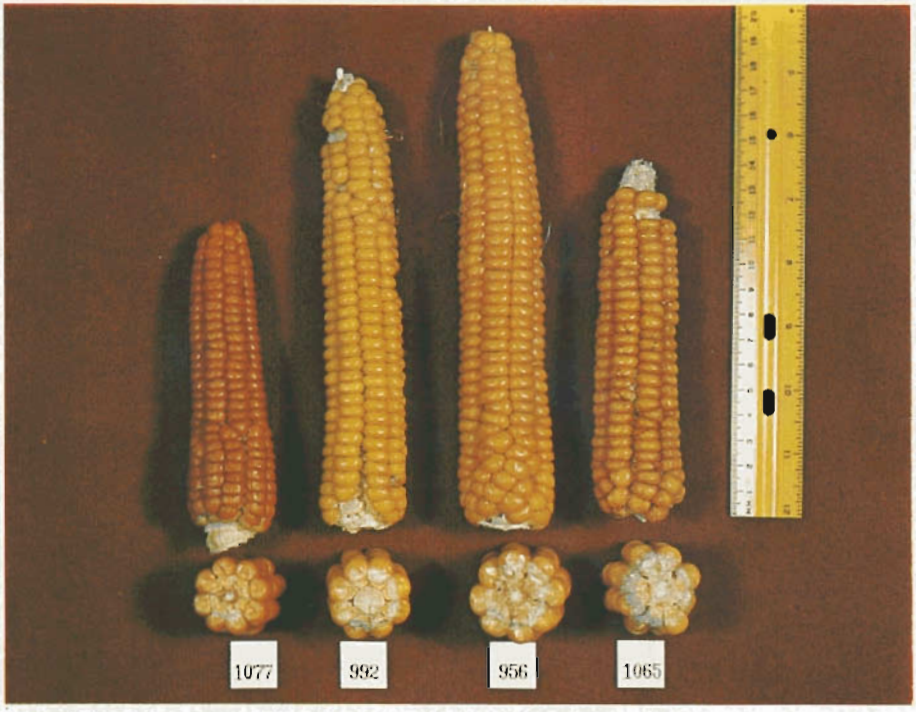

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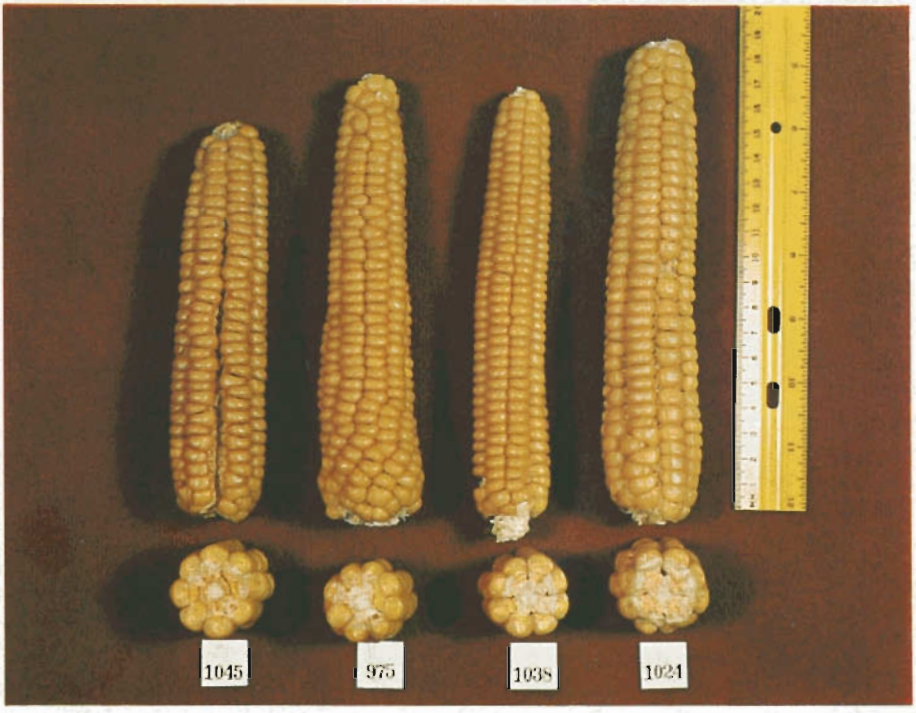

