The necrotic zones expand, covering the leaves almost entirely, producing a premature drying of the plant. The zn plants produce pollen normally and in vigorous stocks they even produce good ears. This characteristic appeared in the progeny of a selfed plant from culture 37,977 of the commercial variety "Colorado Klein". Zebra-necrosis is linked with Og as proven by the following backcross data:

Backcross: $\frac{+\ \ Og}{zn\ \ +}$ x xn +

Og +	Og zn	+ +	+ Zn	Total
36	4	10	44	94

Recombination Og - zn = 14.9%

S. Horovitz

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1. Unlinked characters.

Linkage tests with unlinked characters were generally unsatisfactory because of poor growing conditions. Groups of unlinked characters and the students working with them are: virescents - G. T. Den Hartog; yellow greens - F. S. Warren; glossies - Mr. Mattos. Other characters being tested are: fired seedling, lazy, nl_2, upright tassel, 4-rowed ear, mi, vp_5, bm_4 - Singh, White, Khan, Quinones, Anstey and Miss Ford. Mr. Mattos reports an indication of linkage between Y and gl_{11} with 30.8 ± 5.3%, but the numbers are small. Crosses to renew stocks and for new linkage tests were made.

2. Progress in development of the large "Oenothera-like" ring.

Progeny from selfing supposed crossovers combining translocations two at a time (F_1 = ring of 6) were grown. The test crosses of the normals to isolate stocks homozygous for each combination will be grown this summer. If successful, we will be ready for the second step - combining four translocations into one stock. Field work by:

F. H. White, F. S. Warren and Miss Ford.

3. Effect of temperature on crossing over.

The effect of low temperature on crossing over in T5-6c was studied by counting spore quartets. Exposure of plants to 36 to 38 degrees for one to seven days in the fifth week of growth appeared to increase the amount of crossing over.

S. I. Khan

4. Chromosome segregation in rings. (See Genetics Soc. Amer. Records 13:14-15. 1944.)

Translocations involving chromosome 6 were used for further study of chromosome segregation in the ring. The data from three translocations with the break in chromosome 6 in the short arm are summarized in table 1. The quartet type with one diffuse-nucleolate spore results from a single crossover or a 3-strand double occurring in the interstitial segment (between the translocation point and the centromere). The three stocks in which this crossover value is low are the ones in which both types of adjacent disjunction occur (plane 1 = non-disjunction of nucleolar organizers, plane 2 = non-disjunction of homologous centromeres). The one stock in which this crossover quartet value is high (heterozygous T5-6c without the inversion) is the one in which no plane 2 adjacent disjunction could be measured. As a working hypothesis for this type of cross-shaped pachytene configuration (2 short spokes, each between 2 long ones), it is suggested that the genetic crossover length of the interstitial segment (between the translocation point and the centromere) may be the factor determining segregation. Chromosomes that crossover in this segment practically always pass to opposite poles (evidence from position of division I plane in spore quartets), hence plane 1 segregation does not occur in them. Plane 2 segregation would occur only in those in which no crossovers were present in the interstitial segment. When the interstitial segment is short, most of the chromatid tetrads show no crossing over in this region and both types of adjacents would be expected. This was observed in the three stocks with low crossing over in the interstitial segment; alternate: adjacent (plane 1 + plane 2) being in a 1:1 ratio. The spore quartets with two spores diffuse-nucleolate may result from non-crossovers or the 2-strand and 4-strand doubles. Since in T5-6c a fair estimate of the genetically recoverable doubles is about 12%, about 12% of those quartets are from this source, leaving only 5.5% to come from non-crossovers in which plane 2 segregation might occur. Observed pollen sterility should have been about 2.2% less than the predicted, a value too small to measure. Actually the observed abortion was a little less than the predicted. Genetic crossover length of the interstitial segment seems to be much more important than physical length, and equal lengths of segment in different translocations, involving different chromosomes along with chromosome 6, have different genetic crossover values.

In those translocations having the break in chromosome 6 in the long arm, only the plane 2 segregations can be recognized; these result in non-disjunction of the nucleolar organizers. The preliminary data are in the table. Cytological length of the interstitial segment shows no clear-cut relation to the frequency of plane 2 segregation. This is not surprising if the genetic length is the important factor. In the III-IV Drosophila translocation data, reported by Brown (Univ. of Texas Publ. 4032. 1940), plane 2 segregations were practically absent, although interstitial segment length varied from short to very long. The three with a short interstitial segment (long translocated piece) were the ones with the lowest frequency of plane 1 adjacent segregation, while the three with a long interstitial segment (short translocated piece) were the ones with the highest frequency. In these plane 1 gametes (non-disjunctional for the translocated piece, disjunctional for the interstitial segment and the remainder of the chromosome), crossing over in the translocated piece appears to have been greatly reduced, while in the interstitial segment where genetically measurable it appeared to be similar to that in the heterozygous translocation. Here two adjacent spokes of the "cross" were very short.

It is possible that the translocations will fall into different groups as regards position of the 4 "cross" spokes as seen at pachytene; each group having its own balance between several factors affecting segregation in the ring.

I am indebted to Dr. Barbara McClintock for originally suggesting the problem, and furnishing the seed stocks of T6-10, T5-6c, T5-6c I-5a, and I-5a. I wish to acknowledge the assistance of Mrs. Gertrude Stanton Joachim and Mr. C. H. Li in these studies.

5. Crossing over within inversion 5 a (I-5a).

In the stock homozygous for T5-6c, the 5^6 chromosome is now attached to the nucleolus and the centromere is a considerable distance away. In T5-6c, the entire short arm of 6 was interchanged with a very short piece of the end of the long arm of chromosome 5. In the I-5a inversion in chromosome 5 the two breaks are at about .7 of the long arm and adjacent to the centromere in the short arm bringing about a shift in centromere position. Pollen and spore quartet counts were made on plants (10 pairs of chromosomes) homozygous for T5-6c and heterozygous for I-5a. Single crossovers within the inversion result in the typical crossover type of spore quartet (one diffuse-nucleolate spore). Of the double crossover type that may occur within the inversion the 3-strand type results in the crossover type quartet, the 4-strand type results in a quartet with two diffuse-nucleolate spores, and the 2-strand one results in a normal quartet.

