MAIZE GENETICS COÖPERATION

NEWS LETTER

29

March 17, 1955

Department of Plant Breeding
Cornell University
Ithaca, N. Y.

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I. R. A. EMERSON MEMORIAL FUND

Friends of Dr. Emerson contributed a total of $327.00 to a memorial fund in his name. Since Dr. Emerson had at one time expressed interest in setting up a case to display past and current research work in the fields of genetics and plant breeding, it was decided to apply the fund collected toward the purchase of a lighted exhibit case. This will be placed in the hall of the Plant Breeding Department at Cornell University and it is intended that a part of the case will be used to display continuously some of Dr. Emerson's own work.

II. REPORTS FROM COOPERATORS

BROOKHAVEN NATIONAL LABORATORY
Upton, Long Island, N. Y.

1. Correction on "Dotted r"

In the 1954 Maize News Letter we published an item on "Dotted r". According to the pedigree the genetic constitution should have been r. However, tests in 1954 showed it to be a and R, apparently due to a contamination by an aDt pollen grain some time previously. To keep the record straight this note is being submitted.

W. R. Singleton

2. Hurricane Proof Tags

In 1954 Hurricane Carol blew the tags off of a great many hand pollinated ears. Since the identification of the ears was stamped or written on the bags we lost more than half of the ears although the ears remained on the plants. To avoid such difficulties in future years, we have secured plastic tags which will be wired to the plants with copper wires at the time of pollination. These tags can be harvested with the ears. Since the tags will have all the data regarding the pollination it will not be necessary to put the pollination identification on the tassel bag used to protect the developing ear. This method should contribute to greater accuracy since there is no chance for error in transferring pollination data from tassel bag to tag for the ears harvested. Plastic tags come in 5 different colors making it possible to identify individual experiments by color, thus facilitating sorting ears after drying. Sources of tags will be supplied to those interested.

W. R. Singleton

3. Tags for Pollen Collecting

In the 1954 Maize News Letter, page 62, was an item by Furnham regarding labels for plants and ears. After corresponding with Furnham we devised a modification of his scheme which we believe better suited to corn plants. We secured standard checking strung tags size 5-1/4 x 2-5/8 inches. These are numbered in duplicate from 1 - 5000. (We re-numbered them with waterproof ink). The tags were tied to the plants shortly before pollen shedding. When the central spike began to shed pollen it was broken off and the bottom half of the tag was stapled (aluminum staples) around it and it was dropped into a jar containing 70% alcohol, where it remained until it could be examined for pollen abnormalities. The other half of the tag remained on the plant until harvest. Even with two hurricanes a fairly high percentage of tags remained on the plants. Information regarding sources of these tags will be supplied to anyone interested.

W. R. Singleton

4. Somatic Mutations in Corn

An extensive study on the effect of chronic gamma radiation on the induction of somatic mutations in corn was made in 1954. A stock of popcorn of the genetic constitution Prpr was grown in the Y field at different distances from the source. There was an exponential relationship between mutation rate and dose rate as exists for gametic mutations for endosperm characters, with a definite threshold below which there was no increase over the controls. In a number of instances the mutations were from the P to a variegated pericarp rather than to colorless pericarp. This experiment will soon be written up for publication.

W. R. Singleton and
A. C. Caspar

CALIFORNIA INSTITUTE OF TECHNOLOGY
AND UNITED STATES DEPARTMENT OF AGRICULTURE
Pasadena 4, California

1. Non-disjunction in the Generative Nucleus of the pollen of T-B 10a

The behavior of the chromosomes in translocations involving a B and an A type chromosome has been extensively studied genetically by Dr. H. L. Roman. He attempted to locate a region on the B chromosome responsible for the abnormal behavior that produces hyperploid and deficient gametes during the division of the generative nucleus of the pollen grain. A similar study using cytological material was made of the gametes transmitted through the pollen by plants carrying a translocation between a B type chromosome and chromosome 10 of the normal set. Of the 72 gametes examined that had a complement of normal A chromosomes plus a proximal euchromatic B segment to which was attached a distal segment of chromosome 10 (B^{10}), only five showed non-disjunction of the B^{10} chromosome at the division of the generative nucleus. These five exceptions were all in pollen grains which had received extra heterochromatin either in the form of an extra B chromosome or on an added piece on the abnormal form of chromosome 10. It therefore appears that the heterochromatic terminal segment, rather than the euchromatic proximal segment of the B chromosome is associated with the non-disjunction of the B^{10} chromosome in the generative nucleus of the pollen grain.

2. Pollen transmission from plants heterozygous for ab 10 and a paracentric inversion of chromosome 7.

The data for the transmission of ab 10 and its closely associated dominant R allele through the pollen given last year is now more complete. Plants heterozygous for ab 10 only, show that of the 76764 seeds classified 44.6% carried ab 10. This departure from 50%, first observed by Dr. Rhoades, indicates that ab 10 is at a disadvantage when in competition with pollen carrying normal 10.

Similar data for the transmission of ab 10 in plants also heterozygous for a paracentric inversion of the long arm of chromosome 7 show that of the 71243 seeds classified 45.2% carried ab 10. This per cent is barely significant at the .01 level from the 44.6% observed for ab 10 alone. This higher per cent is possibly due to preferential association of the normal 10 and the deleted chromosome 7, resulting in the loss of the recessive r allele in the population of viable pollen.

Albert E. Longley

3. Dwarfs and anther ears

Chromosome 1

Five anther-ear mutants from radiation have proven allelic to each other and two of these have been placed in chromosome 1. They have not been checked against an_1, with which they may well be allelic. This allele test will be made in the coming year.

Chromosome 2

Two mutant dwarfs from Bikini material have been placed in chromosome 2 and also shown to be allelic. One arose in P51 sweet corn, the other in the single cross L289 x I 205. They showed a difference in appearance, which may however be merely the difference in background.

Chromosome 3

Three mutants from irradiation appear to be allelic and to be in chromosome 3. The appearance of the mutants and the linkage data suggest that they might be alleles of d_1.

Chromosome 7

One small dwarf appeared in a progeny which could trace back to a Bikini source, but no dwarf had been observed earlier. It shows close linkage with a glossy which is probably gl_1. It will require a few specific tests to clear up any doubts.

Chromosome 9

Six dwarf mutants have been placed in chromosome 9, fairly close to wx. Four of these have been shown to be allelic to each other. The remaining two are allelic to each other, but the allele tests with the first four are not adequate.

Chromosome 10

One anther-ear (an 6923) has been placed in the long arm of chromosome 10 in the general region of R.

E. G. Anderson

4. Glossies

Mixups in glossy stocks have led to much confusion. Some of this confusion can now be cleared up. And a series of glossies from Dr. Sprague have now been converted to stocks which are sufficiently adapted to our conditions so that remaining tests can readily be made. Also tests for placement to chromosome are now being made for all except Sprague's glossy 13, which we have not yet been able to isolate. The numbers given are from Sprague's series.

gl_1 - chrom 7 all stocks O.K.

gl_2 - chrom 2 " " "

gl_3 - chrom 4 " " "

gl_4 - chrom 4 (Sprague) confirmed. Stock from Cornell O.K.

gl_5 - two genes giving 15-1 ratios in most crosses with standards, linkage data indicates one of these in chromosome 2. Not yet checked against Laughman's 15-1 glossy (NL 1953)

gl_6 - chromosome 3. Stocks from Sprague and Laughman in agreement. A stock received from coop as gl_7 which we reported for chrom 3 is allelic to these, and this correction should be made.

gl_7 - stock from Sprague is not allelic to the stock from coop which we had listed as gl_7. Crosses with testers have been made but will need another year to locate to chromosome.

gl_8 - chromosome 5. Stock from coop listed as gl_6 proved to be gl_8 also.

gl_9 - stock from Sprague proves to be a good clear cut glossy chromosome tests are underway. No glossy found in stocks from coop or from Dr. Burnham.

gl_{10} - stock from Sprague gave a good glossy. Crosses made for chromosome tests. Received a stock from Dr. Burnham which he indicated contained also a late developing glossy which he tentatively listed as Hayes glossy. The good glossy from this stock is allelic to Sprague's gl_{10}. Stock listed as gl_{10} from coop was homozygous for the late developing glossy (see gl_{15}).

gl_{11} - stocks from Sprague and Burnham in agreement. Also one mutant from irradiation allelic to these. This glossy is clear-cut, but the glossy plants are delayed in growth, tasseling a week or two later than normal sibs. Chromosome tests are underway.

gl_{12}-

gl_{14}- stocks from Sprague only. Crosses made for chromosome placement.

gl_{16}-

gl_{13}- no glossy recognized in stock from Sprague.

gl_{15}- stock from Sprague. Late developing, appearing usually in the 3d leaf. This glossy is very widespread, and has been found in many stocks. "Hayes glossy" from Burnham is the same gene. Location is in chrom 9 near wx from information from Burnham, which we have confirmed in tests with gl_{15} from several sources. Beside the stocks from Sprague and Burnham we have picked it up from many other sources. Coop stock listed as "gl_{10}" was this gene. Some exotic stocks from Matthews were allelic. It was present as a contaminant in the single cross L289 x 1205 sent to Bikini. It was also isolated from commercial hybrids from Pioneer and other sources.

An additional glossy, listed by Sprague under the temporary symbol gl(g) as not all allele tests had been made, proved allelic to a mutant glossy from irradiation. Chromosome tests are underway on both sources.

Chromosome tests are also underway on a number of glossies from other sources, but since these have not been tested for allelism with the Sprague series, they may duplicate some of the glossies already numbered.

E. G. Anderson

5. Anthocyanin synthesis: Some biochemical effects of a_1, a_2, and bz.

Aleurone and husk tissues from the combinations of a_1, a_2, and bz have been studied in sib comparisons in segregating families, using visual observation and chemical technics. B Pl individuals were used for husk studies, and C R Pr individuals were used for aleurone studies.

Visually, husks of the combinations of a_2 and bz with a_1 a_1 are indistinguishable from a_1 tester. Also, by paper chromatography and a phase separation technic, it has been determined that husks of all such combinations contain the usual large quantity of an isoquercitrin-like pigment, and that alcoholic extracts of aleurone tissue of these combinations have similar ultraviolet absorption spectra.

In contrast, husks of a_2 tester, bz tester, and a_2 bz combination all differ visually. Isoquercitrin is present in small quantity in a_2 tester, but apparently absent in husks of a_2 bz and bz tester. Absorption spectra of extracts of aleurone tissue indicate that a_2 bz is more like bz tester than like a_2 tester, although this point is still uncertain.

If the sequence of reactions is linear, all indications are that A_1 is thus the first-acting factor of the three. Some more direct test is needed to confirm this, and to determine the sequence of A_2 and Bz, since the last-acting factor is apparently able to bring about a change in the "substrate" accumulated when the preceding factor fails to act (since a_2 bz husks have a new phenotype, unlike either a_2 or bz). It may be possible to perform such direct tests on sterile cultures of aleurone tissue. Tester lines are being prepared with su and in, the first to allow culture of the tissue, the second to increase the production of anthocyanin pigment.

Aleurone tissue of a_1, a_2, and bz tester was subjected to isoquercitrin tests and found to contain no detectable isoquercitrin, in contrast to the husks, where isoquercitrin is the predominant simple pigment of a_1 tester, and is at least detectable in a_2 tester.

In isoquercitrin content, acyanic combinations segregating for a_1 show. A_1 a_1 husks to be intermediate between the two homozygotes. This dosage effect is to be checked quantitatively for anthocyanin content in cyanic individuals next summer.

6. Anthocyanin precursor in a_2 tester.

In the course of the above investigations, it was found that alcoholic-HCl extracts of a_2 aleurone tissue would give rise to a red pigment on heating. This pigment has since been identified as cyanidin, the aglycone of chrysanthemin. Parallel preparations of chrysanthemin from sib A_2 - kernels are not completely hydrolyzed to the aglycone, so the precursor present in a_2 is probably sugar-free. Since the anthocyanin produced in A C R/pr kernels is, instead, a pelargonidin derivative, a_2 pr extracts were tested, and found to produce pelargonidin on heating.

Husks of a_2 tester do not carry this precursor, nor does aleurone tissue of a_1, bz, a_1 a_2 bz. The precursor is very unstable, and thus far has eluded attempts at purification or concentration.

7. "Metaxenia" in in kernels.

In a self of Pr pr In in, slightly less than one-fourth of the kernels showed a bronze-metallic sheen in the pericarp. These kernels were Pr, and when planted and tested were all found to be homozygous for in in. Subsequent progenies have shown that this effect of the aleurone constitution on the pericarp is reasonably consistent for the in factor, and can be relied upon even in certain colorless-aleurone types. For example, a_1 in and a_2 in kernels have metallic pericarp.

E. H. Coe, Jr.

8. Mutations affecting carotenoid synthesis in the endosperm and seedling.

In these mutants the endosperm is white or pale yellow and the seedlings which are produced upon germinating in the light are a chalky-white with no evidence of chlorophyll or carotenoid pigments being present. We have been interested in these mutants for the past several years and have attempted to bring together all such mutants that have been reported. In all a total of eleven different mutants have been obtained. Five of these (vp-2, vp-5, vp-9, ps, and w-3) besides having an altered pigment synthesis also have a tendency to be viviparous. The other six show little viviparous tendency. Included in this six are three previously described mutants which proved to be allelic to mutants found in our stocks. They are lw-1, lw-2 (See-Tulpule, Am. Jour. of Bot. 41:294, 1954) and cl-1 (See, Everett PNAS 35:628, 1949) which were respectively allelic to our mutants 6474, 7752, and 7716. The three remaining types are lw-3, lw-4 and 7748. Two new mutants (one from Dr. Brunson and the other from Dr. Chase) were tested last summer against our stocks. On the basis of endosperm color these mutants appear to be allelic to each other and to lw-2. Seedling test will be needed to confirm this. Our tests have placed to chromosome vp-5, vp-9, w-3, and cl-1 and have confirmed the placement of vp-2, ps, lw-1, and lw-2. The known linkage relationships for the eleven genes are as follows:

Mutant		Chromosome
vp-2		5
vp-5		1 short arm
vp-9		7 long arm
ps		5
w-3		2
lw-1	(6474)	1
lw-2	(7752)	5
lw-3		5
lw-4		4
cl-1	(7716)	3
7748		unknown

The cl-1 mutant has two modifiers (Cl-2 and Cl-3) described by Everett. When cl-2 is present in cl-1cl-1 plants they are pale green. Our mutant 7716 which proved to be allelic to cl-1 was also modified by a gene carried in our stocks which was similar in action to Cl-2. Crosses are being made between Cl-2 and the other mutants to determine if any of them are modified by this gene.

An interesting mutant which belongs to this group is a mutable allele of vp-2. This allele shows back mutation to normal in both the endosperm and seedling. The endosperm is pale yellow with patches of yellow. The seedlings are white with a mosaic of green tissue. Further

studies to determine the nature of this mutability have been handicapped by the vivipary and small seed size that is associated with vp-2.

These mutants if grown in the dark produce a faint green pigment. This has been shown to be protochlorophyll in w-3 (See Koski and Smith, Arch. Bioch. and Bioph. 34:189-195, 1951). So far we have found that the following mutants show this greening: w-3, lw-1, vp-2, vp-5, vp-9, 7748, cl-1 and 7752. The results were inconclusive for ps, lw-3 and lw-4.

Two other mutants which differ slightly from those above probably belong to this class. The seeds of these mutants have pale endosperms that give rise to pale green seedlings which do not survive past the seedling stage. No albino plants have ever been observed. As yet these mutants have not been placed.

We would be glad to receive seed of any mutants of this type, for allele tests with our series.

D. S. Robertson
E. G. Anderson

CARNEGIE INSTITUTION OF WASHINGTON
Department of Genetics
Cold Spring Harbor, Long Island, N.Y.

1. Spread of Mutational Change Along the Chromosome

When Ds is inserted just to the left of Sh_1 in chromosome 9, it can subsequently effect mutational change in genetic materials located to either side of it. These occur only when Ac is also present in the nucleus. These effects appeared following 2 independent insertions of Ds at this location. A total of 56 mutational changes were examined. Seven affected the action of genetic materials located to the left of Ds and including I; 37 affected the action of Sh_1, located just to the right of Ds, and 12 affected the action of both Sh_1 and Bz_1, the latter located to the right of Sh_1. The origin and general patterns of behavior of some of these mutants were reviewed in recent issues of the Year Book of the Carnegie Institution of Washington. In all 56 cases of mutational change, Ds was present and apparently unaltered in location by the event that produced the mutation. In many of these cases, however, it could be shown that the Ac present underwent a transposition at the time that the mutation-producing change occurred at Ds. Some of the changes affecting only Sh action are unstable in that the recessive mutant, sh, reverts to Sh but only when Ac is also present in the nucleus. These reversions are not accompanied by loss of Ds or by its transposition to a new location. The dominant, Sh, so produced may again mutate to sh, and again, only when Ac is present in the nucleus.

In one of the 12 examined cases of simultaneous change in action of both Sh and Bz (to sh and bz), the bz component of the double mutant proved to be mutable. Mutations to Bz occurred but only when Ac was present. The action of the sh component remained unchanged. It could be shown that Ds was located to the left of the mutable bronze locus and that reversions to Bz were not accompanied by loss or transposition of Ds. No evidence of crossing over within the sh to bz^m interval was obtained. Crossing over to either side of the double mutant was either normal or increased in frequency in comparison with the standard frequency.

In all of the 56 examined cases of Ds initiated mutations, Ds remained unaltered in location. This suggests that loss of Ds from this particular location, following its initial insertion just to the left of Sh_1, results in some lethal action. Some of these mutants have shown that the effects Ds induces on the action of genetic materials located close to it are not confined to local inhibitions of genic action. Some of the mutational changes that spread some distance along the chromosome not only produce an inhibition of the action of genetic materials within the affected segment, but also give rise to a dominant effect that produces a marked distortion in the morphology of the kernel and plant. Such altered growth patterns do not appear in kernels and plants that are hemizygous for the affected segment.