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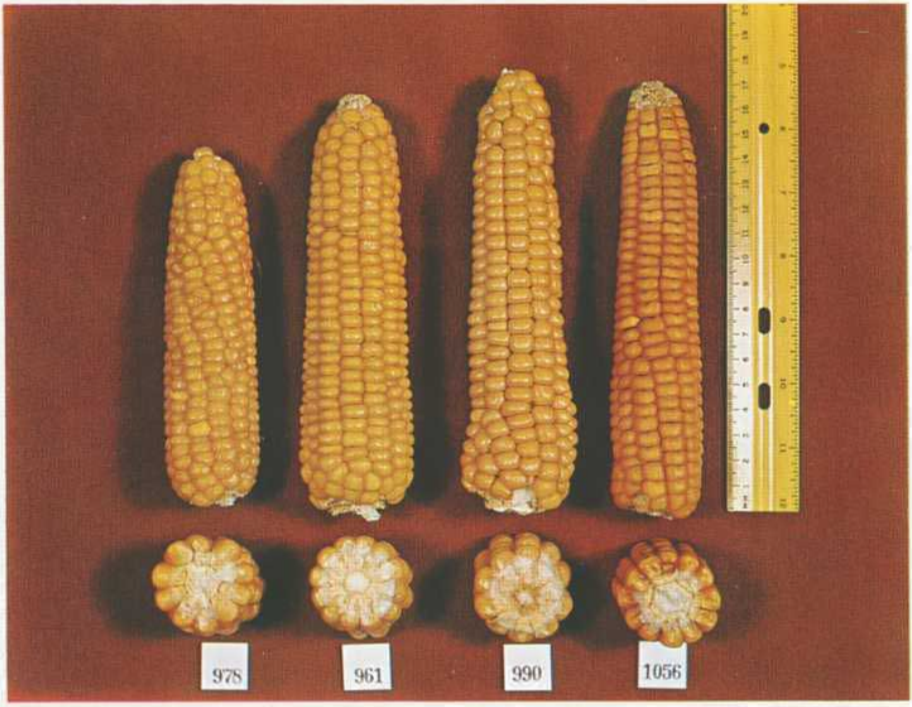

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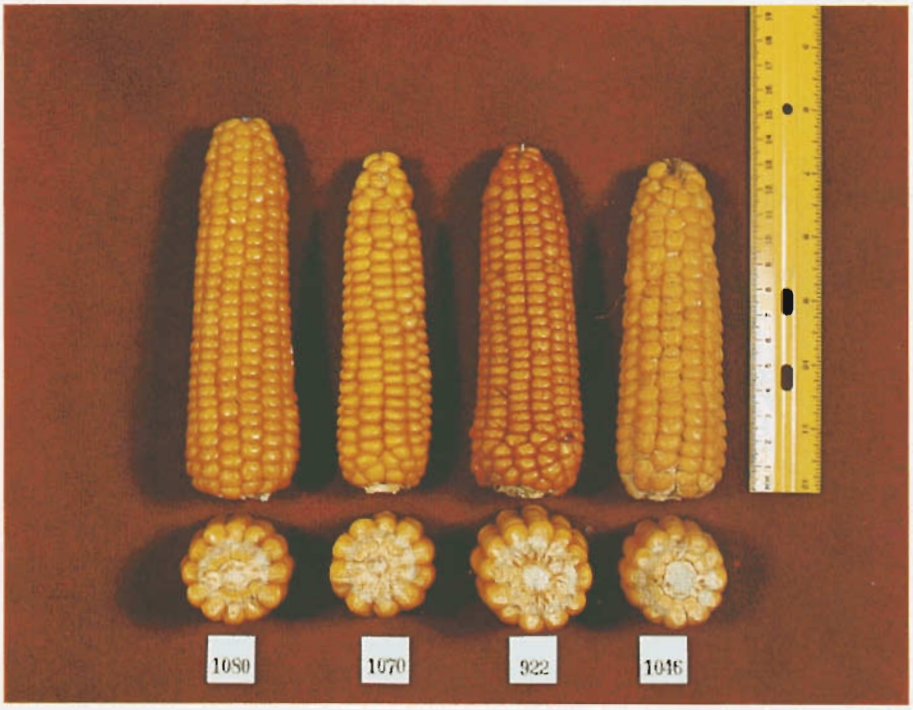