Table 1. Spore quartet and pollen data for translocations

	Spore quartets						Pollen abortion		Non-crossover quartets		
	Normal	2 dif-fuse spores	1 dif-fuse spore	Total	% 2 dif-fuse	% 1 dif-fuse	Predicted	Obs.	% alternate	% adjacent Plane 1	% adjacent Plane 2
Group I. Break in short arm of chromosome 6											
T5-6c + / + +	809	742	2678	4229	17.5	63.3	49.2	46.9	52.2	47.8	0
T5-6c I-5a / + I-5a	4434	1996	759	7189	27.8	10.6	33.0	49.0	51.1	31.0	17.9
T2-6a / +	1738	598	25	2361	25.3	1.1	25.9	52.1	47.9	25.6	26.5
T6-10b / +	1819	429	126	2374	18.1	5.3	20.7	42.9	57.5	19.1	23.4
T5-6c + / T5-6c I-5a	946	16	782	1744	0.9	44.8	23.3	20.7			
T5-6c I-5a / + +	710	491	169	1370	35.8	12.3	54.8	55.4			
T5-6c + / + I-5a	3285	1439	3871	8595	16.7	45.0	51.5	60.5			
Group II. Break in long arm of chromosome 6											
het. 1-6a	3398	623	5	4026	15.5			51.5			
" 2-6c	204	32		236	13.6			ca 50			
" 2-6d	198	98	4	300	32.7			ca 50			
" 2-6 (6049)	166	34	3	203	16.7			46.5			
" 2-6 (6052)	940	10	2	952	1.1			38.0			
" 3-6 Conn.	434	59	45	538	11.0			30.8			
" 5-6a	116	38	3	157	24.2			47.4			
" 5-6(5786-1)	162	82	7	251	32.7			49.0			
" 6-8a	293	65	4	362	18.0						
" 6-9b	2258	823	16	3097	26.6			35.2			
Group III. Break in nucleolar organizer											
het. 1-6 Conn.	307	2	6	315				26.0			
Group IV. Break in satellite											
het. 1-6b	4332	4	3	4339	0.09			26.3			
" 5-6b	2504	19	8	2531	0.8			19.9			

Observations show 45% of the quartets with one diffuse-nucleolate spore and 0.9% with two. If the double crossover types occur at random, the latter value indicates a very low frequency (3.6%) of double crossover quartets. It probably indicates a reduction in the frequency of double crossing over caused by the inversion. This leaves about 43% of quartets resulting from single crossing over within the inversion. Determination of the number of genetically recovered doubles within the inversion in such a stock should give an indication of any great deviation from randomness of the different double crossover types.

6. <u>Heterozygous T5-6c, heterozygous I-5a</u>. (Data in table 1.)

$\frac{\text{T5-6c} \quad \text{I-5a}}{+ \quad\quad +}$. The observed 12.3% of crossover type quartets is similar to that observed in the T5-6c/+ homozygous inversion, since only the crossovers between the new inverted position of the centromere and the translocation point in chromosome 5 are recognizable as crossover type quartets. The presence of the heterozygous inversion has not reduced crossing over in this region adjacent to it.

$\frac{\text{T5-6c} \quad +}{+ \quad \text{I-5a}}$. In this type, crossovers within the inversion are also recognizable. The observed value, 45%, of crossover type quartets is comparable within a few per cent with that which occurs in heterozygous T5-6c without the inversion, i.e., 63.3%. Since 45% of crossovers were observed in homozygous T5-6c heterozygous I-5a where crossing over in the short interstitial segment could not be measured, it appears that crossing over is reduced by T5-6c and by the inversion in heterozygous condition.

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1. The $\underline{Y}_7$ gene, complementary to $\underline{Y}_1$ and $\underline{Y}_3$ in producing yellow-orange endosperm ($\underline{Y}_7$ = albino seedling. Revista de Agricultura 22:42-54, 1947) is now definitively located in linkage group 7. The data obtained in F_2 for eight ears (repulsion phase) are as follows:

++	+ gl_1	y_7 +	$y_7\ gl_1$
961	464	391	4

2. The lemon-yellow seeds of Dr. Merle T. Jenkins (designated yellow in my nomenclature) referred to as y_8 (News Letter 21:33. 1947) did not show differences in color from the yellow seeds, Y^d, of my Brazilian material (Revista de Agricultura 22:42-54. 1947). The F_1 seeds had the same color as the parents and no segregation could be observed in F_2. It is suggested that y_8 and Y^d are alleles.

3. A new gene producing pale-yellow endosperm, provisionally called Y_6, was isolated from Brazilian strains. Crosses with a white seed tester shows normal 3 pale-yellow : 1 white segregation. The pigments belong to the carotenoid group as indicated by the extraction with methyl alcohol. Proper tests and crosses are being conducted this summer in Brazil in order to check the Y_1 gene in chromosome 6. If the yellow pigment should be due to the Y_1 gene and the pale-yellow color determined by a new selected modifier, I should prefer to change the designation Y_6 to Y^R (R = reduce, $Y^dY^dY^rY^r$ = pale yellow), since I prefer numbers to designate genes conditioning the presence of yellow-orange pigments in the endosperm (Y_1, Y_3, Y_5, Y_7)and letters to designate differences among its shades (Y^D, Y^R).

4. Two seeds, similar to sugary except that the corrugated part was only from the middle to the top of the grain, were detected in a commercial dent strain of Brazil, called "Armour". One plant secured was crossed with the su_1 la (chromosome 4) and the F_1 seeds were apparently pseudo-sugary. Other generations are being investigated this summer.