2. A Case of Ac-induced Instability at the Bronze Locus in Chromosome 9

A case of insertion of Ac at the bronze locus in chromosome 9 has been found that results in instability of action at this locus. It originally appeared in a C sh bz wx carrying gamete produced by a plant that was Ac I Ds Sh Bz Wx/ ac C ds sh bz wx in constitution when this plant was crossed to one homozygous for ac, C, ds, sh, bz, and wx. Mutations to Bz occur at this mutable bz locus. They are Ac controlled and the mutational response to doses of Ac is similar to that expressed by other Ac controlled mutable loci--the higher the dose of Ac, the later the time during development of a tissue that mutations occur. Tests to determine the location of Ac were conducted with 135 plants heterozygous for this mutable bz^m. In all of them, an Ac factor was present and situated close to or at the locus of bz^m. It could be determined that the mutational response to doses of Ac is dependent not only on the dose of bz^m that is present (Ac at the bronze locus) but also on that produced by additional Ac factors located elsewhere.

Several distinctly different phenotypes result from mutation at this bz^m locus. The most common of them gives rise to a Bz expression or to a stable bz expression, the latter occurring about five times more frequently than the former. Some of the mutations to Bz are stable in that no further mutations occur in the presence of Ac. Six such cases were examined and in all 6, Ac was no longer present at the Bz locus. Fourteen cases of mutation to stable bz were examined and again, in these cases, it could be shown that the change was associated with removal of Ac from

the $\underline{bz}^m$ locus. In some of these cases, Ac was present in the chromosome complement but located elsewhere, either within chromosome 9 or at a position that gives no evidence of linkage with genetic markers carried in this chromosome. Three additional cases of mutation to Bz were examined. Each of them was characterized by instatility of expression of Bz. Mutations to bz or to $\underline{bz}^m$ occurred. An Ac factor was found to be present in each case and located at or close to $\underline{Bz}^m$. Analysis of the progeny produced by plants carrying one of these $\underline{Bz}^m$ mutants indicated that stability at the Bz locus could arise if Ac were removed from its immediate vicinity.

The Ac element originally present at this $\underline{bz}^m$ locus produced some chromosome breaks. They occurred with rather low frequencies in comparison with those mutations to bz or to Bz that are unaccompanied by gross chromosomal aberrations. However, a state of this Ac at $\underline{Bz}^m$ has appeared that gives rise to many dicentric-forming chromosome breaks and at rates that are comparable to those produced by known states of Ds.

In addition to the events described above that occur at this $\underline{bz}^m$ locus, other types of events also occur but with very much lower frequencies. Two of them have received some examination. Each appeared, initially, in a single gamete produced by a plant having $\underline{bz}^m$ and was detected because of a marked change in the appearance of the kernel produced by functioning of the gamete. In one case, the rate of mutation to Bz was strikingly increased in comparison with that usually produced by this $\underline{bz}^m$. Tests of the plant arising from this kernel indicated that the mutations were no longer directly initiated by events occurring to Ac at the $\underline{bz}^m$ locus. The Ac factor present in this plant was located elsewhere. The evidence indicates that a two-factor system of mutational control is present and suggests that one of these factors is Ac.

The second type of altered pattern of mutation at the bronze locus was derived from a gamete of a plant that carried $\underline{Bz}^m$ (Ac at the Bz locus) in one chromosome 9 and a normal recessive, bz, in the homologue. The kernel showing the altered mutation pattern had a background coloration suggesting a weakened expression of Bz. Areas were present showing either a weaker or a stronger expression of Bz coloration. In the plant derived from this kernel, 2 Ac factors were present, one located close to this modified $\underline{Bz}^m$ locus, and the other located elsewhere. In the progeny of this plant, the pattern of mutation present in the kernel that gave rise to it was again repeated. However, present evidence is insufficient to indicate the mode of control of mutation.

3. Transposition sequences of Ac

In the study described above, it has been possible to follow transpositions of Ac through several sequential steps. Three of them occurred in the ancestry of the plant that gave rise to the mutable bronze condition. Ac was first present in a plant having the constitution I Sh Bz Wx Ds/C Sh Bz wx ds and it showed no linkage with these markers in chromosome 9. It

then appeared in an I Sh Bz Wx Ds carrying chromosome at a position that was approximately 20 crossover units to the right of Ds: I Sh Bz Wx Ds Ac. Ac was then inserted just to the left of I, and coincident with this was insertion of Ds to the left of Sh: Ac I Ds Sh Bz Wx. Ac then appeared at the bronze locus in a gamete of a plant having this last position of Ac, and it produced the mutable condition described above. From this position, in turn, its insertion at several other locations has been determined: to positions not showing linkage with markers in the short arm of chromosome 9, to a position close to sh_1, and to a position that is very close to wx. The removal of Ac from this last location coincident with its appearance at a new location, not showing linkage with markers in the short arm of chromosome 9, has also been followed.

4. A suppressor-mutator system of control of genic action and mutational change.

Several systems that control genic action and mutational change, other than that of Ds and Ac, are being examined. One of them has received a considerable amount of study and its pattern of behavior is now apparent. It is the system associated with control of genic action and mutation at the a_1^{m-1} locus. (Designation refers to a mutable condition that arose at the A_1 locus in the Cold Spring Harbor cultures.) It was originally thought that a_1^{m-1} was an "autonomous" mutable locus. This now appears not to be true and for reasons that will be apparent. An independently located factor, designated Spm for Suppressor-mutator, is responsible for the observed behavior of a_1^{m-1}. When this factor is present, anthocyanin development in kernel and plant is suppressed until a mutational change occurs at a_1^{m-1}. These changes give rise to stable mutants distinguishable from one another by different levels of expression of anthocyanin pigmentation in kernel and plant. These range from no pigment formation to the apparent full A_1 expression. When Spm is removed from the nucleus, either by a somatic loss or transposition, or by means of meiotic segregations, the a_1^{m-1} locus can express itself, producing uniformly distributed pigment in both kernel and plant. This expression is stable in subsequent generations as long as Spm is absent from the nuclei. The degree of this expression varies with the particular state of a_1^{m-1} that may be present. Strikingly different states of a_1^{m-1} have appeared, one arising from the other through the influence of Spm on the a_1^{m-1} locus. They are characterized by the types of mutation that occur, by the time during development when these occur, and by the type of pigmentation that is expressed in the absence of Spm. This latter ranges from almost none to very intense. When through appropriate crosses, Spm is returned to the nucleus, the Suppressor-mutator action it induces at a_1^{m-1} is again apparent. The types of effects that it will produce are quite predictable if the state of a_1^{m-1} is known in advance.

The Spm factor behaves much like Ac in that it occupies a definite position in the chromosome complement but may be transposed to a new position, remaining at the new location until a subsequent transposition occurs. Several different positions of Spm within chromosome 6, within

chromosome 5 and within chromosome 9 have been found. As long as Spm remains in a particular position, it gives clear-cut linkage relations with known factors. These are expressed directly in backcross tests or in progeny tests. It is in the progeny tests, however, that new positions of Spm are discovered. Unlike Ac, Spm does not give a sharply defined dose action. Therefore, when 3 or more independently located Spm factors are present in a plant carrying a_1^{m-1}, nearly all of the gametes carry one or more of them and, in test crosses, the a_1^{m-1} locus appears to be "autonomous" in its mutation control. Progeny tests are required to separate the different Spm factors and to determine the number present in the parent plant if more than 2 are present.

To summarize, Spm is a chromosomal element, subject to somatically occurring losses from some nuclei or changes in location in others, that suppresses the potential action at the a_1^{m-1} locus until a change occurs at this locus under the influence of Spm that produces either an altered type of response to Spm in subsequent cell and plant generations (a change in stage of a_1^{m-1}) or a stable mutation that expresses a particular level of anthocyanin pigmentation in kernel and plant.

5. System responsible for mutations at a_1^{m-2}

Although the system responsible for mutations at a_1^{m-2}, another mutable condition that arose at A_1 in the Cold Spring Harbor cultures, is less well understood than that associated with Dt, Mp, Ds, Ac, or Spm, its mode of action appears to differ from these other better known systems in one striking way. Present knowledge suggests the following interpretation. An independently located factor, subject to loss or to change in location in somatic cells, is responsible for maintaining one particular type of expression of anthocyanin pigment formation at a_1^{m-2}. Following removal of this factor, either through a somatically occurring event or by means of meiotic segregations, a mutational change occurs at the locus of a_1^{m-2} which results in a stabilized expression of this locus in subsequent cell and plant generations. The types of mutation-producing changes that occur fall into two distinct classes. One class contains mutants expressing different levels of anthocyanin pigment formation and these range from those giving nearly none to those that produce intense coloration in the aleurone layer of the kernel. All of the mutants in this class produce intense pigmentation in the plant but this is confined to certain of its tissues. The mutants in the second class give an apparent full A_1 type of expression in both the aleurone layer of the kernel and in the plant tissues.

Barbara McClintock

THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION
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1. Mutations in pollen sterility.

Pollen producing plants that occur rarely in otherwise sterile WF9 of the S type, propagated by backcrossing by normally fertile plants of the same genotype, have remained fertile in all of the progenies during three generations of selfing. The original backcrossed fertile plant was slightly taller than the sterile plants in the same progeny but appeared to be otherwise normal. The selfed plants in the following three generations have been shorter and slower in growth and show considerably more yellow chlorophyll streaking than is characteristic of the WF9 inbred. These fertile plants are clearly weaker and less productive than normal. Pollen production seems to be about normal for this inbred.

These fertile plants have been tested for mutation to dominant gene pollen restorers by crossing on other sterile progenies of the same inbred, as reported last year. Five progenies were grown and all plants were completely sterile, no anthers being extruded on any plants. This past season two progenies of crosses of these fertile plants by normal fertile plants of the same inbred were grown. These all produced normal pollen. This eliminates the possibility of a mutation to recessive gene restorers. The evidence, therefore, points clearly to some change or segregation in the cytoplasmic condition itself. These fertile plants occur normally about one in 400 sterile plants in this inbred. They might include some normal plants by accidental mixture, but this possibility seems to be ruled out by the increased chlorophyll deficiency of this mutant line.

2. Additional sources of cytoplasmic sterility.

Ten different sources of pollen abortion controlled by the cytoplasm are being transferred to a series of tester lines. So far, none of these have differed clearly from the S or T types. I153 and W22 seem to be the best inbreds to differentiate between S and T types of cytoplasm. I153 restores T but not S. W22 is a partial restorer for S but has no ability to restore T.

3. The number of genes involved in pollen restoration.

A number of inbreds have the ability to restore pollen production to sterile plants of both the S and T types. One of these restorers (Ky 21) crossed on A158 S sterile and backcrossed four generations has shown no completely sterile plants in two progenies. About 15 plants in each progeny were grown each generation. This past season pollen samples from several anthers from 20 plants in two of these backcrossed progenies were examined under the microscope. Pollen production ranged from 0 to 70 percent normal pollen in individual anthers, but all plants produced some pollen.

These restored fertile A158 plants were crossed on to I205 T sterile and backcrossed. Two of these backcrossed progenies grown this past season segregated into 12 plants showing no anthers and 11 plants with normal anther production. Pollen examination under the microscope showed no normal pollen grains in the sterile plants, and 90 to 95 percent normal pollen in the fertile plants. Other backcrossed T lines from the same original source of the restorer gene gave a total of 42 sterile and 45 fertile plants. This evidence shows clearly that this restoring inbred has several genes capable of restoring pollen production to the S type, but only one restorer gene for the T type. This one T restorer does a better job of pollen restoration than the several S restorers.

4. The comparative yielding ability of sterile and fertile double crosses.

Twenty-six double crosses produced on sterile and fertile single crosses of the T type were tested for yield and maturity as shown by moisture content in the grain at harvest. Percent moisture averaged the same for both series. The yield was 102 bushels for the sterile and 100 for the fertile. This difference is not statistically significant. Seedsmen report higher yields of seed produced on sterile seed parents. This may be due to less injury to plants that are not detasseled. Seed produced in detasseled fields may also show a higher proportion of inbred plants as compared to seed from sterile seed parents. These factors are not involved in the trials reported here since all seed was produced on hand pollinated plants.

D. F. Jones

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1. A method for doubling the number of chromosomes in monoploid corn plants.

A total of 119 monoploid plants of 18 different seed stocks were treated with aqueous solutions of colchicine. The concentrations of colchicine varied from 0.025 per cent to 0.25 per cent. The length of time of treatment with colchicine ranged from 3 to 40 hours. Colchicine treatments were applied by placing all roots of monoploid plants in 300 ml. of aqueous solutions of colchicine.

Reactions of the monoploid seedlings to colchicine treatments varied from slight swelling of the root tips and scutellar nodes to killing of the seedlings. Diploid tassel sectors were observed in many of the treated monoploid plants. Variation in the extent of these diploid sectors included single anthers, single florets, numerous florets, and complete tassel branches.

The effects of two different treatments on self-fertility of monoploid plants are shown in the following table. For each colchicine treatment a number of treated plants are compared with untreated plants from a similar seed stock. Both colchicine treatments significantly increased the per cent of self-fertile plants.

	Number Progeny	Plants With Diploid Tassel Sectors	Per Cent Self-Fertile Plants
.05% Colchicine for 24 Hours			
Treated	18	11	67%
Untreated	11	3	18%
.05% Colchicine at 24 Hours in Colchicine, 24 Hours in Nutrient Solution, 24 Hours in Colchicine			
Treated	30	16	40%
Untreated	23	6	8.7%

In using the described method of treatment, a concentration of 0.05 per cent colchicine was most desirable from the standpoint of seedling reaction and doubling of chromosome number. Higher concentrations often caused severe injury or death of the monoploid seedling, even when the length of time of treatment was considerably shortened.

R. R. Seaney

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2. Stability of cytoplasmic male sterile corn to chemical spray treatments.

Various environmental conditions have been reported to induce pollen restoration in cytoplasmic male sterile corn. With this in mind, T-sterile and fertile plants of inbred Oh 51A and single cross (Oh 51A x B8) were sprayed in the field when the plants were approximately 12-16" tall. One or more concentrations of the following compounds were used: maleic hydrazide; 2, 4, 5-T; 2, 4-D amine; M.C.P.; Chloro I.P.C.; Sodium Penta; dinitro-ortho secondary butyl phenol; (indole-3) -n-butyric acid; indole-3 -acetic acid; streptomycin sulfate; terramycin HCL; and colchicine. Tassel

samples were collected from two replications and pollen counts were made. In all but one treatment, marked stability for the sterile condition was observed, no normal pollen being produced. In both replications, an exceedingly small number of normal pollen grains were observed from steriles treated with dinitro-ortho secondary butyl phenol (Sinox P.E.).

3. Reaction of cytoplasmic male sterile plants to Gibberella zeae and Ustilago zeae

Employing a split plot design, a highly significant difference of stalk rot incidence was obtained between M-4 plants inoculated with a gravity-flow barrel inoculator as compared to uninoculated plants. No significant difference was obtained between male-sterile and fertile plants.

In a comparison involving limited data, no significant difference was obtained between sterile and fertile plants of Oh 51A for reaction of the stalk proper to Ustilago zeae. However, a highly significant difference was obtained for the tassel region alone, fertile plants being considerably more smut susceptible than steriles. It is suggested that the greater resistance in the tassel region of sterile plants is due to the morphology inherently associated with the sterile condition.

H. L. Everett and
P. J. Loesch

4. Albino corn seedlings as a tool in studies of the obligate parasitism.

Stocks of dent and sweet corn, which segregated 3:1 for normal vs. albino seedlings were used to determine the role of chlorophyll in obligate parasitism.

Dr. Victor Cutter (1951) conducted two experiments to determine the role of photosynthesis in obligate parasitism. He inoculated green virescent and albino corn seedlings of one strain with aecio-spores of Puccinia sorghi. These were grown in sterile agar cultures using Hoagland's nutrient solution plus 2 per cent dextrose supplied to the roots. One series of the plants was kept in the light, the other in dark. These plants became infected in direct proportions to the amount of chlorophyll present. Hypersensitive flecks showed on the albino plants maintained in the light with no sign of infection on the plants kept in the dark. In another experiment Dr. Cutter inoculated the variegated leaves of Geranium maculatum with teliospores of Puccinia-polygoni-amphibii. In all cases infection was confined to the green portions of the leaves, whereas adjacent chlorophyll deficient parts show no sign of infection. This evidence suggested that in addition to carbohydrates and minor elements, the rusts derive other essential metabolites from their hosts. This material is synthesized in the light and is unstable since it is not conserved during dark periods.

The present author inoculated albino dent and sweet corn seedlings devoid of all known chloroplast pigments with uredospores of Puccinia sorghi. The seedlings were supplied with 0.3M sucrose solution through their leaf tips. Sugar feeding was initiated when the seedlings were eight days old and the solution was changed daily. The roots were supplied with Hoagland's complete nutrient solution in sand culture. These albino seedlings became severely infected with corn rust and characteristic sori in great numbers were produced on the infected leaves. Thus, the absence of chlorophyll from the albino corn seedlings did not influence the development of the obligate parasitic fungus, when the host plants were provided with an adequate supply of carbohydrates. These results indicate that the failure of the albino corn seedlings to show infection with Puccinia sorghi in Dr. Cutter's experiment was not due to the lack of an assumed labile transition product of photosynthesis, but rather, that it is a direct result of an inadequate supply of available carbohydrates. A second factor involved is the presence of genetic resistance or susceptibility to disease in albino as well as in green maize stocks.

G. S. Sayed

5. Relative importance of genetic and nutritional factors in influencing susceptibility of corn to stalk rot caused by Gibberella zeae (Schw.) Petch.

A study was conducted during 1953 and 1954 to determine the effect of varying levels of nitrogen and potassium on the occurrence of stalk rot of corn in divergent genetic material. In general, increasing levels of nitrogen tended to increase the amount of stalk rot while increasing amounts of potassium tended to decrease the amount of stalk rot. The data indicated that heavy applications of potassium can, in part, overcome the effect of excessive nitrogen levels. For those hybrids which were highly susceptible to stalk rot, differences were shown in the severity of the disease, but the disease was by no means controlled by differential applications of fertilizers. The more resistant hybrids showed smaller amounts of stalk rot when grown on soils with balanced levels of nitrogen and potassium, but tended to become more rotted as the nitrogen was increased or as the potassium level was decreased.