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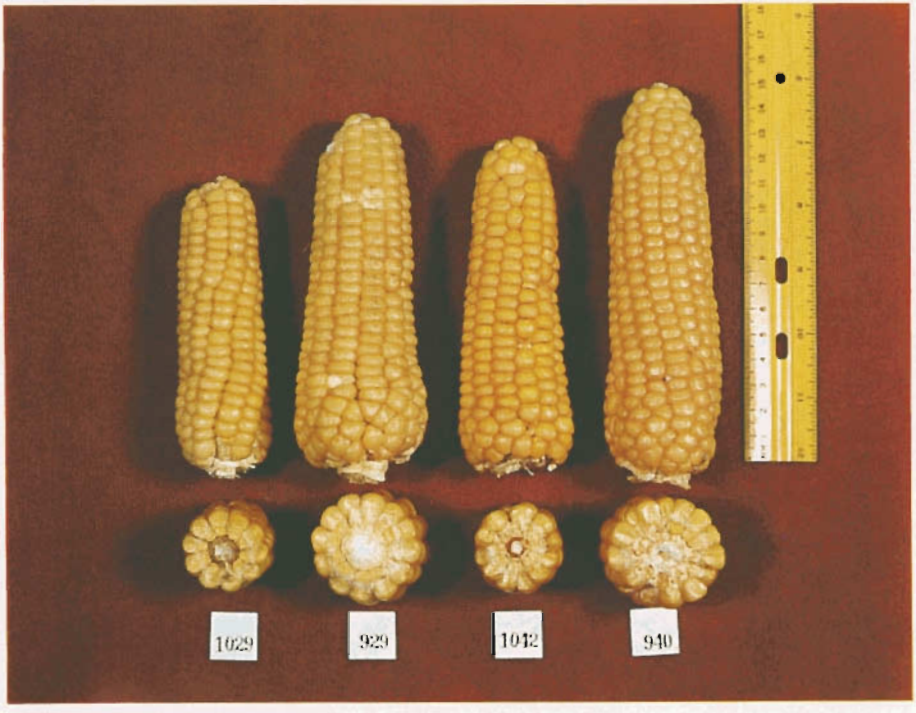