5. Stocks for linkage tests involving all 10 chromosomes that I made up while in the United States in 1942 by crossing North American lines with an Argentine strain and later selected in Brazil, have now been crossed with Brazilian material in order to improve their vigor.

E. A. Graner

I. Breeding work

1. Breeding program.

Since relatively little has been published about the main varieties of our region, which extends from the State of Minas Gerais in the North to the Argentine in the South, a short resumé shall be given.

A. Orange hard flints

Cateto is the dominant type in the States of São Paulo and Minas Gerais. The plants are generally tall to very tall with the first ear at about two thirds of the height of the culm. Silking occurs at about 80 days after planting. The kernels are of light orange color and of medium size. The ears are slender, often conical, and weigh from 80 to 150 grams each, approximately.

A special variety is the so-called "Cateto de palha roxa" with purple colored husks and glumes on dilute purple or sun-red plants.

Cateto Rio Grande from the State of Rio Grande do Sul, is earlier (70 days to silking), the plants are smaller, but very strong, the ears cylindrical and heavy, weighing from 150 to 230 grams each.

Colorado - The plants are considerably smaller than the above mentioned types with an average height (without tassel) of about 1.60 m. The ear is formed below the middle of the plant. The kernels are of a deep orange color and of medium size. Silking at about 64 to 68 days.

Cuarentino - The smallest and earliest variety, silking after 60 to 64 days. Plant height 1.00-1.30 m. Ear relatively low in the second quarter of the plant, rather short and thick, from 80 to 120 grams. Kernels are deep orange, small, and very tightly compressed.

The most frequent unfavorable plant characters found were: white, yellow or striped seedlings, and barren stalk. The main deficiencies of ear are irregular row arrangement caused by an increase of number of spikelets per alveolos, inverted embryos (due to the development of the second flower), various grades of defective kernels, from defective lethal to a type which we call "light yellow soft" in accordance to the appearance of the grains; kernels with mosaic corneous defective endosperm are not rare.

In several crosses involving Colorado x "Early Yellow" (an extract of Canadian "Little Yellow" and Cateto) we found an F_2 segregation for purple aleurone, approximately in the ratio of 13:3.

In crosses of Cuarentino x Early Yellow, one third of the F_1 ears gave a segregation of about one half orange to one half purple, with shades ranging from deep to very pale.

No special references shall be made to "Amarillo" a large-grained early yellow flint of the La Plata regions which is of no great interest to us owing to its light color. A large-grained, very late and very hard white flint (Cristal) of our regions is also of little importance commercially.

B. Dent corn

It seems that all types of commercial dent corn here are derived from both yellow and white North American Dent, the former generally out-crossed to the local Cateto varieties. Most commercial dents are thus very variable, and not differentiated into regional types as the hard orange flints.

We received recently several samples of an excellent white, soft dent corn, cultivated by the Caingang Indians from Paraná and São Paulo, and which seems very promising for breeding commercial corn.

C. Soft corn

Soft corn is grown very little commercially, though it is the principal field corn of the Indian tribes.

D. Pop corn

The only native type seems to be the "Pointed Pop" with small strongly beaked kernels in straight and salient rows.

"Milho de Pinto" (translation: chicken corn) with very small grains on small cylindrical ears, each plant producing several ears, and a type of "Rice pop corn", are most probably imported varieties.

E. Sweet corn

No sweet corn has been grown formerly on any scale, except from imported seeds, but new varieties have been produced by crossing. Several types of Piracicaba sweet corn are in distribution and gave good results in the field. By planting, with ten-day intervals from early September until January, green corn may be harvested over a very long period.

2. Resistance to diseases and pests in general.

Practically no pest or disease has been so far of major importance. This is, however, not due to the absence of fungi or insects, but to a very pronounced and widely distributed resistance. Thus, planted side by side, Piracicaba Sweet Corn P-18 had at the most one earworm at the tip of the ear, while Andean corn from Bolivia was almost completely eaten from top to base, with several larvae per ear. While most strains of Cateto are not attacked by aphids, sometimes a whole inbred line shows a high degree of infestation. The same is true for rust attack, which is generally very low in local strains, but rather high in material from the tropical North of Brazil and also in several U.S.A. strains. Smut is a very minor disease, and was somewhat heavier only in segregates of the cross, corn x teosinte.

F. G. Brieger

3. Resistance against grains weevil and moth.

The studies about which we gave a short report last year are continuing, and other varieties were included in the tests. The hardness of grains have no influence on the resistance, since the most resistant types are a soft dent and some indigenous floury types. Hard pop corn and "Cristal" (hard white flint) are very susceptible.

Furthermore, the resistance so far affects only the attack of the grain weevil, while even the resistant types are susceptible to the grain moth.

N. Kobal

II. Indigenous corn and studies on the origin of corn

4. Indigenous corn.

Our collection has now been increased sufficiently to allow to draw some general conclusions. These are at variance with those of other authors, who had not been able to inspect and study extensively material from the lowland regions, east of the Andes, which in its extreme variability alters considerably the picture.

If we accept the highland region, east of the Andes between about 13° and 18° latitude, belonging partially to Bolivia and partially to Brazil (State of Matto Grosso), as the most probable region of origin, we may distinguish at least three centers of primary domestication, surrounding this center:

A. The Southern Region, formed by the Pilcomayo-

Paraguay-Paraná Basin. There are two main tribes of Indians in this region; the Tupi-Guarani and the Caingang, who cultivate quite distinct types of corn. The principal Guarani corn is a soft corn with yellow color both in the endosperm and the aleurone layer, while the main Caingang maize is a soft white dent. Both these types are very productive, with normal long heavy and cylindrical ears and regular row arrangement. There are several minor types, such as a hard white flint in the Guarani region, and a soft yellow Caingang corn, much inferior to the Guarani Yellow. Both tribes have one primitive type in common: the Pointed Pop Corn, with small hard grains of varying colors, ending in a pointed and curved beak, long glumes and very regular and salient rows. The ears are generally conical and long, ending in a tapering tip which bears mainly male flowers only, thus giving a "tripsacoid" appearance. As an additional type one may mention the large white soft corn, grown by the Chavantes-Opaie, a nearly extinct tribe on the Southern border of Matto Grosso. While generally the aleurone does not contain anthocyanine, purple and red colors are found. Black, red and variegated pericarp is quite frequent.