Six single-cross hybrids were grown at various fertility levels in 1953. Three hybrids, one resistant, one intermediate, and one susceptible to the disease were grown in 1954. The hybrids are listed below with the average percentage of stalk-rotted plants for each year.

Hybrid	Percentage stalk-rotted plants 1953	1954
Ohio 51A X Iowa B8	8.1	21.2
Ohio 26 X Ohio 51	15.9	
N.Y. 2 X N.Y. 1	37.5	
N.Y. 3 X Idaho D50	39.3	83.9
N.Y. 3 X N.Y. 4	56.7	
Ill. A X Wisc. W23	85.8	94.5

The results infer a genetic basis for resistance to the disease, and indicate that resistant commercial hybrids may be developed by using proper procedures.

Harley J. Otto

6. Seedling growth in experimental plots.

It has long been observed, especially in experimental fields where the practice is most common, that the extra seed dropped at the end of a plot usually shows a more perceptible early growth than the attended units of the plot. An experiment was conducted at the Conn. Agr. Exp. Sta. in 1952 to ascertain the reality of this "extra" growth. A Latin Sq. design (n=13) was employed, plots consisting of a single seed, and 2, 4, 8, 16, 32 and 64 seeds clumped and equally spaced in a 4 inch sq. area respectively. Three measurements were taken on every plant harvest 28 days after planting - heighth, stem diameter and green weight - and plot averages were used in the Analysis of Variance. The tables are presented below.

ANOV heighth of plant: (measured to nearest $\frac{1}{4}$")

Source	df	SS	MS	F
Treatments	12	73.448	6.120	.922
Columns	12	151.856		
Rows	12	140.056		
Residual	132	876.317	6.638	
Total	168	1241.677		

ANOV stem diameter: (measured to nearest mm.)

Treatments	12	592.768	49.397	49.207**
Columns	12	27.440		
Rows	12	20.386		
Residual	132	132.509	1.004	
Total	168	773.103		

ANOV green weight: (measured to nearest gm.)

Treatments	12	7122.248	593.521	8.20**
Columns	12	680.360		
Rows	12	487.949		
Residual	132	9551.736	72.361	
Total	168	17842.293		

David B. Walden

DEKALB HYBRID SEED COMPANY
DeKalb, Illinois

1. Vg Sterile.

Vestigial Glume material from R. R. St.John, referred to by J. E. Wright, News Letter 1954, yielded "normal" glume, male-sterile segregates. These segregates were then outcrossed to a number of inbred lines. Back crossing was continued with these recurrent lines for several generations. The reaction of Vg sterile to fertility restoration appears to follow the pattern of A-type (U.S.D.A.) cytoplasm sterility but not T (Texas). This seems to agree with the data from Ames, Briggle thesis, 1953 (unpublished).

2. Restorer screening program.

Material obtained from the Mangelsdorf maize collection, Harvard University is being screened for pollen-restorer genes. This group includes varieties from Central and South America, which were incorporated in an inbreeding program several years ago. Some of the original material is reported on by Edwardson, thesis data, 1954. Additional material being screened, includes open-pollinated varieties of the United States and also U.S.D.A. Plant Introduction varieties obtained from the regional station, Ames, Iowa.

Loring M. Jones

ESCUELA NACIONAL DE AGRICULTURA
Cooperative Program for Corn Investigations
La, Molina, Peru

1. Maize germplasm collection and evaluation.

The collections of Peruvian corn registered at LaMolina, and duplicated at the Andean Seed Center at Medellin, Colombia, now number over 1200.

Extensive propagation work, agronomic evaluation, and biometrical analyses have been conducted on Peruvian corn collections at four field locations: northern and central coast, and central and southern highland (Sierra) regions. A vast array of morphological and physiological characters already found in the corn collections, are being fixed and classified for further study.

Alexander Grobman

2. Chromosome-knob numbers of Peruvian coastal maize.

Chromosome-knob counts were continued on representative collections of Peruvian coastal maize. A previous report (1954 Newsletter 28:87) indicates techniques used. Results obtained until now, and expressed as mean chromosome-knob numbers per cell per collection, are distributed as shown below.

Classes of chromosome-knob numbers						
Less than 1.0	1.01-2.00	2.01-3.00	3.01-4.00	4.01-5.00	5.01-6.00	6.01-7.00
Number of collections per class						
6	11	16	8	7	1	2

The data already accumulated are interesting in that they seem to indicate moderately high values for chromosome-knob numbers in a large proportion of coastal maize collections. Since neither Tripsacum nor Teosinte introgression in situ could be adduced to explain such high values, because of absence of those species in Peru, they might serve to indicate that most coastal maize varieties derive from introductions from Teosinte-introgressed areas, either in Pre-columbian ages or afterwards. Northern coast floury collections, ears of which are similar to those found in pre-inca remains, but exhibiting nowadays tripsacoid characters, had high chromosome-knob counts. The lowest chromosome-knob numbers were found among "Criollo" collections of the southern coast, floury types which definitely show morphological Andean-corn ancestry, and among "Jora" floury corn collections of the Central coast.

If these data on Peruvian coastal maize types are compared to similar data from Mexican corn varieties, interesting facts are immediately apparent (Mexican data from Wellhausen and Prywer's report in Newsletter 28:42, 1954). The mean class of chromosome-knob numbers for Peruvian coastal collections is 2.01-3.00; for 12 Mexican varieties and 24 groups of lines, it is 5.01-6.00. The frequency distribution of Peruvian coastal maize collections shows skewness toward low knob numbers, while the frequency distribution of Mexican maize exhibits skewness toward high knob numbers.

Alexander Grobman and
Ulises Moreno

3. Amylose in starch of Peruvian Andean corn.

A survey of amylose content in corn starch of representative Andean collections, was initiated viewing the finding of possible high-amylose varieties that could be used as basic reservoirs for further breeding here

and abroad. The analyses were kindly performed by Dr. M. M. McMasters at the USDA Northern Regional Laboratory, Peoria, Illinois. First available data are shown below:

Collectors Registration No.	Description of variety	Percent Amylose
Peru FC 115	White, semi-dent trace of blue	26.6
" P 58	Yellow flour	26.6
" VE 24	Red flour	25.7
" RP 16	White flour	25.4
" FC 112	Dirty tan flour	26.8
" FC 111	Dull light red flour	26.0
" FC 107	Mixed yellow semident	26.7
" FC 129	Yellow flour	27.0
" FC 121	Yellow flint	27.2
" AG 221	Mixed black & yellow flour, rough	25.3
" FC 106	Red striped white flour	25.0
" ACV 93	Pale yellow-crowned white flour	25.5
" FC 114	Dark red flour	28.6
" FC 100	Mottled blue and white flour	29.6
" FC 118	Orange-yellow flour	34.0
" FC 124	Black flour	31.2
" AG 220	Pale yellow flour	33.2
" AG 142	Yellow-crowned red flour	28.7
" FC 105	Mottled blue and white flour	32.4
" ACV 2	Red splashed yellow flour	28.0
" ACV 12	Black, red, and blue mixed flour	25.2
" FC 110	Black-crowned red flour	25.8

Collections FC 118 and AG 220 are of the Amazonian tropical corn variety "Piricinco", collected at La Convencion valley, and the Andean variety "Blanco de Camana", respectively. These had the highest amylose percentage among the collections investigated.

Alexander Grobman and
A. F. Swanson

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1. Mutations in teosinte derivatives.

Spontaneous mutations continue to appear in the inbred strains into which one or more teosinte chromosomes have been introduced through repeated backcrossing. From populations totaling something less than 2000 plants we have now gotten the following mutants: 23 defective seeds, 1 albino, 1 virescent, 1 pale green, 2 dwarfs, 1 male sterile and 3 translocations.

A number of these mutations, like the "alleles" at the Wx-wx locus reported by McClintock, are unstable, reverting to various degrees of normality. For example, one of the defective seed types mutates to normal and perhaps even to "super normal" seeds. The pale green mutates back to normal or near normal green.

Paul C. Mangelsdorf

2. Blotched aleurone, a mutagenic system.

The character blotched aleurone, described by Emerson in 1921 and shown by Anderson to be linked with Y on Chromosome 6, is actually a mutagenic system similar to that described by McClintock, and in our cultures is the product of crossing maize-teosinte derivatives with a multiple tester stock.

The Bh factor on Chromosome 6, in the presence of three other factors tentatively located on Chromosomes 4, 5 and 7, causes the gene c on Chromosome 9 to mutate to C. The mutations are apparent only when the gene R on Chromosome 10 is present, irrespective of whether A is dominant or recessive. The stocks involving blotching may segregate for any or all of five loci (including R) to produce ratios of 3:1, 9:7, 27:37, 81:175 and 243:781. Segregation fitting all of these ratios has been obtained and is shown in the following table.

Segregation for Blotched Aleurone

Ratio	No. Ears	Total Seeds	No. Blotched	Theor. Blotched	Deviation
3:1	47	15,952	11,792	11,964	-172
9:7	49	16,131	8,820	9,074	-254
27:37	33	12,324	5,159	5,199	-40
81:175	22	8,045	2,552	2,545	7
243:781	6	1,929	461	458	3

The significant deficiency of blotched seeds in the first two categories and for the population as a whole may be attributed to (1) a failure to identify blotching when only a few cells in the aleurone are involved, or (2) the fact that somatic mutations with respect to the blotching system create small areas on some ears in which no blotching occurs.

The genetic factors involved in blotching have a dosage effect. All four factors must be present in at least one dose in order for blotching to show. With all four factors segregating, the dosage in the triploid aleurone may vary from 4 to 12, with 3 factors from 6 to 12, with 2 factors, 8 to 12, and with 1 factor, 10 to 12. Consequently, the lower the percentage of blotched seeds on a segregating ear, the lower (on the average) the intensity of the blotching.

Paul C. Mangelsdorf

3. A second type of blotching involving the R locus.

In another cross of a teosinte derivative and a multiple tester, a mutagenic system has appeared which involves mutations from r to R on Chromosome 10 and causes a type of blotching similar to, but not identical with, that produced by the system described above. At least two genetic factors are involved in this system and one of these is carried by the inbred strain P39. It may be that this blotching is the equivalent of one described by Emerson et al, 1935, as being due to the R^{mb} allele at this locus.

Paul C. Mangelsdorf

4. Other mutations produced by the blotching system.

In the course of classifying ears for blotching, a number of mutations affecting other aleurone and endosperm characters have been encountered. These include mutations from Su to su on Chromosome 4, from Pr to pr on Chromosome 5, Y to y on Chromosome 6 and R to r on Chromosome 10. The mutations show up as sectors in the seed and, depending upon the time of origin, affect various fractions of the seed.

At the R locus, 42 mutations to r were found in 13,033 seeds. At the Su locus in the same population 19 mutations from Su to su were counted in 23,654 seeds. Mutations affect a definite fraction of the kernel - $\frac{1}{2}$, $\frac{1}{4}$, 1/8 etc. In this study mutations occurring so late in development as to affect less than 1/32 of the seed were not counted.

Paul C. Mangelsdorf

5. Studies of defective seeds originating in teosinte-maize derivatives.

Twenty-three defective seed types which originated from maize-teosinte derivatives are being studied to determine how many of them are different and how many are "repeats" or alleles. Both types have so far been encountered. Among the 23 defectives four are already known to be either identical or allelic. Three of the defectives show linkage with Su on Chromosome 4. Two of these are located to the right of Su, showing little linkage with gl. These two defectives, brought into a stock in the repulsion phase, create a kind of balanced-lethal system in which the ratio of normal to defective seeds instead of being 9:7 approaches 1:1 and in which the majority of the normal seeds when grown give rise to progeny segregating in this same fashion.

Many of the ears segregating various types of defective seeds yield normal 3:1 ratios, but many others exhibit marked deviations, some having more and some less than 25 percent of recessives. Several factors may be involved in these deviations. At least one of the defective seed types is unstable and mutates back to normal, and others may be behaving similarly. There is an indication that some of the mutants in the maize-teosinte derivatives are actually minute deficiencies not always transmitted through the pollen. In several cases the percentage of defective seeds is significantly higher in the upper half of the ears than in the lower.

It will be recalled that defective seeds are among the recessive characters which appear most frequently when maize is inbred. Mangelsdorf (1926) described 14 different defectives and additional ones have since been reported by other workers. Linkages of defective seeds with genes on Chromosome 4, 9 and 10 have previously been reported.

Angelo Bianchi and
Paul C. Mangelsdorf

6. Archaeological evidence of the effect of teosinte (or Tripsacum) introgression on maize.

A study has been made of the effects of teosinte (or Tripsacum) germplasm on the characteristics of two populations of prehistoric maize. The material, dated at 500 to 700 years, was excavated by Mr. Lloyd Pearson from the Montezuma Castle (1440 cobs) and Tonto (1920 cobs) National Monuments in Arizona. Some of the specimens are so highly tripsacoid that they appear to be the immediate products of hybridization with either teosinte or Tripsacum. Some of them can be matched almost exactly with modern specimens of maize-teosinte hybrids. Since maize is known to hybridize regularly with teosinte in Mexico, it is assumed for the purposes of this discussion that the introgression involved is from teosinte.

An arbitrary key of five grades, based on the degree of induration of the tissues and the frequency of single and paired pistillate spikelets, was used to measure the degree of teosinte introgression. This key was found to be reliable when tested on modern inbred maize with various known numbers of chromosome substitutions from teosinte and by determinations of specific gravity of the cobs. All scoring was done by one person. Scores were correlated by the use of key-sort cards with other morphological features of which length and diameter proved to be of special interest.

In the Montezuma Castle material there was a definite curvelinear correlation between teosinte introgression and cob length - the most tripsacoid cobs being either the shortest or longest in the population. The shorter cobs are interpreted as being the result of the homozygous expression of teosinte germplasm while the longer ones are assumed to be the product of teosinte-maize heterosis. Teosinte introgression had no significant effect on cob diameter in this population.

In the cobs from Tonto Cave teosinte introgression was negatively correlated with cob length while there was a positive correlation with cob diameter. These differences between Montezuma Castle and Tonto maize might be attributed to different fractions of teosinte germplasm, perhaps different chromosomes, involved in these two populations. This is suggested because similar differences exist in various modern teosinte-maize derivatives.

The material from both sites supports the theory that fasciation (flattening) had a role in the evolution of extreme polystichy of the ear. As in modern maize, the proportion of fasciated cobs increased with kernel row number. The archaeological material differed from modern maize in that fasciation was more prevalent in the lower row-number classes. In the material studied, teosinte introgression was not significantly related to fasciation.

Several long-glumed types of cobs occurred in these populations. One of them from Montezuma Castle is the first archaeological cob known to duplicate the extreme form of modern tunicate maize. The fact that this specimen was also tripsacoid has stimulated efforts to determine if teosinte germplasm had a role in the origin of the highest tunicate allele, Tu.

Walton C. Galinat and
Paul C. Mangelsdorf

7. Pseudopod, a possible allele of vestigial glume.

Pseudopod, Pp, is a new semi-dominant gene isolated from a Peruvian variety which is concerned with the same characters as vestigial glume, Vg, although the effect is in the opposite direction and is confined to the ear. On the ear the gene for pseudopod lengthens the glumes and rachillas instead of reducing them, reduces the diameter of the rachis instead of enlarging it and produces papyraceous glumes and cupules instead of corneous ones. The last feature of pseudopod represents a defective character, for the cob becomes fragile because it lacks the normal encasement of lignified cupules.

The pseudopod character is apparently identical with the "palee sviluppate" of Bonvicini (1932) and the "semi-vestidos" of Andres (1950). It has been confused by Weatherwax (1954) with half-tunicate to which it has a superficial resemblance. But the glumes of various kinds of tunicate maize are herbaceous and are similar to the normal glumes of other grasses. The glumes of pseudopod, on the other hand, are distinctly papyraceous and the character is distinctly a defect which, contrary to the suggestion of Andres, could scarcely have had a role in the evolution of maize.

In view of the opposite effects of Pp and Vg, it is interesting that there is an indication of allelism. Three-point linkage data place the Pp gene at or near the Vg locus on Chromosome 1. Tests for allelism should be completed next summer.

Walton C. Galinat and
Paul C. Mangelsdorf

8. Maize with vestigial-glume ears and normal tassels.

Recent attempts to separate the tassel and ear effects of the Vg (vestigial glume) gene have been successful. In a cross with Chapalote, a primitive popcorn from western Mexico, the Vg gene acts differentially upon the tassel and ear with respect to glume length. Thus, the advantage of glumeless ears (for canning) may be realized on plants with normal tassels.

In an F_2 population of 49 plants from this Vg-Chapalote hybrid, there were some Vg plants in which the ear glumes were longer than the tassel glumes as they are in vestigial glume-tunicate hybrids. Mangelsdorf has previously found that the Chapalote race carries a weak tunicate, tu^w, allele. This tu^w gene is probably involved along with other modifying factors. The anthers of Vg-Tu hybrids usually have difficulty in exserting, although no such effect was noted in the Vg-Chapalote hybrid. The tassel glumes of Vg-Chapalote plants are not completely normal in all respects, however, since they are decidedly flatter in their general aspect.

Prior to the discovery of the effect of Chapalote germplasm on the expression of the Vg gene, the longest Vg tassel glumes that had been obtained were only slightly longer than the non-exserted anthers. Such tassels were often sterile in the absence of heterosis and especially in lines with a low resistance to tassel blasting.

Walton C. Galinat

9. Effect of various genes on development of tassel glumes on Vg plants.

In the presence of the tunicate gene, Tu, the effect of the Vg gene is about equal on tassel and ear. This is also the case, to varying degrees, in the 9 F_2 genotypes with Tu and in the double heterozygote with half tunicate, tu^h. Although the tassel glumes of these Vg-tunicate combinations may approach normal length, the ear glumes are longer than normal. This is a reflection of the usual activity of the Tu and tu^h genes. In combination with the teopod, Tp, gene, there is a reduction of floral bracts as well as of the spathes characteristic of teopod. Features of teopod other than spathe development are not affected. Glumes of the Vg-pseudopod, Pp, combination are slightly shorter than normal. Thus the Vg gene produces a greater effect in one direction than Pp in the other.