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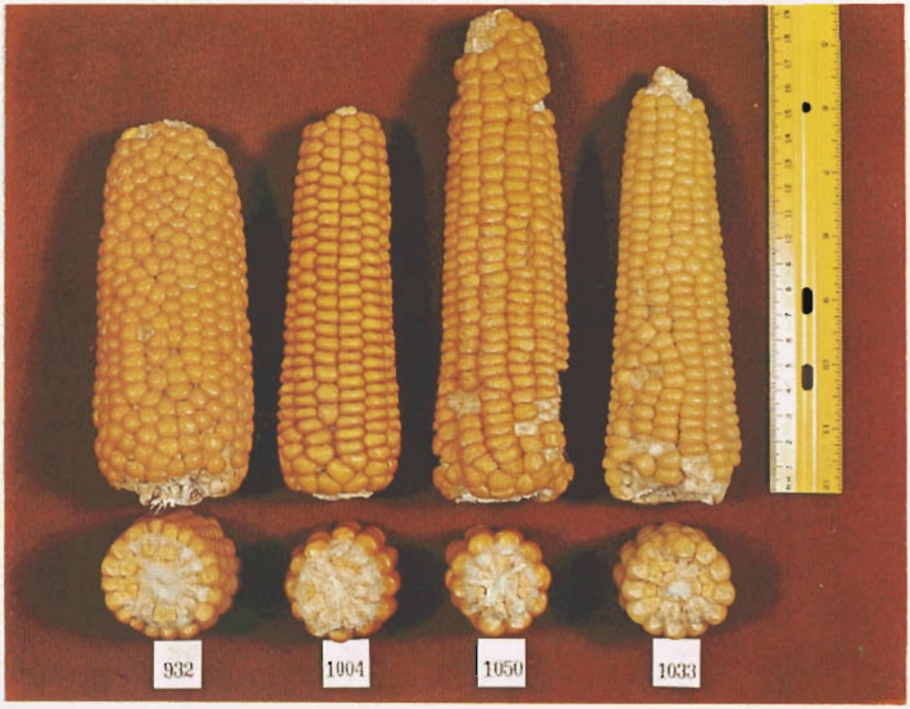

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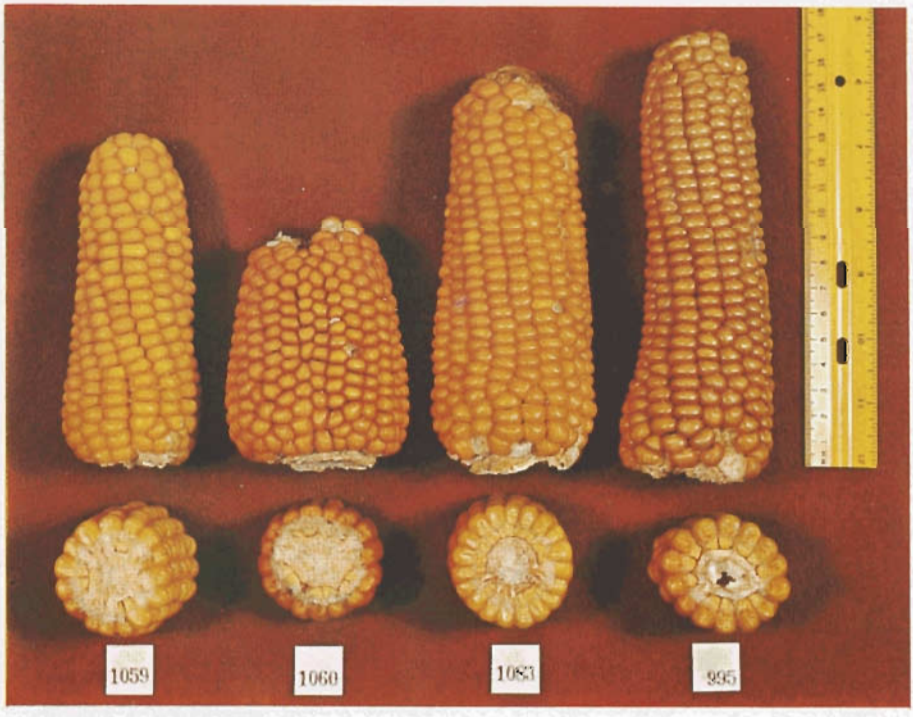