B. The Northern Region, formed by the southern margin of the Amazon Basin from the Andes in the West to the Araguay River in the East, approximately between 8° to 20° latitude.

In spite of the fact that the material came from several completely unrelated Indian tribes - such as the Gaviões in Acre, the Bororo and Cajabi in Matto Grosso, the Tapirape on the Araguaya - all samples belong to the same basic type: Long and thick ears, or long and slender ears with an apparently low row number, owing to the curious type of interlocking described a short time ago by Cutler, and a very pronounced tendency for thin and flexible cobs. This flexible cob is one of the main characters which we may consider as primitive, and which is not found outside the region. The strong development of the husks and the "tripsacoid" ear tip is common to both the Northern and Southern regions.

The grains are large and contain soft starch, no dent or flint corn having been found in the region. An approach to dent is shown by some "shrunken" kernels, due to some recessive endosperm factor.

The color of the aleurone may vary from brown and deep orange to pale yellow, and also to white, in the absence of some dominant factor (Bn). Black, purple or red aleurone is rather rare, except in Acre. Pericarp color shows the usual range from almost black to colorless, including variegated pericarp. The endosperm is generally yellow.

C. The Andean region of the old Chimu and Inca Empire.

The corn types of the Andean region have been considered as "the prototype" of South American corn in numerous collections, but there cannot be much doubt that they represent only just another group of regional types, profoundly different both from the corn of the Paraguay basin or the southern margin of the Amazon basin. The material received from Dr. Cardenas on several occasions and from other sources, ranging from Peru in the North to the Argentine in the South, makes it evident that the spherical ear with irregular row arrangement, found in the highest altitudes, may be a primitive type, but is certainly not the predominant type. In general the ears, though they may be short and thick, have regular row arrangement and often salient rows. Tripsacoid ear tips have been found, however, rarely.

The Andean corn has generally soft starch, and though sometimes indented, no very pronounced dent types were encountered. The Andean pop corn, though having sometimes kernels with a sharp tip, are quite different from the pointed pop corn of the Guarani and Caingang. Andean sweet corn varies very much from ears which are practically identical with Mexican sweet corn to a type with nail-like kernels, sugary only at their tip.

D. The marginal zones

No samples have been received as yet from the west coast, outside the Andean Empire.

The material received from Caribean region (Colombia) are typical tropical flints, either large grained or small grained pop corns, equal to Anderson's "milho rebentador".

On the east coast, it seems to be very probable that the region from the Argentine up to the State of São Paulo has been the original zone of the hard orange flints, which form regional types more or less in correspondence with the latitude. The corn today in cultivation in the States from Rio de Janeiro to the mouth of the Amazon have been classified recently by Cutler as belonging to the "Tropical Flints". However, the variability and unstability of the large amount of material which I received from these Brazilian States leave little doubt that we are dealing with a recent hybrid mixture, in which entered hard orange flint, U.S.A. dent and possibly soft yellow indigenous corn. It seems to me very doubtful now if indigenous corn could still be found there, since the Indian population has been liquidated or assimilated and crossed with both white immigrants and black imported slaves.

Only two samples from the northern margin of the Amazon have been studied so far, and both came from the most extreme points; from Iauarate near the Rio Negro, almost on the border of Colombia, and the other from the Emerillon Indians (Tupi) from Amapa, north of the mouth of the Amazon and near the border of French Guiana. They are different not only between themselves, but also from the corn of the southern Amazon margin, and from the Tropical Flints of the Caribean coast.

E. Tunicate corn was obtained only rarely, and never among the samples of indigenous lowland corn. According to the information of Dr. Cardenas it is also difficult to obtain in Bolivia where it has a "therapeutical" value. Thus it may be "tabu" with the Indians and this may perhaps explain its absence in the collections, or it may not be in cultivation any more. The four strains which were grown in our plots had always initially normal or almost normal tassels, and the special type of tunicate tassel with large glumes and many female flowers was only obtained after outcrossing to non-tunicate forms and selecting. In this connection it may be mentioned that no support could be found that the so-called "fourth type of Azana" with many grains on a tassel-like structure is some kind of tunicate, as Mangelsdorf believes. The interpretation given by Parodi seems much more probable, that Azana was referring to grain Sorghum, and as a matter of fact in the North of Brazil grain Sorghum is locally called "milho de pinto" or "chicken corn", a name generally given to small grained pop corn.

From a general point of view it is also interesting to note that the main type of ear among the indigenous material of South America is the cylindrical or somewhat conical ear with regular longitudinal paired rows, while the spherical ears of the high Andes represent an exception. Furthermore, the fact that representatives of all corn varieties exist among South American indigenous corn makes it probable that all major changes of domestication have occurred already before corn left the primary center of domestication and reached in its migrations Central and North America, though there have probably occurred new and parallel mutations, as for instance in the case of sugary. But there seems no reason to assume that southern and northern corn varieties are fundamentally different, and that any fundamental difference is due to accidental crossing of corn and Tripsacum in Central America.

5. Variation of row numbers.

Since the ear is to be considered the most striking feature of domesticated corn, a special study was made of the increase of row numbers. Accepting the hypothesis that corn had originally, as Euchlaena and Tripsacum, an ear with two pairs of rows on opposite sides, it was considered necessary to find out how an increase of the number of pairs of rows of alveoli may occur.