Walton C. Galinat

IOWA STATE COLLEGE
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1. Plants homozygous dominant vs. heterozygous for 'white seedling' on a heterogenous background.

It is desirable to study single locus heterosis on a homozygous background. The difficulties to obtain homozygosity on all but the locus under consideration are numerous. It was felt that the comparison of the two genotypic classes WW vs. Ww may well be accomplished on an uncontrolled and heterozygous background. Under the assumption of random assortment of genes, any combination can occur equally frequent in WW or Ww plants. Consequently, if a large enough number of WW and Ww plants were grown and measured, possible heterotic effects on the white locus might become measurable.

In the course of an inbreeding study (Maize Genetics Cooperation News Letter 27) a number of selfed ears, obtained from the open pollinated variety Reid Yellow Dent, were segregating for white seedlings. Tests for allelism established two alleles. One occurred with a frequency of .01310 and the other of .00062. Five ears segregating in a 3:1 fashion for the former allele were planted ear-to-row. Since all homozygous recessives are lethal, a field population consisting of two heterozygous to one homozygous dominant plants, was expected. To identify plants as to their genotype, each individual was selfed immediately after the appearance of the first silks. This procedure resulted in selfed seed of at least a section of the ear. The following day ear bags were removed to secure a full seed set of the remaining portion of the ear by open pollination. Ears were harvested and weight of shelled grain, as well as number of seeds, was determined on an individual plant basis. Fifty seeds, taken from the basal portion of each ear, were grown in sand in the greenhouse to determine the genotype of each plant, with respect to the white locus.

The field population of the five progenies, together with the X^2 values of these ratios, are summarized in Table 1. It may be noted that only one progeny segregated in a typical lethal ratio (2:1) as expected. In the other four cases, deviations in both directions occurred. The method of pollination and sampling may be responsible for occasional misclassifications of Ww plants. An excess of WW plants in two progenies can not be explained so easily. Upon pooling the five progenies, the deviation from expectation is not significant; however, the heterogeneity X^2 value suggests that we were dealing with different populations. Hence the analyses were carried out on an ear-to-row progeny basis. Table 2 contains the results. In none of the two attributes, in any of the five populations, was there any significant difference between the WW vs. Ww genotypes.

If the assumptions made in the beginning were correct, then we were not able to demonstrate a heterotic effect on this white-locus. It is realized, however, that the high degree of heterozygosity may well conceal

any existing slight departures in favor of the heterozygous allele combination. Larger population numbers could overcome certain limitations, while others such as close repulsion or linkage of 'White' with major yield genes would not be altered materially by increasing the number of plants. It is felt that the above approach was of the nature of a preliminary experiment.

J. F. Schuler
G. F. Sprague

Table 1. Segregating ratios and X^2 values of five segregating progenies.

Source	Number of plants WW	Ww	X^2	P
1	6	32	5.26	<.02
3	6	31	4.88	<.02
166-2	50	49	13.14	<.01
171-2	29	60	.002	<.95
183-2	33	34	7.64	<.01
			(30.92)	
	124	206	2.67	<.50

	X^2	DF	P
Pooled deviation	2.67	1	<.50
Heterogeneity	28.25	4	<.01

Table 2. Number of kernels and seed weight in grams, means, standard deviations and t-values of 5 ear-to-row progenies.

Parental Source	Genotype	Number of kernels Mean	Standard Deviation	t	$t_{.05}$	P	Seed weight in grams Mean	Standard Deviation	t	$t_{.05}$	P
1	WW	300.1	40.95	.72	2.52	.05	78.5	11.09	.41	2.50	.05
	Ww	269.1	13.28				73.6	4.29			
3	WW	337.8	45.27	2.37	2.48	.05	118.6	16.80	.90	2.53	.05
	Ww	455.1	19.68				134.2	4.91			
166-5	WW	367.6	21.73	2.005	2.006	.05	105.8	6.72	.80	2.02	.05
	Ww	421.7	15.99				112.7	5.34			
171-2	WW	305.7	8.14	1.17	2.02	.05	104.5	2.97	1.63	2.03	.05
	Ww	291.6	8.83				98.4	2.26			
183-2	WW	345.2	22.20	.58	2.03	.05	63.2	3.38	.50	2.04	.05
	Ww	362.7	20.43				65.6	3.38			

2. Gene frequency in a strain of Reid Yellow Dent.

The preliminary part of this inbreeding study has been reported (Maize Genetics Cooperation News Letter 27). Of the 801 ears selfed in 1948, a total of 238 were segregating for seedling and seed characters. The remaining ears, which were free of defective recessives, were regrown under isolation as a composite in 1949, 1950, 1951 and 1952. A sample of the 1952 crop was planted in 1953, and a total of 1137 ears self pollinated. The ears were examined for seed segregations, and about 50 seeds per ear were germinated in the greenhouse and classified for seedling mutants. The results are summarized in Table 1, together with the 1948 data. It may be apparent, from the table, that new mutations appeared in the population at rather high frequencies. On the other hand, previously found characters did not regain former frequencies in the 1953 sample. Allelism within each group of the 1953 samples will be determined in the future. New alleles also will be outcrossed to the corresponding group of the first sample.

J. F. Schuler
G. F. Sprague

Table 1. (See page 31)

Table 1. Frequency of occurrence of segregation for various characters in the 1948 and 1953 sample of selfed ears from the variety Reid Yellow Dent.

	1948			1953		
	No. of ears segregating	Frequency expressed as % of total	% of segregates	No. of ears segregating	Frequency expressed as % of total	% of segregates
germless	87	10.86	36.56	*)		
virescent	25	3.12	10.50	23	2.02	18.25
yellow green	44	5.49	18.49	11	.97	8.73
light green				16	1.41	12.70
luteus	15	1.87	6.30			
white	28	3.49	11.77	10	.88	7.94
pale green	10	1.24	4.20			
glossy	7	.87	2.94	14	1.23	11.11
dwarf	8	1.00	3.36	10	.88	7.94
stripe	6	.75	2.52			
shrunken				17	1.49	13.49
accessory leaf blade				4	.35	3.17
adherent				8	.70	6.35
miscellaneous	8	1.00	3.36	13	1.14	10.32
	238	29.69	100.00	126	11.07	100.00

*) 'germless' was not determined in the 1953 sample

JOHN INNES HORTICULTURAL INSTITUTION
Hertford, England

It was not possible to bulk up the six inbreds, mentioned in the 1954 News Letter as adapted to local growing conditions in England, owing to inclement weather; and only five were able to withstand the severe conditions in the field. The F_1 hybrid trial between the six inbreds crossed reciprocally showed that considerable heterosis was obtainable. Hybrids generally had good germination and plant characters, but unfortunately were often eight-rowed. The row number might be increased by crossing the better combining inbreds with inbred C 13 already used in producing the John Innes Topcross Hybrids. The idiograms of these inbreds and hybrids all revealed a flint pattern, demonstrating that good heterosis is available between sweetcorn inbreds that are flint maize derivatives.

G. Haskell

MACDONALD COLLEGE OF MCGILL UNIVERSITY
Province of Quebec, Canada

1. Another Corn Grass Mutation?

Late in the summer of 1947, a field technician called to the attention of Professor L. C. Raymond an "off-type" plant in a planting of flint double crosses. This plant was weak, with a small tassel, many tillers, and narrow leaves. It produced a few seeds which were saved. A small progeny has been grown every year since this time; the past three years in comparison with Singleton's corn grass.

In all characteristics it is apparently identical with corn grass. Progeny of the original plant had no tassels and only during the past two years have small tassels begun to appear in the progeny of open pollinated plants; repeating the sequence described for Corn Grass.

The corn grass available to me has all been heterozygous for the dominant gene Cg. Similarly the Macdonald stock has existed only in the heterozygous form. This heterozygosity, the apparently identical phenotype of both stocks, the complications of male sterility and the problem of the identity of the homozygote and/or double dominant, have all made the test for allelism most difficult. Hence it is not yet known whether our find is a repeat mutation of Corn Grass or a new mutation.

2. Inverted embryos.

An ear designated S1524 (2) (x) in the culture of R. A. Brink was noticed in the spring of 1947 to have all of the embryos on the butt side

of each kernel (i.e., in the inverted or abaxial position). The known genotype of this stock was A B Pl r^{ch}. It was obviously a rather weak stock. The ear was very small and poorly filled, and, while the abaxial location of the embryos was noted, little significance was attached to it for it could have been a consequence of the wide spacing of the kernels. Two selfed ears from S1524 (2) were harvested in the fall of 1947. Both were very small and sparsely filled, but again with all embryos inverted. In 1948 two outcrosses were made using the inverted A B Pl r^{ch} line as the male parent. This material was then laid aside and only grown again in more recent years.

The primary objective when seed of one of these crosses was planted here in Canada was the improvement of the vigor of the A B Pl r^{ch} parent. The F_1 was selfed and in 1953 twenty selfed F_2 ears were harvested of which 4 had all inverted embryos. Seed from 3 of these ears was planted in 1954. Thirteen selfed ears all had embryos on the butt side of the kernels only. Ten of these were again only sparsely filled, but 3 were normal, well filled ears and on these the inverted embryo position persisted.

3. Pink pollen

Pollen which definitely was not yellow, which looked pinkish brown in bulk, and which could be chocolate (see Tavcar, News Letter 24, 1950) was observed in 1954 in many descendents of ear S1524 (2) described in section No. 2 above. Pollination of the ancestors of this material had been in the hands of technicians for the past few years and the pollen color was not detected until the summer of 1954 when I once again pollinated these lines. Of the several descendent lines of S1524 (2) in the field when the first plant with pink pollen was discovered, pink pollen was found to be present in some plants of two lines. The original find was made in one of the inverted embryo lines. Another line, free of inverted embryos, but saved because it was A B Pl r^{ch} also included some plants with pink pollen.

Several plants in both lines had finished shedding pollen by the time the original find was made. Apparently, however, the pollen color is associated with purple anther color for it was found only in A B Pl or A b Pl plants. In this respect it is similar to Tavcar's chocolate pollen (Co) gene.

The actual amount of pigment in each pollen grain is very slight for examination by transmitted light revealed none. Also very little pigment was noticeable in reflected light at high magnification. Apparently bulk amounts are needed for detection of the color.

The pollen seemed fertile and was used in both selfs and in crosses. F_1 plants and selfs are now growing in the greenhouse.

R. I. Brawn

MISIÓN BIOLÓGICA DE GALICIA
Pontevedra, Spain

1. Breeding for sugar in corn stalks.

Inbred lines that in 1951 had median refractometer readings of the stalk juice of 11.8%, 9.8%, 11.1%, 11.0%, 11.7%, 10.0%, 9.1%, 6.3% were selected for high-refractometer-reading individuals in 1951, 1952, and 1953. In 1954 these lines gave median readings of 14.4%, 14.4%, 13.3%, 18.5%, 15.8%, 16.4%, 16.1% and 14.4% respectively.

Chemical analysis of the grain of 29 ears, in lines selected for refractometer readings at maturity of less than 10% and over 12%, showed some association between refractometer readings and protein percentage of the kernel. This result encouraged us to pursue a systematic study of the subject in inbreds and hybrids.

	Flinty Median		Dent Median	
	Refract. reading	Protein* %	Refract. reading	Protein %
Inbreds with readings over 12%	14.9	14.8	14.3	14.8
Inbreds with readings below 10%	9.4	13.8	7.8	10.9

* = Protein content expressed as percentage of the dry matter of the kernel.

We give thanks to Miss Mª Ameijeiras for the chemical analysis.

Mariano Blanco and
Jose L. Blanco

2. Trials for economic evaluation of hybrids of inbred lines with high refractometrical readings in the stalk juice.

Four trials, including 239 hybrids, were performed in 1954. Included in the trials were 11 hybrids sent by Dr. D. F. Jones. The rest were from American inbreds and our own inbreds selected for high refractometer readings in 1951 and 1952.

For each hybrid data were taken for yields of grain, stalks, leaves, juice of the stalks, and alcohol (obtained by stalk juice fermentation and distillation).

Under good cultivation some hybrids had all the leaves quite green when the ear was mature (with 25-31% moisture in the grain), and the

refractometer reading of such hybrids was from 10 to 13%.

The highest grain yield (13.700 kgs./Ha; 15.5% moisture) was obtained with one hybrid of 115 days maturity period (American scale). It harvested at 31% grain moisture and gave, at same time, 17 tons/Ha. of green leaves and 33 T./Ha. of stalks with 72% of juice, which had 10% refractometer readings. From the fermented juice was obtained 960 lbs./Ha. of 100% alcohol.

With eight tons of green plants, from which mature ears were harvested was made silage which was very much appreciated by the oxen.

Considering in the evaluation stalks for production of a cheap alcohol for motors and leaves for silage, those hybrids with green leaves after the ear was matured represented at Pontevedra a value 32% to 45% over grain of the hybrids in the same trials that did not have green leaves when the ears were matured.

We thank Dr. D. F. Jones very much for the seed and his suggestions.

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A. S. Veiguinha - Estacao Agronomica Nacional, Sacavem, Portugal
Jose L. Blanco - Mision Biologica de Galicia, Pontevedra, Spain

THE PENNSYLVANIA STATE UNIVERSITY
Department of Horticultue
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1. Evidence in support of a linkage between factors located on chromosome three and one of two complementary factors which restore fertility to cytoplasmic male sterile corn.

From a study of the progenies of a series of Sterile Normal x Fertile Marker crosses (News Letter 28:31-33, 1954) this author suggested that duplicate genes were controlling the inheritance of pollen production. Although this data conformed also to the supposition that the fertility restoring (FR) genes could have been complementary in their action, this possibility was not mentioned. A series of F_2 segregating populations from these initial crosses (Table 1) later indicated that the FR genes were indeed complementary in their action. From somewhat similar studies, Duvick (News Letter 28:35-36, 1954) and Brunson (News Letter 28:39, 1954) explained their results on the basis of the action of two complementary genes.

Table I. Fertile and sterile segregates from sterile normal x fertile marker F_2 populations

Sterile x Marker	Chrom. Marked	Fertile	Sterile	Chi-Sqs. for 9:7 Ratios	P
$C106^{T6}$ x Coop 51-80	1	108	72	1.0285	0.50-0.20
x Coop 50-32					
Population 1	1	202	171	0.6660	0.50-0.20
Population 2	1	203	181	1.7884	0.20-0.10
Population 3	1	146	119	0.1380	0.95-0.50
x Coop 49-26	3	129	84	1.7207	0.20-0.10

An analysis of F_2 data obtained from the cross $C106^{T6}$ x Coop 50-32 has suggested that a linkage exists between factors located on chromosome three and one of two complementary genes which restored fertility to the cytoplasmic male sterile line. This particular cross was made in the repulsion phase. The marker line was homozygous recessive for d, ts_4, and lg_2. Table 2 shows the segregation for FR genes and ts_4, Table 3 shows the segregation for FR genes and d, and Table 4 shows the segregation for FR genes and lg_2. Linkage intensities calculated by the product method indicated that there was less than 1% crossing over between the FR gene and ts_4, 21% crossing over between the FR gene and d, and 36% crossing over between the FR gene and lg_2. The markers, ts_4 and d, were linked with approximately 31% crossing over; ts_4 and lg_2 were linked with 25% crossing over; and d and lg_2 were linked with 52% crossing over. The linear arrangement of these loci and the units between them may be illustrated as follows: d--21-FR--10--ts_4-25--lg_2.

If the FR gene is approximately 21 units from d, it should also be approximately 36 units from lg_2. The distance between the FR gene and lg_2 is approximately 36 units. The distance between the FR gene and ts_4 is apparently somewhat in error. The data indicate, however, that the FR gene is located approximately 21 units from d and not more than 10 units from ts_4.

Table 2. Segregation for FR Genes and ts_4

Segregating Classes	No.	Chi-Square Values	
Normal Fertile	87	Chi-sq. for total (27:21:9:7)	11.5707*
Normal Sterile	73	Chi-sq. for FR segregation (9:7)	0.2286**
ts_4 Fertile	42	Chi-sq. for ts_4 segregation (3:1)	0.6289***
ts_4 Sterile	11	Chi-sq. for linkage	10.7132*

* P = <0.01 ** P = 0.95-0.50 *** P = 0.50-0.20

Table 3. Segregation for FR Genes and d

Segregating Classes	No.	Chi-Square Values	
Normal Fertile	97	Chi-sq. for total (27:21:9:7)	8.6081*
Normal Sterile	73	Chi-sq. for FR segregation (9:7)	0.0452**
d Fertile	33	Chi-sq. for d segregation (3:1)	0.0601**
d Sterile	10	Chi-sq. for linkage	8.5028***

* P = 0.05-0.02 ** P = 0.95-0.50 *** P = <0.01

Table 4. Segregation for FR genes and lg_2

Segregating Classes	No.	Chi-Square Values	
Normal Fertile	89	Chi-sq. for total (27:21:9:7)	4.8027*
Normal Sterile	66	Chi-sq. for FR segregation (9:7)	0.0861**
lg_2 Fertile	40	Chi-sq. for lg_2 segregation (3:1)	1.1264***
lg_2 Sterile	18	Chi-sq. for linkage	3.5902****

* P = 0.20-0.10 ** P = 0.95-0.50 *** P = 0.50-0.20

**** P = 0.10-0.05

Robert J. Snyder

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Lafayette, Indiana

1. Linkage studies with su_2

A three point test from A/a Pl Su_2 py / pl su_2 Py selfed gave results as follows:

	Pl Py	Pl py	pl Py	pl py	Sum
Su_2	96	12	32	16	156
su_2	4	1	60	0	65

Recombination values were Pl-su_2, 6 ± 2; and su_2-py, 17 ± 6.