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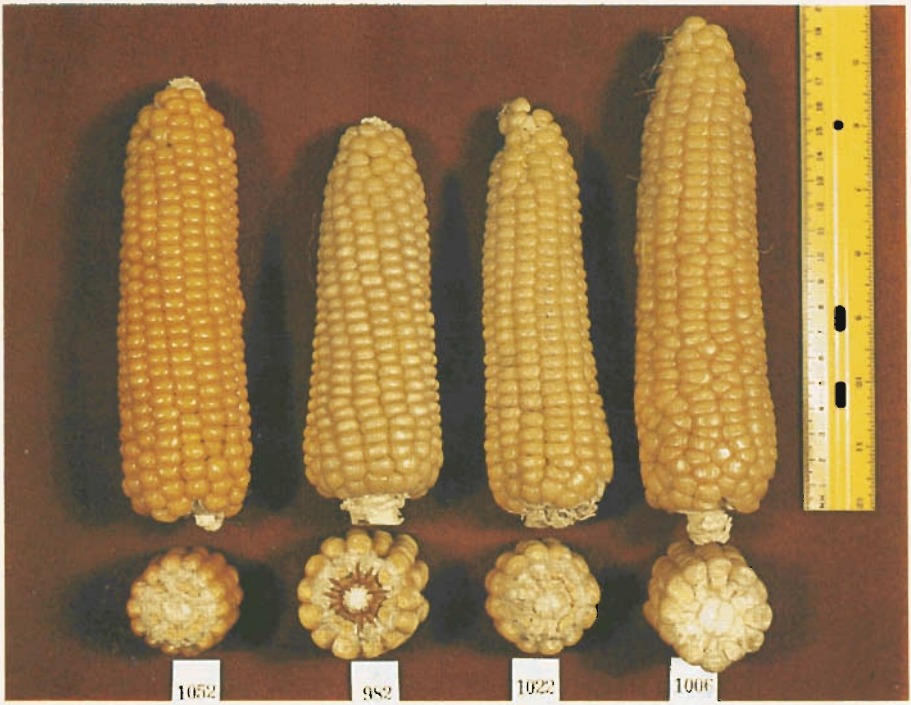

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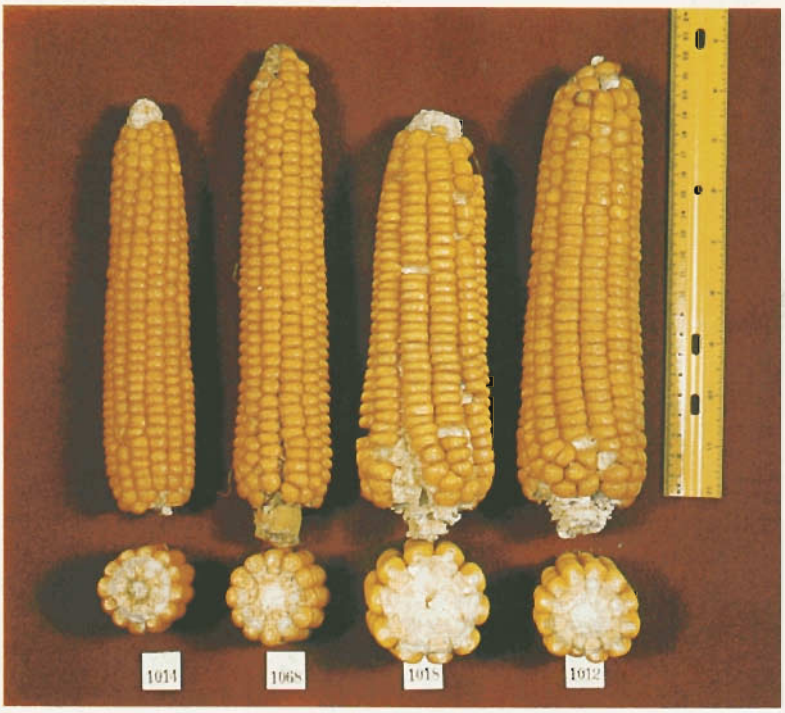

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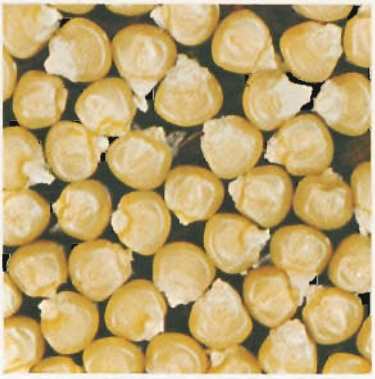

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