(a) A number of ears was studied which had two rows of alveoli in the upper half and a higher number in the lower half. If only one row of alveoli was interposed at the bottom, there was not only a twist in the transition zone, but the three-rowed part was twisted throughout. If there was an intercalation of two rows, these were placed side by side between the two original rows causing a twist in the transition zone which makes the two original rows, become neighbors. An addition of three rows of alveoli was observed only rarely, and then there was one new row on one side, and two on the other side, and only a slight twist of the two original rows occurred in the transition zone. It may be mentioned that not all the ears inspected could be analyzed satisfactorily, since this could be done only where the pairs of rows were sufficiently salient to be identified as belonging to the same alveolus.

In Tripsacum australe an increase from two to three rows in the female part of the inflorescence was observed very rarely without causing any twisting.

(b) An increase of spikelets per alveolus, beyond the normal number of two, was found occasionally. This addition seems to be the cause for the not infrequent increase of rows at the base of many ears. In several lines, especially of Cuarentino, the increase of spikelet number was, however, not limited to the base of the ear, but affected the whole ear.

The addition of the new spikelets caused a zigzag arrangement of the kernels, and when occurring in large parts or in the whole ear, the result was the obliteration of longitudinal rows, and the appearance of a spiral arrangement of kernels belonging to neighboring alveoli. It seems quite possible that this may also be the explanation for the situation found in the spherical ears from the Andean highland.

The genetical basis of this type of increase is very complicated.

(c) A development of the second flower has been observed only as an abnormality, occurring always in a limited number of spikelets. When both flowers develop into kernels, irregularities of rows were caused. But when it was only a question of which flower develops and which degenerates, no irregularities may be observed, except the appearance of "inverted" embryos. The genetical analysis of this character in our material is difficult, owing to the irregularity of its occurrence in a sufficient number of grains. In crosses it gave the impression of a recessive condition.

(d) Finally a botanical peculiarity should be mentioned which was first observed in descendants of the cross, teosinte x corn: The terminal inflorescence of the ear branch was frequently a many rowed ear while all the lateral inflorescences of the same branch had only two pairs of rows on opposite side of the rachis. For the first time this condition was also observed in pure corn: Cusco from Bolivia.

In branched ears it was considered the rule, as in the tassel, that the central spike should be many rowed and all branches should have only two pairs of rows on opposite side of their rachis. Exceptions were observed now in branched ears from Goyaz Pointed Pop and in Cuarentino.

(e) No indication of any fusion was ever observed, neither in pure Zea, Euchlaena, Tripsacum, nor in descendants of hybrids of the first two.

6. Zea-Euchlaena crosses.

While a full report of these experiments which have now reached the seventh generation shall be given later, one point may be mentioned. If teosinte should really be a segregate of a cross between some Tripsacum species and Zea, it seems rather astonishing that Euchlaena shows so little variability and that all existing forms have been included in a monotypic species. Selection in the descendants of several hybrids, obtained by continuous selfing after F_1, showed that many combinations of Zea and Euchlaena characters are possible and can be more or less stabilized. Those with predominantly Euchlaena characters are perfectly viable in nature and show that without prejudice for the survival rate many Zea chromosome regions could be introduced into Euchlaena. The characters of these descendants, and of those from backcrosses to either parent show beyond doubt that a genetic analysis of the species differences cannot be obtained from backcrosses to corn only, where a large part of the Euchlaena genes become obliterated and lost.

F. G. Brieger

III. Cytogenetical studies

7. Linkage testers.

With the inclusion of several new lines we have now almost completed the collection of the testers, with four or more genes in each chromosome and other combinations for special purposes. We found material from the Argentine very disappointing, and had to transfer the genes to a central-South American background. As such we use now an early commercial flint and an indigenous corn from Parana (South) top dominant for all genes for aleurone color. At the end of 1948 all testers should have been transferred and their linkage values checked. Thus a list will be given in next year's Maize Letter for the use of South American geneticists, and for subtropical zones in general.

8. Husk color.

(a) Purple husks in sun-red plants are quite common in South American material, and it seems that several genes are responsible, acting only in certain backgrounds. A_1 is always present in colored husks.

(b) Rosewood self and variegated color of husks are due to a new series of pericarp alleles at the P locus. The types found up to now are:

Pericarp	Cob	Husk
red	red	rosewood
red	red	white
variegated	variegated	variegated rosewood
white	red	dilute rosewood
white	red	only margin of each husk stained (fimbriated).

(c) Tobacco color in husk appeared last year in material from Colombia, and previous to any genetical analysis we are selfing in order to get homozygous and deeply colored strains.

The husk's color appears in ears picked when completely dry, about 40 to 50 days after pollination. Before this time, purple husk seems sun-red or very dilute purple, the rosewood color does not show at all and tobacco color is so light that it is confused with the natural yellowish shade of the husks.

N. Kobal

9. Yellow endosperm.

A detailed analysis of endosperm color became indispensable both for the breeding work and in the analysis of the indigenous corn, and thus we intensified these studies again. In order to get some order in a rather confused situation we suggest to adopt some rules about symbols, reserving the letters Y-y for basic factors of dominant yellow, the symbols Or-or for dominant orange shades and Am-am (amarello) for dominant yellow shades.

Excepting the basic factors Y_3 and Y_7 which cause also chlorophyll deficiences in the plant, there exist evidently at least two more Y factors causing separately a ratio of 3 yellow to one white, and together the ratio of 15 yellow to one white.

The shade of the endosperm color is controlled by at least three sets of factors:

(a) Dosage effects of the main factors Y

(b) Interaction of major factors for shade and of a various number of modifiers

(c) At least one plant character giving a segregation of three plants with all yellow-orange endosperm to one plant with all yellow endosperm.

The main endosperm ratios so far encountered were: 3 orange to 1 yellow; 1 orange to 3 yellow; 1 deep orange to 2 orange to 1 yellow.