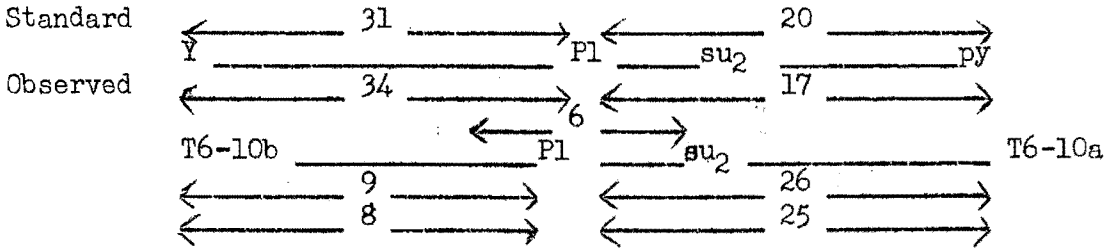
Two point tests of $\underline{su_2}$ with $\underline{Y}$ in F_2 gave:

	YSu_2	$Y\ su_2$	$y\ Su_2$	$y\ su_2$	Sum	Recombination
Repulsion	90	46	48	7	191	34
Coupling	179	44	35	31	289	33
"	76	15	16	10	117	34
"	102	22	19	14	157	34

Backcross tests of $\underline{su_2}$ with T6-10a and T6-10b are compared with backcross tests of $\underline{Pl}$ with T6-10a and T6-10b from Anderson and Kramer, Genetics (in press) as follows:

su_2T	T6-10a	T6-10b	Pl-T	T6-10a	T6-10b
Su_2SS	56	53	Pl SS	147	8
Su_2 N	21	5	Pl N	56	64
su_2SS	21	6	pl SS	50	62
su_2 N	69	68	pl N	140	4
Sum	167	132		393	138
Recombination	25	8		26	9

The linkage values indicate that $\underline{su_2}$ is probably slightly distal to $\underline{Pl}$ on chromosome 6. The map may be summarized as follows:



2. A new gene suppressing the wrinkling due to su_1

A new gene which shows an almost imperceptible endosperm translucense when segregating in normal dent stocks was found to increase amylose content to approximately 60%. In crosses with $\underline{su_1}$, an F_2 segregation of 477 normal starchy: 164 wrinkled: 66 non wrinkled glassy which approaches a 12:3:1 ratio. The non wrinkled glassy kernels bred true. The wrinkled kernels either bred true or segregated in a ratio of 3 wrinkled: 1 glassy. It would appear that this new gene (tentatively called $\underline{ha}$ for high amylose) is suppressing the wrinkling normally associated with $\underline{su_1}$, the recessive $\underline{su_1}$ $\underline{ha}$ endosperms being glassy instead of wrinkled. Chemical analyses are in process.

Herbert H. Kramer

3. Polytypic Ear in Linkage Group 6

The semi-dominant gene Polytypic Ear recently reported from this laboratory can be placed on Chr. 6. Its locus is apparently close to the salmon silk locus. A backcross progeny, Sm Pt/sm pt x sm pt/sm pt gave 96 sm pt/sm pt plants, 76 Sm Pt/sm pt plants, 6 plants which were Sm pt/sm pt, and 1 sm Pt/sm pt plant.

THE ROCKEFELLER FOUNDATION

Colombian Agricultural Program
Colombia, South America

1. The races of maize of Colombia.

The agricultural program of Colombia has, since its inception, sponsored the collection of maize varieties throughout the country. In recent years it has had the cooperation of the National Research Council in this enterprise. Almost 2000 separate collections, representing all parts of Colombia, have now been assembled. These have been studied intensively from the standpoint of the characters of the ears and plantings of the principal types have been made in four different localities in Colombia and extensive field notes have been taken. During the past year particular attention has been given to idntifying and describing the principal races of Colombia of which 19 are recognised.

Apparently maize in Colombia had its origin in two races of pop corn known locally as Pira and Pollo. The former has a very slender and flexible cob and has given rise to two races at somewhat lower altitudes, Clavo and Puya, which exhibit this character to a somewhat less degree.

The race Pollo is unique in the number of grain colors which it exhibits. These include several pericarp colors, purple aleurone, bronze aleurone (apparently a higher allele at the brown aleurone locus), yellow and white endosperm and mid-cob color. Pollo has given rise to the two principal high-altitude races of Colombia, Sabonero and Cabuya. Each of these occurs in four different forms - yellow flint, white flint, yellow flour and white flour. At lower altitudes two derivatives of Sabonero known as Cacao and Cariaca occur. Both are characterized by a floury endosperm and by segregation for alleles at the brown aleurone locus. The lower the altitude the lower the frequency of the bronze allele and the higher the frequency of the brown allele.

One of the larger-eared races grown at high altitudes, Montaña, is believed to be the product of hybridizing Clavo and Sabonero. Montana has in turn given rise to a large-seeded race, Capio, at high altitudes and to Amagaceño at somewhat lower altitudes.

In addition to these eleven races of highland origin, there are in Colombia seven lowland races. The two most commonly grown are Commun, principal maize of the watershed of the Magdalena River, and Costeño, principal maize of the north coastal region. Both of these occur in both yellow and white forms.

Chocoseño, the maize of the Colombian Choco, is perhaps the most unusual of all the Colombian races. It is highly tripsacoid in its vegetative characters, some of its plants tillering freely and resembling F_1 hybrids of maize and teosinte. Whatever introgression of Tripsacum Chocoseño contains must have come directly from that genus which is common in the Choco region for teosinte is unknown in Colombia.

The race Chocoseño occurs in five forms - yellow and white flint yellow and white floury and red pericarp.

Four other lowland races - Yucatan, Negrito, Caqueteño and Imbricado - are recognized, but collections of these are still too few to justify final conclusions.

A few collections of sweet corn similar to the sweet corn of Peru have been made in Colombia.

It was suggested several years ago by Birket-Smith, largely on the basis of linguistic evidence, that Colombia is the center of origin of maize. Our own recent studies suggest that although Colombia may not be the center of origin it is certainly one center of domestication and perhaps one of the centers of Tripsacum introgression. Colombia is certainly the center of alleles at the brown aleurone locus. These alleles diffuse out into the lowlands and are found in high frequency in the flour corn of Paraguay and Brazil as well as in the flour corn on the eastern slopes of the Bolivian Andes. Colombia may also be the center of a group of genes still not genetically analyzed affecting the glume color of the pistillate spikelets of the ear. Red glume color is common at the higher altitudes. Red pith color and internal red stalk color have also been observed.

The maize of Colombia has been spread both eastward and westward. Races resembling Commun, Costeño, Clavo and Puya occur in the Caribbean. These same types as well as Sabonero, Montañã and perhaps several others occur in Mexico and some of the countries of Central America.

2. Ear characters of Colombian corn collections.

The collection of indigenous corns of the Andean Region have been increased to over 5,000 samples. This represents several hundred collections from each of the following countries: Venezuela, Colombia, Peru, Ecuador, Bolivia, Chile. Samples have been obtained from most of the important corn-growing regions of these countries.

The cataloging and classification of the collections made in Colombia are nearly complete. Several characters have been observed which may be of considerable interest to geneticists. These characters are listed in the following table:

KERNEL CHARACTERISTICS

Pericarp Colors	Aleurone Colors	Endosperm Colors
Boy 428 red-orange	Boy 408 tan	White or yellow in all collections
Boy 438 pink streak	Sas 318 orange to brown series	
Boy 430 red	Boy 314 brown series	
Boy 332 red streak	Boy 428 colorless to bronze series	
Sas 369 red stripe	Boy 307 bronze to blue series	
Boy 408 salmon	Sas 345 dark bronze	
Nar 335 brown bar forming V on cap	Boy 339 blue series	
	Boy 320 purple series	

COB CHARACTERISTICS

Lemma and Palea	Glumes
Boy 392 white	Boy 336 white
Boy 317 dilute pink	Sas 324 pink inverted V on white
Sas 369 pink stripe	Sas 333 red
Boy 351 pink with red stripe	Sas 340 brown speckled
Boy 320 pink, red, and light purple	Sas 354 brown streak
Sas 338 cherry	Sas 346 chocolate brown
Sas 318 purple	Boy 307 bronze
	Sas 354 brownish purple
	Sas 338 cherry
	Sas 324 dark cherry
	Boy 392 purple stripe
	Sas 369 dilute purple
	Boy 438 purple
	Boy 428 dark purple

Mid-Cob	Pith
Boy 332 white	Boy 408 white
Sas 324 pink	Boy 348 pink
Sas 324 light brown	Sas 354 light purple
Sas 346 brown	
Boy 428 dark cherry	
Sas 357 dilute purple	
Boy 320 purple	

For each character listed a type collection has been selected and the origin and number is given in the table. Various combinations of these characters occur in the same collection. Anyone desiring seed with any of these characters or a particular combination of characters should request it by the collection origin and number or by a listing of the combination of characters desired. Requests for seed from the germplasm bank should be addressed to: The Rockefeller Foundation
Apartado aereo #14-68
Medellin, Colombia
South America

L. M. Roberts,
P. C. Mangelsdorf,
Ulysses J. Grant and
Donald L. Smith

SERVIÇO NACIONAL DE PESQUISAS AGRONOMICAS
(National Research Service in Agronomy)
Ministerio da Agricultura
Rio de Janeiro
Brazil

1. National hybrid corn project.

Since 1953 a project was started to enlarge hybrid seed production and to offer larger collaboration among experiment stations. Brazil was divided into seven ecological zones. A breeding center for each of the zones was established. A National Corn Committee is in charge of the general plan, which includes members of federal, state and private organizations. Brazil has probably more than 10,000,000 acres planted in corn, and actually hybrid seed is only available commercially in the 5th zone (States of Minas Gerais, Rio de Janeiro, São Paulo and north of Parana). In this region 10% of the area is already planted with hybrid seed. The demand by the farmers for hybrid seed is increasing steadily and several private hybrid seed organizations are already established.

2. Cytoplasmic male-sterility.

A male-sterile stock from Texas was crossed and three times backcrossed to ten Brazilian commercial inbred lines. Inbred lines having South American flint characters, restored their fertility, showing different genetic background. While inbreds having dent, and probably the North American genetic background remained with the cytoplasmic male-sterility. This differential reaction of the inbreds opened immediate possibilities for the use of the cytoplasmic male-sterile character in commercial production. The best double-cross hybrids in

Brazil are semi-dent hybrids, using two flint inbreds in one single-cross and two dent inbreds in the other. The two dent inbreds may have the cytoplasmic male-sterility, which will be covered in the double-cross by the restoring of fertility from the flint single-cross.

3. Cytological studies on hybrid vigor.

G. Schreiber is collaborating on this project from the Instituto Agronomico, Belo Horizonte, Minas Gerais.

Two Brazilian dent and two flint inbred lines were crossed in all possible combinations and selfed. Samples of ovules before pollination and kernels 3, 6, 10, 15, 20 and 25 days after pollinations were harvested and fixed in F.A.A. Cytological studies are under way to investigate differences among reciprocal crosses in pericarp, endosperm and germ tissues. The growth of endosperm and germ nuclei are being compared in selfed and crossed ears.

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UNITED STATES DEPARTMENT OF AGRICULTURE
Plant Industry Station
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1. Linkage test of genes for Helminthosporium turcicum resistance

A search for genes for Helminthosporium turcicum leaf blight resistance was conducted utilizing L. F. Randolph's multiple dominant and multiple recessive marker gene stocks. The stocks were crossed with the resistant inbreds NC34 and Mo21A. The F_1 involving the multiple dominant stock was backcrossed to the resistant parent. In the F_1 involving the multiple recessive it served as the recurrent parent. These crosses provided suitable marker genes for all chromosomes except 5 and 7.

Highly significant associations were found for seven regions involving six chromosomes in the Mo21A crosses. Of these four were positive and three were negative. Genes for H. turcicum leaf blight resistance were found linked with bm_2 and Pr in chromosome 1, lg in chromosome 2 and su in chromosome 4. Negative associations were found for the genes cr, j and g located in chromosomes 3, 8 and 10, respectively.

In crosses involving NC34 a highly significant positive association was found for j. A highly significant negative value also was found for cr in crosses with this inbred.

The results suggest that factors governing resistance to H. turcicum are located at least in chromosomes 1, 2 and 4 of Mo21A and in chromosome 8 of NC34. Apparently the cr gene is linked with a factor for resistance present in the multiple recessive stock or contributes a pseudo-type of resistance associated with its effect on plant morphology. Genes for susceptibility to H. turcicum evidently are located in chromosomes 8 and 10 of Mo21A, linked with genes j and g. A negative association was not obtained for the latter locus in the multiple recessive-NC34 backcrosses.

It should be pointed out that the above results are based on one year's data. Genotype environmental interactions may give different results in another season.

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Merle T. Jenkins
Alice L. Robert

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1. Auxin relations in dwarf coleoptiles.

While conducting a survey of the amounts of diffusable auxin that can be obtained from dwarf seedlings, an interesting "inactivation" effect has been observed from some of the mutant coleoptiles. This effect appears to be present in some dwarfs that are small at maturity. The dwarf-1 gene does not produce this effect.

Seedlings are grown in an "avena chamber" and the coleoptiles from 5 day old plants assayed for diffusible auxin. Routinely, six 3 mm. coleoptile tips are placed on moist filter paper for one hour and then transferred to an agar block for 6 additional hours. The amount of diffusible auxin that accumulates in this block is assayed by the standard avena test.

In a typical experiment with a chromosome 9 dwarf mutant (dwarf 8201 CIT) 6 dwarf coleoptile tips gave 5.1° curvature, 6 normal tips 21.9° curvature. However, when 6 dwarf tips and 6 normal tips were placed on the same block for 6 hours, and the block then assayed for diffusible auxin, less than 5° curvature resulted. In addition, dwarf tips will also negate the curvature produced from a block of agar containing indoleacetic acid. These results suggest the presence of a "diffusible inactivator" in the dwarf tips that in some way negates both the curvature expected from diffusates of normal tips and the curvature expected from an agar block containing IAA.

In contrast, working with an allele to dwarf-1 (dwarf 6016 CIT), dwarf coleoptiles gave 13.4° curvature, normal coleoptiles 26.6° curvature. When both normal and dwarf coleoptiles were placed on the same agar block, the curvature was in excess of that obtained from normals alone. Dwarf-1 coleoptiles placed on a block of agar containing a known amount of indoleacetic acid resulted in a curvature in excess of that found from an agar block containing IAA only.

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1. Shrunken-floury, a gene affecting protein synthesis.

Circumstantial evidence is available which shows that a recessive gene sh^{fl} may have an effect on protein metabolism. The following phenotypic effects are exhibited by this allele:

(1) Shrunken-floury kernels. The horny endosperm layer is reduced or entirely missing so that only the floury or starchy endosperm remains, producing a smaller and lighter kernel whose surface is shrunken and convoluted.

(2) Stunted plants. These plants are strikingly smaller than their normal sibs.

(3) Aleurone layer abnormalities. The aleurone pigmentation is not uniform giving a speckled or mosaic pattern. Microscopically many of the aleurone grains are not pigmented but appear as "aleurone ghosts". Large globules, probably fat droplets, are seen in shrunken-floury aleurone tissue but never in normal aleurone.

(4) Aberrant meiotic mechanism. In most sh^{fl} families a varying degree of pollen and ovule sterility has been noted. (4-35 percent aborted pollen is found, the most frequent value being around 14 percent abortion.) Examination of sporocytes of shrunken-floury plants reveals striking meiotic abnormalities in some plants. These include:

(a) Anaphase I: There is no normal anaphase movement. Apparently the chromosomal fibers are not functioning and spindle formation is seemingly absent. The appearance of some distended chromosomal arms suggests the formation of neocentromeres.

(b) Telophase I: This stage is absent since the chromosomes do not move to the poles. No cell wall formation occurs.

(c) Metaphase II: Twenty dyads line up on the metaphase plate.

(d) Anaphase II: The two chromatids of each dyad do not pass to opposite poles but separate slightly when the centromere divides.

(e) Telophase II: Again there is no cytokinesis. Instead of quartets only one large cell with 40 chromosomes is produced. These 4N cells give rise to aborted pollen grains.

Since horny endosperm differs from floury endosperm largely by the amount of protein, since aleurone grains, spindle and chromosomal fibers are proteinaceous, and since the sh^{fl} gene produces abnormalities in these areas, it seemed possible that the sh^{fl} gene is concerned with protein synthesis.

In an attempt to get some quantitative data to support this circumstantial evidence, Kjeldahl determinations for total nitrogen were run on different genotypes from the same ear. The results which follow are average values for three ears:

Genotype	Average kernel weight	percent nitrogen
$Sh_2\_\_Sh^{fl}\_\_$	.200 gm.	2.24
$sh_2sh_2Sh^{fl}\_\_$	.123 gm.	2.75
$Sh_2\_\_sh^{fl}sh^{fl}$	.127 gm.	2.18
$sh_2sh_2sh^{fl}sh^{fl}$	.052 gm.	2.69

These data show that the per cent nitrogen is probably not affected by the recessive sh^{fl} gene. (The increase in the nitrogen percentage for the sh_2 gene, however, is significant and its effect is what might be expected for a gene blocking the carbohydrate pathway.) Although there are indications that protein synthesis is affected by sh^{fl} it produces no effects on total nitrogen. Thus the sh^{fl} gene may act at a relatively late stage in protein metabolism so that the high molecular weight proteins are not produced, yet the per cent nitrogen is unaffected.

The sh^{fl} gene has been located on chromosome 5 near the pr locus; preliminary results indicate a distance of about 15 cross-over units. Linkage data from three-point tests are not yet available. Two modifiers, one dominant and one recessive, have been found which increase the weight of the $sh^{fl}sh^{fl}$ kernels.