A good classification is, of course, possible only in the absence of any orange to yellow aleurone color and in the presence of hard and corneous starch. Soft corns which contain, as shown by crosses, deep yellow endosperm, exhibit only a slight cream colored endosperm, owing to the optical effect of the soft starch and its air content.

F. G. Brieger
N. Kobal

10. New mutants.

Both in our commercial material and in the indigenous lines a number of mutant types appeared which shall be studied in detail and localized later. Those which permit a phenotypical classification are cited below:

Yellow striped - Identical to yellow stripe-1. The character shows from the fourth leaf until maturity. Pollen and sometimes ears are produced.

Tassel seed - Phenotypically identical to Tassel seed-5, but recessive. Ears are normal.

Brachytic - We received a pop corn with spherical small ears from Acre, and the plants proved to be homozygous for a recessive type of brachytic except for two contaminations. Height about 50 cm., internodes short, leaves more or less stiff. The plants have a normal fertile tassel, and give two to three ears. The cross with brachytic of chromosome 1 gave normal (tall) F_1 plants.

Stiff leaves - The plants are smaller than their normal sisters, with very stiff straight and narrow leaves. Pollen and normal ears produced. Recessive.

Dwarf - Not classifiable in seedling stage. The plant is higher than other dwarfs. Leaves are broad. Pollen and good ears produced.

Ramosa - Plants and tassel normal. Branched ears well filled, the branches having more than four rows, in constrast with other known ramosa. Recessive.

<u>Crinkly</u> - Plant dwarf, leaves strongly crinkled and sticky. Pollen and good ears produced.

<u>Virescent</u> - Only one was maintained because of the obviousness of the character. The virescent seedlings are white and remain white for more than a week. The majority of the plants do not change color and die. Others grow slowly and silk about 40 days later than normal sisters.

<u>Barren stalk</u> - From a commercial strain; the plants are normal in all ways and strong but without sign of an ear.

<u>Waxy</u> - Quite common, and selected from Goyaz (Center of Brazil) and lowlands of Bolivia and Paraguay. The classification with iodine is somewhat difficult, as is the case also in Argentine waxy.

<u>Scarred endosperm</u> - The endosperm is scarred. In homozygous ears the scarred character can change to semi-defective types.

<u>Shrunken</u> - One ear of a commercial strain gave a segregation of three normal to one shrunken kernel. The phenotype is identical to shrunken-1. Incomplete types of shrunken were found in Bororo corn, and behave also as a simple recessive.

<u>Brittle</u> - Several ears of Caingang corn segregated clearly for a recessive endosperm character, phenotypically identical with brittle.

<u>Defective endosperm</u> - Found very frequently both in commercial inbred lines and in indigenous corn. The types vary from inviable defective to mosaic defective or to yellow-soft defective. Some of the latter germinate and give normal plants.

F. G. Brieger
N. Kobal

11. <u>Knob position and knob number</u>.

The work has been started only recently and some preliminary results were obtained. The numbers so far found in the indigenous material range from 1 to 6 per complement. The positions so far found are identical with those already reported from other material.

From these preliminary results it seems already justified to draw the conclusion that knobs had been in existence already during the primary phase of domestication and have then scattered over the whole corn area. Otherwise it would be difficult to explain that knob positions are always the same.

F. G. Brieger
W. E. Kerr

12. Sterility in Soft Paraguay Yellow. A partially sterile type, conserved during several years, has now finally come under closer inspection. Selfs, sibs or intercrosses within the sterile lines give generally poorly filled ears, with a certain amount of variation from almost empty ears to ears with one side almost normally filled. When pollinated with pollen from unrelated plants the ears are always well filled.

Studies on the germination of the pollen grains gave the following result:

	Germination
Pollen of sterile plants on silks of sterile plants:	very little
Pollen of sterile plants on silks of fertile plants:	normal
Pollen of fertile plants on silks of sterile plants:	normal
Pollen of fertile plants on silks of fertile plants:	normal.

The crosses carried out agree with these results and, for instance, by dividing the silks of an ear and selfing one half and outcrossing the other, only the latter half of the ear was well filled. F_1 hybrids of sterile x fertile gave sterile F_1s, while the reciprocal cross has not yet flowered. At meiosis the only abnormality observed was a tendency for partial asynapsis. From 95 to 100% of the pollen grains are, however, normal, though variations in size occur frequently. The tassel also shows some sporophytic sterility in its branches.

N. Kobal

13. Sterility of crosses. In several commercial hybrids tested last year, male sterility appeared. The pedigree records show that in nearly all cases one dent variety (Pelotas) was used as female parent. The sterility seems to be due to some abnormality in pollen development. Meiosis appears to be normal, but the development stops after pollen tetrads are formed. Instead of the pollen grains, mature anthers contain aborted grains or masses of cells which stick together.

F. G. Brieger
N. Kobal

Acknowledgment

A comparison of this year's report and former contributions shows a very great progress in our work which includes now also cytological studies. We are for this very much indebted to Dr. Marcus M. Rhoades who stayed in Piracicaba for a few months, from October to January, and who gave us very valuable help in the study of many problems of corn genetics. His stay was made possible by grants from the Rockefeller Foundation, and the Secretary of Agriculture in São Paulo.

III. MAIZE PUBLICATIONS -- 1947

(Including certain 1945-46 publications not previously listed and some early 1948 publications.)

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James E. Wright, Jr.

IV. SEED STOCKS PROPAGATION

In the following inventory are listed the stocks of genes and gene combinations of which a supply of viable seed is now available at Cornell. Only those stocks grown since 1942 are considered viable as indicated by our experience last summer in attempting to grow cultures from old seeds.

Thus it may be assumed that stocks for genes other than those listed have been lost or have never been incorporated into our supply. Especially is the latter true for those genes which have been reported since 1942. It would be helpful to the Coöp. therefore, if each coöperator would check his stocks against this list, and if he has any that do not appear here to forward a small supply to the Coöp. for multiplication.

Most of the propagation of material during the past summer involved the growing of cultures from old seed which were in danger of losing their viability. This included both single-gene stocks and multiple-gene linkage testers. In addition, certain weak stocks were outcrossed to adapted inbreds in order to make material available in more vigorous combinations. Reselection within previously-made hybrids of this sort was continued.

(m.s. = may segregate)

a	44-163; 45-68; 45-147; 45-151; 47-23; 47-26
a_2	45-78; 45-92; 47-44; 47-173
a_3	45-127; 47-102
ad	47-100
an	47-6; 47-13; 47-101
an_2	43-5,6,7,8 (m.s.)
ar	45-95; 47-58
at	45-94 (m.s.); 47-103
au	47-64 (m.s.)
b	43-100; 45-11; 47-171
B	43-101; 47-17
B^w	44-205
ba	45-42; 45-96
ba_2	45-97
bd	45-82; 47-49; 47-52
bk	45-98
bk_2	47-65
bm	44-76; 47-43
bm_2	45-56; 45-58; 47-4,5,8,10,11,12,13
bm_3	45-99; 45-143
Bn	47-54

bp	44-163
br	45-56; 45-57 (m.s.); 47-4,6,8,10,11,13
bt	46-107; 47-42
bt_2	43-142; 45-13
bv	45-94 (m.s.); 46-107
c	43-163; 44-174; 44-206; 47-56,59
Ch	43-11; 47-105
cl (corrugated leaf)	43-141; 47-106
cr	43-106 (m.s.); 44-159 (m.s.); 45-122 (m.s.); 45-100; 47-30,31
d	43-12; 44-75; 45-67; 45-69; 47-25,29,32; 47-107
d_2	44-154; 45-102; 47-121
d_3	44-72; 44-97; 44-146; 47-122
d_5	43-13; 44-40
da	45-88; 47-58
Dt	44-163; 45-68; 47-24
du	47-174
f	45-57; 45-150 (m.s.); 47-6,8,10,11,13
fl	45-61; 46-104; 47-20,21,67
fl_2	45-103
fs	45-104; 47-68
g	43-155; 44-90 (m.s.); 45-12 (m.s.); 45-90; 47-62,63,173
g_2	44-76 (m.s.); 47-123
g_3	43-18 (m.s.)
g_4	43-19; 44-41 (m.s.)
gl	44-159; 45-80,82,84,98,122; 47-50,51,52,53,173
gl_2	45-8,9,10; 47-14,18,19,20,21,71
gl_3	45-71,72,73; 47-36,38,39
gl_4	45-20 (m.s.); 45-51,52,89,103,106; 47-56,59
gl_5	43-23,143; 44-5,36
gl_6	45-107; 47-109
gl_7	43-24; 45-139
gl_8	44-88,89; 47-125
gl_9	43-147; 47-126
gl_{10}	45-109; 47-110
gl_x	43-142; 44-66 (m.s.)
gs	47-12,13
gs_2	45-11; 47-15,16,127
h	45-110 (m.s.); 47-128
hf	45-111 (m.s.); 47-111 (m.s.)
Hs	45-112; 47-112
I	47-82

ij	45-82; 47-49,51,52,113
in	44-170 (m.s.); 45-151
j	47-55,173
j_2	44-191; 45-72 (m.s.)
Kn	45-113
l	43-25,26; 44-6,7,42,43
l_2	43-137 (m.s.)
l_3	43-193,194; 44-95; 47-129
l_4	45-140
l_6	44-156
l_7	43-27,128; 44-8,44,45,77
la	43-212 (m.s.); 47-131
lg	43-174 (m.s.); 44-69,76,92 (m.s.); 45-9,10,11,106 (m.s.); 45-61,145,149; 47-14,15,16,17,18,19,20,21,22,173
lg_2	44-177,178 (m.s.); 45-18,65,68,69 (m.s.); 44-163; 45-68; 47-23,27,32
Lg_3	44-162 (m.s.); 45-63 (m.s.); 45-63
li	45-12 (m.s.); 45-91; 47-61
lo	43-151,152; 47-133 (m.s.)
mg	43-28; 44-9,10,11,12,46
mi	43-29; 44-13; 44-47,78; 47-134,135,136
ms_2	43-31 (m.s.); 45-73 (m.s.)
ms_3	43-159 (m.s.); 44-107 (m.s.); 47-137,138
ms_5	43-32 (m.s.); 47-139,140
ms_6	43-33 (m.s.); 44-99 (m.s.); 47-142
ms_7	44-157 (m.s.); 45-116 (m.s.); 47-143,144
ms_8	43-34 (m.s.); 44-10 (m.s.); 47-145,146
ms_9	43-35 (m.s.)
ms_{10}	43-36 (m.s.); 44-101 (m.s.)
ms_{11}	45-117 (m.s.)
ms_{12}	43-38 (m.s.); 44-102 (m.s.); 47-147,148
ms_{13}	45-118 (m.s.); 47-87
ms_{14}	45-119 (m.s.); 47-88
ms_{17}	47-9
ms_{18}	44-137; 44-108 (m.s.); 44-137 (m.s.)
ms_{20}	43-46 (m.s.)
ms_{34}	43-47,48,49,50 (m.s.); 47-149,150
ms_{37}	45-120 (m.s.)