Dewayne L. Richardson

2. Heterotic genes in the long arm of chromosome 3.

In 1938 Dobzhansky and Rhoades suggested the use of paracentric inversions as a method of locating genes affecting agronomic characters such as yield. The advantage of inversions in this connection is that all of the loci included within the inverted sector are inherited as a block except for rare double crossovers. A strain homozygous for inversion 3a (see Rhoades and Dempsey 1953) and carrying the recessive $\underline{a}_1$ allele in the inverted segment was crossed to a number of elite inbred lines with the $\underline{A}_1$ allele. The F_1 plants, all heterozygous for $\underline{A}$:$\underline{a}$ and the inversion, were backcrossed by the recessive $\underline{a}_1$ inversion stock. On the F_1 backcrossed ears there was a ratio of 1 colored: 1 colorless kernels. The colored kernels are heterozygous for the inversion and the colorless kernels homozygous for the inversion. The two classes of kernels were planted in a replicated yield test and the grain yield determined. The data from the backcross experiments are given below as are available F_2 data. The kernels from selfed ears of F_1 plants were planted at random in the field without classifying for aleurone color. The F_2 plants were detasseled and intervening rows of an $\underline{a}_1$ tester used as the pollen source. Ears with only colored kernels are homozygous for the chromosome 3 segment from the inbred line, those with half colored and half colorless kernels are heterozygous for the inverted segment, and those with only colorless kernels are homozygous for the inversion. Although these data are from a single year's testing, it is apparent that certain of the inbred lines carry genes in the long arm of chromosome 3 which give a heterotic effect when tested against the same segment in the inversion strain. It is also apparent that other strains lack such heterotic loci.

In 3a yield test--F_2 data

	AA		Aa		aa		"t" value	
	No. ears	Av. Wt. per ear in gms.	No. ears	Av. Wt. per ear in gms.	No. ears	Av. Wt. per ear in gms.	AA vs Aa	AA vs aa	Aa vs aa
I 205	33	98.15	102	148.01	39	153.08	5.6**	4.8**	.6
K 187-2	27	100.96	82	127.35	27	126.18	3.3**	2.6**	.1
C 103	55	135.18	100	142.75	37	126.27	1.0	1.0	2.1*
R 59	44	133.77	98	150.90	40	124.22	2.1*	1.2	4.2**
WF 9	40	121.53	81	130.35	43	125.65	1.0	.5	.6
M 14	53	124.91	99	131.47	39	103.46	.8	2.3*	3.4**
R 4	43	101.95	114	122.90	38	124.42	2.2*	2.1*	.2
Oh 45	46	132.83	81	117.15	38	113.05	1.4	1.7	.5

* significant at 5% level
** " " 1% "

In 3a yield test--Backcross data

	No. reps.	Av. Wt. per rep. in lbs. Aa	aa	"t" value
I 205	4	3.98	3.23	1.3
K 187-2	10	3.82	3.07	2.9**
C 103	16	5.33	5.01	1.3
WF 9	6	3.90	4.23	1.8
M 14	10	4.44	3.93	2.8**
R 4	10	3.96	3.69	1.8
Oh 45	10	4.37	4.08	1.8
Oh 41	10	4.35	4.40	.3
5120 B	6	3.72	3.75	.2
W 26	6	3.68	4.00	1.4
O 7	10	3.63	3.72	.4
R 2	10	4.06	4.05	.1
38-11	10	4.30	4.32	.1
K 4	10	4.50	4.15	1.6

* significant at 5% level
** " " 1% "

M. M. Rhoades and
Chuan-Ying Chao

3. Location of glossy-6 in the long arm of chromosome 3

The data presented below come from crosses in which the pollen parents were heterozygous for Roman's TB-3a translocation and for the genes lg_2 and a_1 which lie distal to the break in 3L.

Constitution of pollen parents: $\frac{3 \quad a \ lg \ Gl}{B^3 \quad A \ Lg \ Gl}$ ^{3B}

The fact that glossy plants occurred in the progeny indicates that gl_6 is also located distal to the break in 3L. Glossy plants are produced following non-disjunction of the B^3 chromosome when the sperm fertilizing the egg nucleus carries no B^3 and the sperm fertilizing the polar nuclei carries two B^3 chromosomes. Thus the aleurone would be colored due to the A gene while the plant should be both liguleless and glossy. The glossy plants arising from kernels with colorless aleurone are due to crossovers between a_1 and gl_6 which place the a_1 allele on the B^3 chromosome. The frequency of glossy plants should be approximately half of the frequency of non-disjunction.

	Gl A	Gl a	gl A	gl a	% gl
gl_6 a_1 X 16367-22	32	73	16	5	16.7
gl_6 a_1 X 17265-12	122	155	29	18	14.5

	Gl Lg	Gl lg	gl Lg	gl lg	% gl
gl_6 lg_2 X 16367-22	19	24	0	7	14.0
gl_6 lg_2 X 17265-12	36	29	0	14	17.7

Ellen Dempsey

4. Neo-centromere formation as the cause of preferential segregation.

The hypothesis has been advanced that preferential segregation in megasporogenesis of a bivalent consisting of a knobbed and knobless chromosome results from preferential orientation of heteromorphic dyads at M II due to neo-centromere formation at A I. To test this hypothesis plants heterozygous for a knobbed and knobless chromosome 9 were backcrossed as the female parent by a knobless strain. The knobless 9 was deficient for the wd locus of McClintock while the knobbed 9 was not deficient for this segment. Plants homozygous for the wd chromosome but possessing a ring covering the deficiency were used as pollen parents. In the backcross progenies all wholly green plants had the knobbed 9 from the female parent while white or green-white striped plants had the knobless wd chromosome from the egg parent. Three different kinds of F_1 plants, all heterozygous for a knobbed and knobless 9, were backcrossed by wd pollen. When plants homozygous for normal chromosome 10 were tested there was a ratio of 659 green: 664 wd; when plants heterozygous for abnormal 10 were backcrossed, the progeny consisted of 2001 green: 1366 wd and when plants homozygous for abnormal 10 were tested there was a ratio of 1040 green: 655 wd seedlings. It is obvious that preferential segregation for heteromorphic chromosome 9 occurs when abnormal 10 is either heterozygous or homozygous. Earlier it had been demonstrated that normal segregation for the R:r locus in 10 occurs in plants homozygous for abnormal 10. If neo-centromeres are the cause of preferential segregation for heteromorphic bivalents other than 10, then off-ratios should occur for such bivalents in the presence of homozygous abnormal 10. The type of segregation found in heteromorphic bivalents should depend only on the presence or absence of abnormal 10 and should be independent of the type of segregation in the chromosome 10 pair. This proved to be true.

M. M. Rhoades

5. Chromosomal control of nucleolar composition in maize.

The composition of microsporocyte nucleoli of maize with different chromosomal constitutions was studied by the analysis of absorption spectra obtained from an ultraviolet microspectrophotometer. The presence of ribonucleic acids (RNA) and proteins in the nucleolus was confirmed by the presence of two broad and overlapping absorption peaks around 2637A and 2800A. The former peak was removable by treatment of the tissue sections with cold perchloric acid. The amount of RNA per nucleolus was determined by measuring the absorbance and the diameter and thickness of nucleolus sections at 2637A. Non-specific light loss and absorption due to proteins

were corrected for by the use of blank slides which were subjected to cold perchloric acid extraction. By means of the above technique, the amount of RNA per nucleolus was found to be significantly different in the various strains of maize studied.

The size and the amount of RNA in the nucleolus were found to increase until mid-pachynema and then diminish and finally disappear at late diakinesis. The increase in volume was found to lag behind that in the RNA content. This observation, together with the observation that the RNA/protein ratio went down during the same period, was interpreted as indicating that during the growth of the nucleolus the RNA content increases faster than does the protein content, and that the synthesis or incorporation of proteins into the nucleolus is dependent upon RNA. The RNA content of the nucleolus was found to have doubled at some time between mid-leptonema and zygonema, an increase which was thought to be the result of the reduplication of the nucleolar organizer during leptonema.

A linear relation was established between the RNA content of the nucleolus and the number of extra nucleolar organizers present on supernumerary B^6 chromosomes. The extra organizers did not change the RNA/protein ratio of the nucleolus. Extra heterochromatin in the supernumerary B chromosomes was found to increase the RNA content of the nucleolus only very slightly. Extra euchromatin was believed to have no appreciable effect on nucleolar composition since the RNA content of nucleoli from triploid plants, like that of nucleoli from plants trisomic for the nucleolar chromosome, was only three-halves as much as in their respective normal diploid siblings. The entire nucleolar chromosome is probably involved in nucleolus formation since changes in the RNA content, though not in the RNA/protein ratio, were found in plants carrying a translocation involving the nucleolar chromosome.

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1. bp.

We have tested the stock received from the Coop labeled as bp. As it had colorless pericarp, it was crossed with red pericarp. A brown was extracted but it shows no linkage with waxy or chrunken in Chromosome 9. We would particularly like to obtain some known stocks of bp with which to test this anomalous bp stock.

2. Directed segregation tests - KYS.

The tests for directed segregation are being continued thus far with no very promising leads. In the tests with a stock of KYS inbred there is no directed segregation; but there is segregation for an ms which is linked with the translocation tester. In addition to the partial sterility due to the translocation, there is also segregation for a class with less starch but of nearly normal size. Plants having the latter type and no sterility due to translocation have normal ears.

A possible explanation of the segregation is the following: The translocation stock is assumed to carry the genes Ms (dom. male sterile) S^{ga} (inhibitor of male sterility) reported by Baumann (Abstract Agron. Meetings 1953, p. 79), and Kys is ms s. The cross was: (Translocation ♀ x Kys) x Kys. The segregation of 3 fertile:1 male sterile is expected if the translocation stock introduced a type of cytoplasm which permits the expression of male sterility. The results indicate one of the factors is linked with the T6-9^b translocation, and is therefore in chromosome 6 or 9.

3. Location of bm_4.

The data from several tests are:

X	y	XY	Xy	xY	xy	Total	% recomb.
T1-9b vs bm_4 bkc.		109	15	13	91	228	12.3
T6-9(C23) vs bm_4 bkc.		92	20	17	64	193	19.2
Bm_4	bk F_2	293	106	112	27	538	44

Limited and very unsatisfactory data from a test with White-Capped (Wc) show fairly close linkage. In earlier News Letters Wc-bk_2 showed 32% recombination (News Letter #21 p. 36), and Langham reported 15% recombination between wx and bk_2 (News Letter Mar. 5, 1940, p. 21). The probable order of the genes is wx—15—bk_2—32—Wc—bm_4.

44

4. Tests with unlinked characters.

F_1 tests between a crinkly-leaved dwarf and TB1a show it to be in the long arm of chromosome 1. It has not been tested for allelism with br. In using the TB tranlocations to locate genes, it should be noted that if the F_1 tests are negative, an F_2 will determine if the gene is in the non-translocated portion, if not too far away from the break.

Several new characters are being tested for linkage with T2-6a and T2-6d. These test the long arm of chromosome 2 and should test the entire

chromosome 6. An expanded tassel glume character, a narrow-leaved many-tillered character, and midget show no linkage with either of these translocations. Earlier tests had indicated midget might be in chromosome 6.

5. Sources of Fertility restorer genes.

Several of the exotic stocks have been crossed on the Texas ms. The Maiz Chapaloti and Argentine pop restored fertility completely; Long Ear Papago gave a few fertiles, but most were sterile; Zapahita Chica, KYS, and strawberry pop gave completely sterile F_1's.

6. Studies of chromosome segregation.

During the building of stocks for the genetic part of the study, it was found that a homozygous stock of T5-6c shows independence of ys and v_2. This places v_2 in the short distal segment of the long arm beyond the knob and beyond the translocation break point which is at .9.

Among a group of translocations with either or both interstitial segments long was one which gave an exceptionally high value for adjacent-2 segregation, 17.4% in place of an average of 3.2% for the eight others, (Genetics 35:446-481, 1950).

This, T6-8a, has been backcrossed to normal stocks. These semi-sterile plants have low values of adjacent-2 segregation, an average of 6% with a range from 3 to 9%.

7. Tester set of translocations to mark all chromosome arms.

Dr. Longley furnished additional information on the positions of the breakage points of the translocations being used. A few translocations with breakage points in better positions have been substituted. The series crossed with inbred A188 (medium maturity) has been backcrossed for several generations. Dr. M. T. Jenkins is using the series on A188 and is making the final backcrosses. The series has been crossed with A201 (early) but has not been backcrossed. The series was crossed also with M14 as a late line, but that line seems to have certain undesirable characters. Line W22 was grown last summer and the series has been crossed with it.

C. R. Burnham, E. Clark, Mr. M. S. Ramloo aided in the note-taking.

8. Linkage tests with other characters.

Fired - This character is evident as whitish or yellowish white spots on the leaves in the 2-3 leaved stage in corn seedlings. Some plants die in the early seedling stages. In the surviving plants the character

continued to show until mature. The X^2 test for independence showed linkage with red vs. green base color and with aleurone color, but the results need further confirmation.

A second fired character from another stock showed no linkage with sugary or with yellow vs. pale endosperm.

M. Aslam

Zebra ($\underline{zb_1}$) - This zebra is quite variable in expression. In some plants it was evident at an early stage, in others at about the 4-5 leaf stage. The character is evident as characteristic pale whitish transverse stripes on the leaves, usually quite apparent on leaves well-advanced in growth.

The linkage test with $\underline{na}$ and $\underline{ts_4}$, showed no evidence of linkage in F_2, the recombination values being 0.441 ± .032 for $\underline{ts_4}$ and $\underline{zb_1}$ and .51 ± .035 for $\underline{na}$ and $\underline{zb_1}$. A recombination value of .21 ± .021 was observed between $\underline{na}$ and $\underline{ts_4}$.

Linkage also seemed to be lacking between this character and endosperm color, aleurone color, and basal color of the plant.

M. Aslam

9. Abnormal germ position.

In an F_7 inbred line from the breeding program here at Minnesota, 20-35% of the kernels on the ears have their germ in an abnormal position; i.e. the germ face is toward the butt rather than the tip of the ear. The percentage is variable. The character is being studied in reciprocal crosses, F_2 and backcrosses. The study is not completed but the character seems to be inherited in a relatively simple manner; i.e., with one or possibly two major factors being involved. As might be expected, it behaves as a maternal plant character as shown by the results of the following crosses:

A188 x abn. germ = normal (7 crosses)
abn. germ x A188 = 25.6% (avg. of 6 crosses)
(abnormal germ x A188) x abn. germ = all normal ears
abn. germ. x (abn. germ. x A188) = ears with abnormal germ positions

Another inbred line from Dr. F. S. Warren, Central Experimental Farm, Ottawa, Canada, has a similar character but in a much higher frequency, 92% of the kernels on the ears show it. It gives a similar behavior in reciprocal crosses. Crosses with my stock show that it is due to different factors. F. G. Brieger in the 1948 Corn Genetics Cooperation News Letters No. 22, reported a similar character.

Gertrud Joachim

10. Waseca stripe

This character was first reported in the Corn News Letter 27, 1953. Data from linkage tests follow:

	R++	R+w*	Rg+	Rgw	r++	r+w	rg+	rgw	
1. 168-7	41	8	6	-	6	12	23	10	106
2. 168-6x7	67	14	12	1	12	21	37	23	187
3. 168-12x 153-18	96	23	8	1	21	61	10	37	257
4. 168-3 x 153-17	103	32	10	4	16	60	18	53	296

*w = stripe

$$168 = \frac{R++}{rgw} \qquad 153 = \frac{rgw}{r+w}$$

	% Crossing Over		
	Rr vs. Waseca stripe	Rr vs. Golden	stripe vs. golden
Cross 1	30.5-31.0	18.5-19	indep.
" 2	30.0	20.5-21.0	48.5-49
" 3	21.4	17.0-18.0	30 -31%
" 4	23.6	15.0-16.0	32 -33%

The order of the genes appears to be g___R___stripe. Some of the crosses are segregating for A_3 also.

G. Joachim and
C. R. Burnham

Crosses have been made with the navajo, stippled, marbled and mottled patterns (probably alleles of R), for an allelism study.

C. R. Burnham and
G. Joachim

11. Big ring studies.

We now have a homozygous stock which gives a ◎10 when crossed with normal. It was produced by X-raying the homozygote for a ◎8.

The other method, building larger rings by planned intercrosses is making some progress. A number of different homozygous stocks have been produced which give a ◎6 in crosses with normals. Intercrosses have been grown, and what appear to be the desired crossovers will be tested this summer.

The suggestion of Nishimura and Kurakami is that a combination of smaller rings may be usable. This should be attainable earlier than a ring including all the chromosomes. In corn, plans are set up to produce a ⑩10 + ⑩10; also ⑩10 + ⑥6 + ④4 first; although the final goal is the complete ring.

A ring of 8 has been obtained in barley as a chance result of a cross.

C. R. Burnham

12. A method of avoiding some of the high sterility during the process of building the rings.

In this method the different crossovers needed are selected in a series of crosses, all of which may be in progress more or less simultaneously. If the needed crossovers are obtained, the combinations finally required can be obtained by segregation without further crossing over.

The feasibility of this method for producing large chromosome rings at will, by chromosome segregation from intercrosses of permanent ring stocks that have a common translocation (2-3d/2-4b x 2-4b/4-8a ---- 2-3d/2-4b/4-8a), is being tested. The homozygous permanent ring of six 2-3d/2-4b previously isolated by Burnham was crossed with a multiple translocation stock of 2-4b/4-8a believed to be a heterozygous permanent ring of six. Test crosses will be made this winter with standard normals and the progeny will be examined cytologically next summer for a ring of eight.

A search is in progress for a permanent ring of 4-8a/8-9b in order to utilize another permanent ring of six previously isolated by Burnham 8-9b/9-10b to build a ring of twelve. (2-3d/2-4b/4-8a/8-9b/9-10b)

Should the proposed method be successful it is planned to reduce the problem of high sterility associated with the production of large chromosome rings by intercrossing stocks with as many translocated chromosomes in common as possible. Theoretically, the F_1's of all the following should cytologically be two rings of four.

2-3d/2-4b x 2-4b/4-8a.
(2-3d/2-4b/4-8a) x (2-3d, 4-8a/8-9b)
2-3d/2-4b/4-8a/8-9b x (2-3d/2-4b, 8-9b/9-10b)

Theoretically, chromosome substitution lines might be produced by the use of big rings. As an example chromosome 5 from inbred B might be substituted in inbred A as follows:

Cross both inbred A and inbred B with a homozygous stock with chromosomes 1-2-3-4-5 in one ring and chromosomes 6-7-8-9-10 in another ring. Self and isolate from the progeny of the F_1 of inbred A a plant

homozygous for the ring 6-7-8-9-10 and the normal chromosomes 1,2,3,4,5. Similarly isolate a plant from progeny of the inbred B F_1 homozygous for ring 1-2-3-4-5 and for normal chromosomes 6-7-8-9-10. Intercross and then self the selections from inbred A and inbred B and recover a synthetic inbred composed of the normal chromosomes 1,2,3,4,5 from inbred A and the normal chromosomes 6,7,8,9,10 from inbred B. Similarly by using a stock homozygous for chromosomes 1-2-3-4-6 in one ring and 5-7-8-9-10 in another ring with the synthetic inbred and inbred A the desired substitution of chromosome 5 from inbred B into inbred A might be achieved.