ms_{39}	43-52 (m.s.)
ms_{42}	44-158; 45-43,44,121
Mt	43-178
na	43-106,107 (m.s.); 44-34,64,84,85,159 (m.s.); 45-122,123; 47-28
na_2	47-73
nl	43-138; 47-62
nl_2	43-55,56,57,58
o	45-124; 47-74
o_2	45-86 (m.s.); 47-50
Og	45-126,127,137 (m.s.); 47-1
P	47-8
pmo	47-9
prr	47-4
pvv	45-132; 47-114
pb_4	45-128
Pc	45-37,38,39
pg	43-59,60; 44-14,15,16,17,18,48,49,50,79 (m.s.)
pg_2	45-67 (m.s.); 47-29,30,31,152
pk	43-172,173,174; 44-38; 44-69,91,92,107 (m.s.); 45-14(m.s.)
Pl	45-147; 47-46,47,48
pl	45-152
pm	45-64
po	45-129
pr	45-78,151,153; 47-42,45
py	43-119 (m.s.); 44-87 (m.s.); 47-46,154
R	47-41,42
r^{ch}	43-62
R^{gg}	44-201; 45-149; 47-89,90
r^{gg}	47-71,72
r^{gr}	43-175; 44-70 (m.s.); 45-5 (m.s.)
R^{mb}	45-130; 47-115
R^{nj}	45-131
R^{rg}	45-132
r^{rr}	45-143
R^{st}	47-75,76
ra	45-80,81,86 (m.s.); 47-50
ra_2	45-65 (m.s.); 47-23
Rg	44-162; 45-63,111; 47-1,25
Rs	47-77
rs_2	47-78
rt	43-63 (m.s.); 47-157
Sx	45-149; 47-116
sa	45-88; 47-58
sb	45-135
sh	43-163; 44-67,68,107,134,174; 45-150; 47-56,57
si	45-94 (m.s.); 47-164

sk	45-136 (m.s.)
sl	47-91 (m.s.)
sp	47-33,92,93
sr	45-58; 47-5
st	44-205 (m.s.); 47-159
su	43-165; 44-195; 45-19,71,72,73,133; 47-33,34,35,36,38, 172,173
su_2	43-64; 44-19,51,182
sy	44-119; 45-4 (m.s.)
tn	44-20,120 (m.s.); 47-160 (m.s.)
Tp	45-84,85; 47-53
ts	43-181 (m.s.); 44-124 (m.s.); 45-9,10 (m.s.); 47-14,17,161,162
ts_2	44-104 (m.s.); 45-6,7,94 (m.s.); 47-7
Ts_3	47-101
ts_4	43-68; 44-64,85,122 (m.s.); 45-69 (m.s.); 47-28,32
Ts_5	43-112; 44-105,164; 45-19; 47-34
Ts_6	44-160; 45-45,137
Tu	45-71; 47-36,39,40,172
tw	43-195; 44-110 (m.s.)
tw_2	43-196 (m.s.); 44-111; 47-165
tw_3	43-197; 44-71,96 (m.s.)
v	44-169,206; 45-50,51,52
v_2	43-117 (m.s.); 45-78 (m.s.); 47-94
v_3	45-79; 47-166
v_4	43-69; 45-61; 45-8,9,10 (m.s.); 47-14,16,17,21,22,171
v_5	44-159 (m.s.); 45-84; 45-85,86,122 (m.s.); 47-50,53
v_6	43-70; 44-21,22,52,53,80 (m.s.)
v_7	43-71,72; 47-117
v_8	43-73; 44-23,54,55,81 (m.s.)
v_9	43-74; 44-24,56 (m.s.)
v_{12}	43-75; 44-25 (m.s.)
v_{13}	45-138 (m.s.); 47-95
v_{17}	45-139 (m.s.); 47-97
v_{18}	45-91,140 (m.s.); 47-98
v_{19}	43-76; 47-79
v_{20}	43-77; 44-20
va	43-183; 44-109 (m.s.)
va_2	47-80
Vg	43-78; 44-103
vp	43-80; 44-57; 44-26,82 (m.s.)

vp_2	43-184; 44-93,141,143,144
vp_4	43-81,82,186; 44-58
w	44-27,28,29,30,59,60,61
w_2	43-87; 44-83
w_3	44-32,62
v_{11}	43-89; 44-33; 45-46
wa	43-83 (m.s.); 47-99
Wc	45-142
Wh	43-84,187,188; 47-118
wl	43-112 (m.s.); 44-86 (m.s.); 47-34,167
ws	45-89
ws_2	47-39
ws_3	45-60; 47-18,19
wx	43-163; 44-156,170,174,206; 45-88,95,141,146,148,150, 154; 47-56,58,59
y	45-68,133,149; 47-173
yg	43-190
yg_2	44-174; 45-20 (m.s.)
yg_3	45-143 (m.s.); 47-168
yp_2	43-191
zb	43-208; 44-38,73,112 (m.s.)
zb_2	43-209; 44-74 (m.s.)
zb_3	43-210; 44-39,98 (m.s.)
zb_4	43-91,92; 45-57; 44-63,104 (m.s.); 47-7,10,11
zb_6	45-144; 47-120
zg_3	43-93,192 (m.s.); 44-94 (m.s.)
zl	47-9

Linkage testers

Chromosome 1

bm_2 br P^{rr}	(47-4)
br f an gs	(47-6)
ms_{17} zl P^{mo}	(47-9)
br f an gs bm_2	(47-13)

Chromosome 2

lg gl_2 v_4 ts	(47-14,22)
lg gs_2 v_4	(47-16)
ws_3 lg gl_2	(47-19)
lg gl_2 v_4 fl	(47-21)

Chromosome 3

Rg d	(47-25)
na ts_4	(47-28)
lg_2 d ts_4	(47-32)

Chromosome 4

su Tu gl_3	(47-36)
Ts_5 su	(47-34)

Chromosome 5

bm v_2 pr ys	(47-43)
pr v_{12}	(47-45)

Chromosome 6

Pl sm py y	(47-46)

Chromosome 7

ra v_5 gl o_2	(47-50)
gl ij bd	(47-52)
ij Tp gl ra v_5	(47-53)

Chromosome 8

j v_{16} ms_8	(47-55)

Chromosome 9

c sh wx gl_4 yg_2	(47-56)
wx da sa ar	(47-58)

Chromosome 10

g_1 l_2	(47-63)

Mangelsdorf's multiple tester:

47-173 - p bm_2 lg_1 a su Pr y gl j wx g

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