L. L. Inman

13. Pollen restoration.

When crossed with cytoplasmic male-sterile inbred $B8^t(BC_5)$, Minnesota inbred A293 completely restored fertility in the single cross. Plants from the cross of $B8^T$ and inbred A73 were completely sterile. All progenies from the cross of $B8^T$ x (A293 x A73) segregated 1 sterile: 1 fertile. Of the two groups of progenies resulting from crosses of $B8^T$ x individual (A293 x A73)A293 plants, the first had all fertile plants and each progeny of the second group segregated 1 sterile:1 fertile. Progenies derived from crosses of $B8^T$ x individual plants of the backcross (A293 x A73)A73 were also in two groups. The first group had only sterile plants and each progeny of the second group segregated 1 sterile:1 fertile. Three groups of progenies were obtained from crosses of $B8^T$ x individual F_2 (A293 x A73) plants in the ratio of 1 (all sterile):2 (seg. 1:1):1 (all fertile).

Crosses of the same plants of A293, A73, their F_1, both backcrosses, and the F_2 to $A158^S$ (U.S.D.A. source) gave results which were entirely different. These data apparently do not fit any simple genetic ratios.

Results from crosses involving $B8^T$ fit the hypothesis that segregation occurred for one factor pair. Brunson (Maize Newsletter #28) reported Ia. 153 carries two complementary factors for restoration when crossed to $WF9^T$. Since A293 has Ia. 153 as one of its parents, their genotypes may be AABB. If the genotype of $B8^T$ is aabb, then the genotype of A73 should be aaBB. If $B8^T$ has the genotype of aaBB, A73 may be aaBB or aabb. Duvick (Maize Newsletter #28) found a similar case with K4 and WG3 and suggested that the genotype of $WF9^T$ is aabb.

Owen J. Newlin and
E. H. Rinke

The inheritance of some factors which restore pollen shedding to plants that contain the Texas source of cytoplasmic male sterility is being studied. Inbred line A293 gives complete pollen restoration in the F_1 in the crosses studied. The F_2 segregation is in the following table.

	Fertile	Sterile	Total
*(B164^T x A293)F2	343	101	444
(A73^T x A293) F_2	356	114	470
(Oh5^T x A293)F_2	328	111	439
(Os420^T x A293)F_2	280	80	360
Total	1307	406	1713

*The (B164^T x A293)F_2 data were obtained in 1953, the other data were from 1954.

The data indicate that a single factor is segregating. F_3 data of the (B164^T x A293) cross further substantiate the single factor hypothesis.

Crosses of (B164^T x A293) and translocation linkage testers were made to determine the location of the restoration factor. Crosses are also being made between the A293 source of restoration and other sources of restoration to see if they are identical.

Note: B164^T, A73^T, Oh5^T and Os420^T are all in a heterozygous condition in various stages of backcrossing.

A293 is an inbred line derived from the single cross (L317 x A344). A344 is a Minnesota "within line" selection of Ia. 153.

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1. Structural and functional variability in A^b complexes.

The order of alpha (pale-acting) and beta (purple-acting) elements of the closely linked complex constituting the original A^b (Ecuador) is centromere-alpha-beta. Studies based on the crossover derivatives from special, marked heterozygotes carrying A^b and particularly from marked homozygous A^b plants indicate that alpha and beta, or the segments in which they reside, are members of an adjacent duplication in which the genetic materials are ordered in the same direction (tandem, serial duplication).

Similar studies have been made of three A^b alleles of Peruvian extraction, here designated A^b:P. Analyses of the pale or dilute derivatives from marked A^b:P/a plants indicate that (1) the alpha member of this complex is associated with a more dilute phenotype than is the alpha of the original A^b complex, and (2) the sequence of constituent members, centromere-beta-alpha, is the reverse of that in the original A^b. The crucial test of the hypothesis of differing sequence in these two A^b complexes is afforded by an analysis of the alpha derivatives

from marked $\underline{A}^b$ /$\underline{A}^b$:P heterozygotes. Twelve dilute derivatives whose origin was associated with crossing over were obtained from this background and all twelve isolated strands carried the same recombinant condition for the markers thus confirming the changed order of alpha and beta in the two complexes.

The finding that $\underline{A}^b/\underline{A}^b$:P heterozygotes, as well as heterozygotes of these complexes with the same recessive a, yield wholly functional gametes carrying the alpha derivatives on crossover strands indicates that the only complex is not simply a gross inversion of the other. Rather it suggests that the members of the duplication have exchanged position while retaining the serial order of the duplication as a whole. Changed sequence of members of a serial duplication would be expected if the members retain homology and synaptic equivalence and thus may be expected to engage in oblique synapsis. Evidence for the latter is available from homozygous $\underline{A}^b$ individuals which are found to yield alpha derivatives in association with crossing over.

2. Retention of sugars after harvesting.

Previous studies on the carbohydrates of normal, sugary, shrunken-2 and sugary-shrunken-2 kernels suggest that the shrunken-2 factor blocks starch synthesis in endosperms at an earlier biochemical step than that associated with the su factor. In particular, it was noted that $\underline{sh}_2$ endosperms have a low dextrin content whereas sugary endosperms have long been known to accumulate excessive amounts of water soluble polysaccharides. If, as supposed, the $\underline{sh}_2$ gene represents a partial block prior to the formation of dextrins it would be anticipated that endosperms carrying this factor would show a greater retention of sugars after harvesting than sugary endosperms in which sugars may be changed readily to dextrins.

Preliminary studies on sugar holding capacity have been carried out with kernels on ears of self pollinated plants of three genotypes: susu ShSh (F_1 of a well known sweet corn variety), SuSu $\underline{sh}_2\underline{sh}_2$, and the double recessive susu $\underline{sh}_2\underline{sh}_2$. The results must be considered as suggestive only since the material studied was not related and is subject to background differences due to modifiers.

Ears of the several types were harvested at 18 days after pollination. Each was cut lengthwise into quarters and these were held for varying periods at room temperature under conditions to prevent loss of moisture, after which they were placed in dry ice and removed to the freezer. Analysis of dry kernel weights indicated that loss of weight during the first 16 hour period was negligible. Analyses of total sugars expressed as percent of dry kernel weight are given in the table below.

Genotype	Hours after harvesting 0	16	24	48	Percent loss of sugars over 48 hour period
susu ShSh (1)	21.9	14.5	12.3	8.4	62
susu ShSh (2)	25.1	18.2	15.4	7.9	69
SuSu shsh	38.5	35.1	33.6	30.9	20
susu shsh	43.8	40.7	----	39.5	10

John R. Laughnan

3. Similarity of M and Ac Mutator Systems.

As reported in the 1954 news letter bz_2^m was found to mutate in the presence of a separate factor M. Furthermore the behavior of the bz^m-M combination was found to resemble McClintock's Ds-Ac system. Experiments have been conducted to determine whether bz_2^m will respond to Ac and whether M will activate Ds. In the trial made to test the first of these two points, a bz^m m stock was crossed to an Ac stock and backcrossed to bz^m m. Half of the pale (bz bz bz) seeds on the resulting ears had typical full colored Bz sectors just like those seen when M and bz^m are present. The second test consisted of crossing bz^m bz^m, m m and M m plants by a homozygous Bz_2, I Ds ac stock. The m m plants crossed in this fashion produced ears with all colorless stable seeds while the Mm plants yielded ears with half colorless stable seeds and half colorless sectorial seeds of the type commonly produced when an I Ds stock is crossed by Ac.

It is quite clear the Ac does activate bz_2^m just as does M and that M activates Ds just as does Ac. In many other respects Ac and M are so similar that it is concluded that they must be closely related or perhaps identical systems. The independent reporting of Ds-Ac, P^{rr}-Mp and bz_2^m-M systems all with strikingly similar characteristics along with the observations of other similar cases in this laboratory leads to the conclusion that this type of behavior is quite prevalent in maize and had long been overlooked until Dr. McClintock's initial discovery.

4. The Effect of Dt on Mutations of A_1 to a_1

The effect of the gene Dt on a_1 has long been known but its relationship to the mutational behavior of the dominant allele A_1 has not been adequately reported. To determine whether or not Dt causes A_1 to mutate to a_1, a particular A_1 allele (A:D2, which arose from a through the action of Dt) was tested for its mutation rate in homozygous Dt and dt cultures. The test consisted of crossing AA Dt Dt and dt dt cultures by an a dt pollen stock and examining the resulting ears for colorless (a a a) seeds. The data are shown below in table 1.

Table 1. Mutation of A:D2 in Female Germ Cells

Dt. Const.	Gametes Tested	Mutants
Dt Dt	56,000	19
dt dt	21,000	0

Another experiment was conducted to determine the effect of Dt on the frequency of colorless aleurone sectors on the colored Aaa seeds which were produced from crossing of homozygous a sh_2, Dt and dt by homozygous A Sh_2, Dt and dt. These crosses provided ears whose seeds had no Dt, Dt in the female parent, Dt in the male parent, and Dt in both parents. The sh_2 marker was added to permit recognition of losses due to chromosomal aberrations. Mutations of A:D2 to a should not be accompanied by changes of Sh to sh. The frequency of sectors indicating the loss of A Sh, A, and Sh are listed in table 2. Sectors including 1/8 of the seed surface or larger were scored.

Table 2 Mutation of A:D2 Expressed as Aleurone Sectors

Parents	No. of Seeds	Sectors, 1/8 seed or larger		
		a sh	a Sh	A sh
a sh Dt x A Sh dt	10,219	56	9	1
a sh Dt x A Sh Dt	1,550	7	2	1
a sh dt x A Sh Dt	5,650	48	2	3
	17,419	111	13	5
a sh dt x A Sh dt	34,604	178	2	3
Total Cases	52,023	289	15	8

The data from Table 1 and 2 clearly show that Dt does have a marked effect on the frequency of mutant changes of A to a both in female germ cells and in the aleurone. The data from Table 2 also show (1) that there is a remarkably high frequency of simultaneous losses of A and Sh (289) compared to the losses of either A (15) or Sh (8) alone. These simultaneous cases may be interpreted as actual losses of a chromosome segment including both A and Sh, while the single changes probably represent actual mutational changes and perhaps very small deficiencies, (2) That Dt, while strongly influencing the mutation frequency of A alone, has no significant effect on the coincident losses of A and Sh. If these coincident losses can be taken as deficiencies arising from chromosome breakage one can conclude that Dt causes A to mutate to a but by a mechanism which does not alter the frequency of spontaneous chromosome breaks in the chromosome region to the left of A.

5. Dosage effect of multiple Dt Loci

The gene, Dt_1 produces an exponential like increase in mutational events (dots) at a when its dosage is increased from 1 to 3 in the endosperm. Since the discovery of Dt_2 and Dt_3, both of which closely resemble Dt_1, it has been possible to produce seeds with doses of Dt ranging from 1 to 9. Dot counts of seeds produced by the combination of Dt_1 and Dt_2 and,

therefore, with doses ranging to six have been made. The data show that any increase above 3 still causes a sharp rise in the frequency of dots but it is not clear that this is an exponential increase. Counts of seeds with 7 or more doses are not technically practical with the present stock. However, it is clear from observation that the higher-dose seeds do have more dots than lower-dose seeds.

6. Peculiar Mutational Behavior at the A_1 Locus

When a_1 mutates in the presence of Dt it may give rise in a single step to any one of a graded series of A_1 alleles, which differ from each other in a simple linear fashion. This series ranges in strength of pigmentation from the full purple, recessive red pericarp (A^r) type down to the dilute purple, recessive brown pericarp (A^{lt}) type. The native North American A^r alleles fit into this series. There is, however, a group of alleles derived from or related to the complex allele A^b from South America that are non linear and differ from the previously mentioned group in that they express a dominant brown pericarp. One of this group, an allele designated a^{pm}, and described as having pale aleurone, red-brown plant and a dominant brown pericarp color, has proved to be mutable. It mutates in somatic and germ cells to the full colored dominant (A) form. A test of 15 of these A mutants showed that 14 were of the full color, red pericarp A^r type and one was a full color, dominant brown pericarp (A^b) type. Several were unstable in that they frequently reverted back to the a^{pm} type.

The surprising thing about this behavior is the apparent single step change of the recessive pale, dominant brown pericarp allele (a^{pm}) to the dominant purple, recessive red pericarp allele (A^r). This is actually a simultaneous change of dominant to recessive in one aspect of the expression of the locus and recessive to dominant in the other. Such behavior is not consistent with conventional ideas about mutation of single genic units either as separate loci or as members of a compound locus.

M. G. Nuffer

7. Spontaneous aberrations in male gametes.

Spontaneous aberrations were found in chromosome 10 by means of selecting colorless seeds from the cross of $r^g\ r^g$ X $R^r\ R^r$. The colorless seeds consisted of two types, (1) colorless seeds with plant color, designated r^r and (2) colorless seeds lacking plant color, designated r^g. The latter class was saved for cytological analysis since the r^r seeds commonly represented a mutation of R^r to r^r. Three stocks were used, one possessing the heterozygous abnormal knob 10 (K/k), one carrying the homozygous knob 10 (K/K), and one lacking the knob (k/k).

In 108,466 gamets tested from plants of the R^r K/R^r k constitution, 106 colorless seeds were observed. The 106 colorless seeds produced 79 r^r seedlings, two variegated plants, and 18 r^g seedlings. Six seeds did not germinate and one colorless seed was not tested. The r^r seedlings were discarded; thus the number of r^r plants was not a true indication of the spontaneous mutation frequency since confirmatory tests were not made.

Mutants secured from male gametes are always suspected of being contaminants and need to be tested for the presence of specific contamination markers.

The variegated and $\underline{r}^g$ plants were saved for cytology. Among the 18 $\underline{r}^g$ plants, the following cytological alterations were found: 13 terminal deficiencies; one deficiency translocation; and one plant with a normal knobbed-10 chromosome. Three of the $\underline{r}^g$ plants were not samples cytologically but one plant showed 50% aborted pollen at maturity. No pollen samples were obtained from the other two $\underline{r}^g$ plants. The two variegated plants both possessed normal knobbed 10 chromosomes. The three plants with the normal knob have not been tested for contamination.

In this same experiment, one male culture was used which was homozygous for knob 10 in some plants and heterozygous for knob 10 in others. Among 33,896 gametes tested from this culture, 34 colorless seeds were found of which 25 were $\underline{r}^r$ and five were $\underline{r}^g$. Four seeds did not germinate. Three of the $\underline{r}^g$ plants were analyzed cytologically. The examination showed one terminal deficiency, one interstitial deficiency, and one normal knobbed-10 chromosome.

In plants of the $\underline{R}^r$ $\underline{k}/\underline{R}^r$ $\underline{k}$ (knobless 10) constitution, 87 colorless seeds were found in 42,635 gametes tested. The 87 colorless seeds included 69 $\underline{r}^r$ plants and 13 $\underline{r}^g$ plants one of which died in the seedling stage and one died before maturity. Five colorless seeds did not germinate. The 11 $\underline{r}^g$ seedlings included six terminal deficiencies, one with the entire chromosome 10 missing, and four with normal knobbed-10 chromosome. These four plants exhibited normal pollen but were not tested to exclude contamination.

The alterations which were observed in the heterozygous and homozygous knobbed-10 stock could be attributed to (1) failure of terminalization of a chiasma since a large subterminal knob was present; (2) breakage as the result of precocious movement of the knob to the poles at anaphase (Rhoades, 1952); or (3) presence of a small inversion in the region distal to the $\underline{R}$ locus in the knobbed-10 chromosome.

The deficiencies that have occurred spontaneously in the homozygous knobless 10 chromosome could be due to the failure of terminalization of a chiasma. The other processes mentioned in connection with the heterozygous knob 10 would not account for deficiencies occurring in a knobless stock.

(Rhoades, M. M. 1952 Preferential Segregation in Maize. Heterosis, Iowa State College Press 66-80.)

8. Spontaneous Trisomes for Knob-10 Chromosome.

Six triplo-10 plants were found among 11,424 seedlings carrying the heterozygous knob 10 chromosome (designated, $\underline{K}$ 10). In 33,599 plants homozygous for the knobless 10 chromosome (designated, $\underline{k}$ 10), the trisomes were absent. These six cases originated in $\underline{g}$ $\underline{R}^g$ $\underline{K}/\underline{G}$ $\underline{r}^r$ $\underline{k}$ and

C R^g k/g r^r K cultures which were tested for the possibility of crossing-over between the seed and plant color elements of the R^r locus (J. L. Hahn, unpublished). The trisomes were phenotypically R^r and thus were detected as presumed cross-over types. When the six R^r plants were back-crossed by an r^g tester stock, the expected ratio of 1 R^r/r^g: 1 r^g/r^g was not obtained but instead four classes were recovered, R^r, R^g, r^r and r^g. Cytological examination showed that each of the six R^r plants was trisomic for chromosome 10.

Since the trisomic frequency was high in the heterozygous K 10 cultures, it was suspected that the frequency might be greatly increased in the homozygous K 10 progeny. Among 806 seedlings examined from the cross of C R^g K/ g r^r K X g r^g k/g r^g k, 10 R^r plants were found one of which died in the seedling stage and one gave a poor cytological specimen. The following cytological alterations for chromosome 10 were found so far in the eight remaining R^r plants:

Total No. sdgs.	No. of R^r	Iso-chromosomes	Trisomes From Root Tips	Trisomes From Pachytene	Died	Cyto.
806	10	2	2	4	1	1

A possible mechanism to account for the unexpectedly high frequency of trisomes in the presence of knob-10 is failure of terminalization of a chiasma at meiosis. It is noteworthy that three of the six trisomes from the heterozygous knob-10 series indicated crossing-over between R and C, the C locus being 14 units from R. In the homozygous knob-10 series, four of the eight R^r plants were crossovers for C. This does not exclude the possibility that crossing-over did not occur in the other cases since the stocks were not marked for the detection of crossovers proximal to C.

9. Altered Knob-10 Chromosomes.

Several altered knob 10 chromosomes have been produced presumably as cross-over products from an X-ray induced ring-10 in compound with a rod chromosome. The original ring chromosome included nearly the entire knob 10 chromosome. The break points must have occurred close to the end of the short arm of chromosome 10 and in the knob itself, leaving about two-thirds of the knob intact. The stable rod chromosomes produced from this ring included the following types of altered knob chromosomes: one lacking the knob but possessing the dissimilar chromomere pattern distal to R; one with the knob in a terminal position; two with the knob located interstitially on the long arm; and another with the knob located on the short arm of chromosome 10.

Another altered knob 10 chromosome originated spontaneously from a normal knob 10 chromosome. This chromosome possesses an elongated knob 10, approximately twice as long as the normal knob. The knob, however, is considerably reduced in width.

Tests of preferential segregation are being made for each of these altered knob 10 chromosomes.

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1. Centrifugal fractionation of corn shoot preparations with respect to various enzyme activities.

Homogenates, in unbuffered mannitol solution, of etiolated shoots of corn (L289 x I205 and Krug) were subjected to centrifugation at approximately 40,000 x g for 20 minutes, using a Spinco model L refrigerated ultra-centrifuge. The sediments and supernatants from this centrifugation were compared with the original homogenates with respect to the activities of catalase, cytochrome oxidase, peroxidase, phosphatase, and polyphenolase. Results of a typical set of determinations are presented in table 1. It is apparent that the sedimented fraction accounts for most of the catalase, cytochrome oxidase, and polyphenolase activities of the original preparation, indicating that under the conditions used, these activities are primarily associated with cytoplasmic particles of some sort. The supernatant fraction, on the other hand, accounts for most of the peroxidase and phosphatase activities of the original homogenate. It follows that if these two activities are associated with cytoplasmic particles, such particles are not readily sedimented under the conditions of this experiment.

Table 1. Distribution of enzyme activities following high speed centrifugation of a preparation of 5-day etiolated shoots of Krug corn.

	Percentage of total activity			
Type of activity	Original homogenate	Sediment	Supernatant	Sum of sediment and supernatant
Catalase	100	69	21	90
Cytochrome oxidase	100	83	0	83
Peroxidase	100	24	69	93
Phosphatase	100	8	93	101
Polyphenolase	100	66	28	94
Protein nitrogen	100	37	59	96

F. A. Haskins

2. Effect of seed irradiation on the activities of various enzymes in corn.

Seeds of the single cross hybrid, L289 x I205, were irradiated with X-rays or thermal neutrons at the Brookhaven National Laboratory. The following dosages were used: X-rays-- 4,000, 10,000, 40,000, and 80,000 roentgen units; thermal neutrons-- 5.3×10^{12}, 7.8×10^{12}, 16.1×10^{12}, and 23.3×10^{12} neutrons per square centimeter. Preparations of embryos, etiolated shoots (excised at the scutellar node), and green seedlings

(excised at the coleoptilar node) from control and irradiated seeds were assayed for catalase, cytochrome oxidase, peroxidase, phosphatase, and polyphenolase activities. In the assay of embryo preparations, no appreciable differences were noted among the treatments. Similarly, the experiments with etiolated shoots failed to disclose any striking differences in enzyme activity between irradiated material and controls, although it appeared that there was some tendency for the polyphenolase activity of shoot preparations to increase with increasing dosage of thermal neutrons. In the work with green seedling preparations, however, marked differences were found between control seedlings and seedlings grown from irradiated seeds. From the data presented in table 1, it appears that irradiation-induced height reduction is associated with increased activities of catalase, peroxidase, phosphatase, and polyphenolase in the seedling preparations. The full significance of this observation is not known, but it does seem clear that there are differences in certain types of enzyme activity between irradiated and control treatments.

Table 1. Specific activities of five enzymes in preparations of 10-day green seedlings grown from control and irradiated seeds of L289 x I205 corn.

Seed treatment	Seedling height (mm)	Specific activity[a]				
		Catalase	Cytochrome oxidase	Peroxidase	Phosphatase	Polyphenolase
Control	260	24	0.61	31	1.6	2.1
5.3 x 10^{12} N_{th}/cm^2	250	23	0.55	39	2.0	2.7
7.8 x " "	225	24	0.60	39	2.0	4.2
16.1 x " "	138	25	0.67	53	2.2	5.4
23.3 x " "	42	61	0.71	169	4.1	8.9
4,000 r X-ray[b]	108	34	0.52	59	3.0	10.0

[a]Specific activities are expressed in the following units per min. per mg. protein N:

catalase--micromoles H_2O_2 destroyed
cytochrome oxidase--micromoles cytochrome c oxidized
peroxidase--increase in optical density at 460 mμ
phosphatase--micromoles p-nitrophenol liberated
polyphenolase--increase in optical density at 410 mμ

[b]This was the only one of the X-ray treatments in which sufficient seedling material was obtained for enzyme assays.

F. A. Haskins

3. Studies on the expression and transmission of s^{ga} in Kys male sterility.

In 1952 a study was begun to transfer the cytoplasmic-genic type of male sterility found in the strain Kys to several inbred lines. Crosses were made between Kys ♀ mm s^{ga} s^{ga} and M_{14}, N_6, 38-11, 187-2, Hy_2 and WF9, all of which should have the genotype ♀ MM$S^{ga}S^{ga}$. In 1953 the F_1 plants were backcrossed as females to the respective lines and the progenies were grown in the field in 1954. They would all be expected to carry the cytoplasmic factor for sterility but would segregate 1 MM$S^{ga}S^{ga}$: 1 MM$S^{ga}s^{ga}$: 1 Mm $S^{ga}S^{ga}$: 1 Mm $S^{ga}s^{ga}$, and the $S^{ga}s^{ga}$ plants should have 50% partially filled pollen (see Bauman, Maize Newsletter 28:51, 1954). Each of the six progenies segregated for plants having 50% partially filled pollen, but in varying ratios as shown in Table 1. The expression of s^{ga} as partially filled pollen in $S^{ga}s^{ga}$ genotypes seems to vary with the line background, although the numbers are rather small in each progeny.

Table 1. Segregation of plants having filled pollen ($S^{ga}S^{ga}$) and 50% partially filled pollen ($S^{ga}s^{ga}$) in the first backcross progenies from crosses between Kys male sterile and each of six inbred lines.

	Number of plants having		
Line involved	Filled pollen	50% partially filled pollen	50% small pollen
WF9	20	2	4
38-11	7	13	4
Hy 2	12	13	0
N6	13	13	3
187-2	13	8	0
M14	19	6	1

Where possible, plants having 50% partially filled pollen were selected for the second backcross to the line. The silks of the ear shoots on these plants were divided, and roughly half the silks were pollinated with a Kys ♂ mmssACRPr stock to test the condition of the M gene. The other half of the silks were pollinated a day or two later with the appropriate line. At maturity the purple seeds from the cross with the Kys tester stock were separated from the colorless aleurone seeds resulting from the cross with the line, although some difficulty was encountered with the expression of purple aleurone. The progenies of these crosses are being grown in the greenhouse to test and use the appropriate genotypes in the third backcross to two of the lines, WF9 and 38-11.

In order to test the functioning of s^{ga} pollen in competition with S^{ga} pollen, F_1 plants from crosses involving the lines WF9 and M14, and having the genotype ♂ MmS^{ga} s^{ga} were self-pollinated in the greenhouse, using pollen sparsely in an attempt to get one pollen grain per silk. The functioning of s^{ga} pollen would be indicated by the occurrence of male sterile plants in the F_2 progenies with a frequency of 1 in 5 or less.

In 1954 23 F_2 progenies were grown in the field and, of 891 F_2 plants, 856 were classifiable for pollen. The remaining 35 plants had broken tassels (corn borer damage) or dried tassels (drought damage).

None of the 856 classifiable plants had sterile tassels. One plant had mainly empty pollen grains, but a few grains were partially filled. Thirty-one per cent of the plants had 50% partially filled pollen. These are likely $\underline{S}^{ga}\underline{s}^{ga}$ genotypes although, even if the $\underline{s}^{ga}$ gametes functioned only through the eggs, there is a significant deviation from the expected 50%. Some of these genotypes may have been missed if they were not always expressed by partially filled pollen as indicated in table 1, or there may be a competitive effect of the $\underline{S}^{ga}$ and $\underline{s}^{ga}$ alleles on the female side. Nine plants had 50% empty pollen and a few plants segregated for small pollen. In view of these results it would appear difficult, if not impossible, to transfer the $\underline{s}^{ga}$ allele of an $\underline{S}^{ga}\underline{s}^{ga}$ plant to its progeny by sparse pollination.

In order to determine whether an $\underline{S}^{ga}\underline{s}^{ga}$ plant lacking the cytoplasmic factor for male sterility would segregate for 50% partially filled pollen, crosses were made between the inbred lines WF9 and M14 as female and the Kys stock. The F_1 plants were grown in 1954 and the pollen classified. Out of 30 plants from the two crosses none showed any segregation for partially filled pollen. It would seem that the cytoplasmic factor for sterility is needed for the incomplete development of $\underline{s}^{ga}$ pollen grains, although tests involving other lines are needed, since WF9 and M14 may give poor expression, as shown in table 1.

Rosalind Morris,
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4. A tasselless phenotype in Maize.

A new maize phenotype has been observed for the past two years. During the summer of 1953 two plants were found which did not develop tassels. These were part of a group of crosses of exotic varieties with Argentine Waxy made by Dr. M. S. Zuber at the University of Missouri. The normal-appearing shoots of the two plants without tassels were pollinated with Argentine Waxy pollen, but only two seeds developed and these were from the same shoot. The plants from these two seeds, which were grown in the greenhouse, developed tassels but one was sterile. The fertile plant was selfed and the sterile plant was outcrossed to a single cross hybrid (940 x WF9). Dr. Zuber sent a few seeds from each plant for testing at the University of Nebraska during the summer of 1954. In the progeny of the selfed plant 6 plants developed out of 10 seeds planted, and these segregated 3 plants without tassels to 3 normal plants. The progeny of the outcrossed seed segregated 2 plants without tassels to 8 normal plants. The plants without tassels appeared normal in other respects, but the stalk ended in a whorl of leaves. Some of

the normal plants had a high percentage of abnormal pollen. Seeds were obtained from both normal plants and plants without tassels and will be planted for further observations.

Benjamin H. Beard

5. Dominance of genes controlling yield in maize.

Gardner, et al. (Agron. Jour. 45:186-191. 1953) outlined a method for estimating the degree of dominance of genes determining quantitative characters in corn and applied the method to two F_2 populations of Southern dent corn. All estimates obtained for yield were in the overdominance range varying from 1.31 to 2.14. Comstock and Robinson (Heterosis. Iowa State College Press. 1952) have shown that linkage of partially or completely dominant genes could result in estimates as large as those observed. Therefore an experiment was conducted in 1954 to determine the degree of dominance of genes determining various quantitative characters in an F_2 population descended from a cross between two corn belt lines. The F_8 population obtained by random breeding over the years was also used in the same manner as the F_2 to determine whether linkage was causing bias in estimating degree of dominance by this method. Results for yield gave an estimate of degree of dominance of only 0.44 in the F_2 generation and 0.63 in the F_8 generation. The amount of dominance variance observed was the same for the two populations but 75 per cent more additive genetic variance was observed in the F_2 population as compared to the F_8. Analyses of data on other quantitative characters have not been completed but all estimates obtained so far are in the partial dominance range.

The degree of dominance obtained for genes controlling yield is somewhat surprising in view of earlier findings in Southern dents using the same method. These results certainly do not appear to support the overdominance hypothesis and there is no evidence of linkage bias in the estimates obtained using this particular population. Since the test planted at Lincoln, Nebraska, was a complete failure because of drouth, data were collected on only one test at North Platte, Nebraska. The interaction of additive genetic effects and of dominance effects with environment could not be estimated and, of course, are included with the genetic effects in the analysis used (See Gardner, et al. cited above). No complete interpretation has yet been given these data and the experiment is being repeated at 2 locations in 1955 using a new sample of progenies.

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1. Concealed variability in South African maize varieties.

To determine the extent of concealed variability in different varieties of maize 25 locally grown open-pollinated commercial varieties including yellow and white dent and flint types, were used. Approximately 100 ears, taken at random in each variety were selfed. These selfed ears were examined and scored for defective endosperm and viviparous kernels. Thirty to forty kernels of each ear were subsequently germinated in the greenhouse and classified for recessive seedling mutants. The remaining kernels were planted in the field and the resulting plants observed for certain mature plant mutant characters.

The frequency of selfed families segregating for various recessive mutants in each of the 25 varieties is given in the table. Generally distinct 3:1 ratios were obtained.

It is interesting to note that the two synthetic varieties contain less concealed variability than the others.

A beginning has been made in testing for allelism of the mutants obtained in different varieties. The virescents of all the varieties were found to be allelic except those in White and Pale Boesman. Most of the glossies appear to be non-allelic. At least two distince loci condition striped seedlings. All the liguleless mutants were found to be allelic. The two lazies were likewise allelic. The dwarfs were transmitted at several different loci.

In the present season additional observations were made. A group of 932 S_1 lines derived at random from the variety Early Potchefstroom Pearl contained the following recessive mutants segregating in 3:1 ratios:

mutant	no. of separate occurrences
tassel-seed	30
male sterile	9
liguleless	3
brachytic	4
fine stripe	4
zebra	1
brown midrib	1

Percentage of S_1 families of different varieties segregating for certain mutants.

Varieties	Mutants											
	virescent seedling	albino seedling	yellow seedling	pale green seedling	glossy seedling	pale yellow seedling	striped seedling	defective endosperm	viviparv	ligueless seedling	lazy	dwarf
Yellow Boesman	2	5	5	5	11	4	3	18	4	1	0	0
Potch. Pearl	0	1	0	0	1	0	1	6	1	0	0	1
Potch. Pearl Early	0	6	0	0	1	0	3	2	0	0	0	0
Wisconsin (Dykema)	1	8	0	2	2	2	3	16	11	2	0	1
Potch. Pearl 14 row	0	3	0	1	1	0	2	3	3	1	0	3
Early King	1	1	0	3	6	2	3	13	2	1	0	0
White Boesman	2	8	0	9	2	3	4	9	0	0	0	1
Pale Boesman	3	7	1	8	16	4	4	10	3	1	0	1
Early Pearl (Mosterd)	0	1	1	7	0	4	4	9	1	0	0	1
Potch. Pearl Synthetic	0	0	0	0	0	1	0	4	1	0	0	0
Wisconsin (Evans)	1	7	1	11	0	7	3	12	4	2	0	1
Anveld Synthetic	0	0	0	0	3	0	2	4	0	0	0	0
Hickory King	0	3	0	1	6	1	3	13	0	1	0	0
Golden Beauty	0	4	5	5	15	9	3	14	2	0	0	0
Anveld	2	1	0	2	3	1	0	3	1	0	0	0
Uys	0	7	0	5	0	3	4	22	0	0	0	0
Peruvian	1	2	0	0	3	5	2	5	0	0	0	0
White Stalk Silver King	0	5	2	3	4	0	2	10	1	0	0	0
American White Flint	3	8	3	8	0	4	3	9	0	0	1	2
Natal 8 row	1	4	1	3	2	4	1	12	0	0	0	0
Mic Success	0	4	0	0	0	6	2	14	0	0	0	0
Hotnot	0	6	1	4	4	4	0	3	0	0	0	0
Teko Yellow	0	2	1	3	3	2	4	8	0	0	0	1
King's Cross	1	1	3	4	1	2	2	11	0	0	1	1
Salisbury White	1	3	0	4	3	4	3	12	0	0	0	0

G. W. Terblanche

UNIVERSITY OF SAO PAULO
Piracicaba, S.Paulo, Brasil

Department of Cytology and Genetics

1. Indigenous races of maize (Brazilian Seed Center).

(A) New collections have been made, but give little new information. The Amazon Basin remains as the main gap, where collecting is extremely expensive and time consuming. Material from the Guianas showed that the coastal area belongs definitely to the region of the Caribean Orange Flints, which extends south, along the coast, to the LaPlata. From the southern margin of the Amazon Basin, new material was obtained of races with interlocked kernel rows, which reduce row number by one half. The absence of a possible original type with regular rows, which should contain from 12 to 26 rows (the interlocked types have from 6 to 13 rows) induces us to suppose, that this racial group with interlocked rows is really a very old one and that interlocking was present in the basic or original type with low row number. Such an "interlocking" is present in two ranked ears of corn and in Euchlaena and Tripsacum, where the alternating alveoli, on opposite flanks are always exactly in the middle between the next higher and next lower alveolus. When selection for higher row number was started by the primitive breeder, this must have been accompanied in most cases by a selection for a larger cob surface, either by an increase in rachis diameter or in rachilla length, while such a selection evidently did not occur in the interlocked group. Thus I consider now the interlocking as an old and primitive character, which explains both its very considerable geographical range and the absence of any limitation to cultivation by Indian tribes or ethnological groups. It should also be remembered, that the region considered as a possible center of origin of maize, on the eastern foothills of the Andes, falls into the present-day region of interlocked races.

F. G. Brieger

(B) Indigenous maize of the Caingang Indians in southern Brasil. The analysis of five different origins from still-existing reservations have shown, that the main cultivated race is uniformly the White Soft Caingang Dent. There are no essential differences as to the main ear characters, though formation of local races exists with regard to details. This is true especially of vegetative characters, such as the usual negative correlation between plant height and original latitude, clearly visible when the material is grown in the same plot. No relations could be found with any other race of dent corn, and thus Caingang Dent must be considered as a very old indigenous race, which tends toward extinction with the disappearance of these Indians. Owing to its general characters and good combining ability, it represents promising basic material for modern breeding, though for our conditions the white color of the kernels and their softness are unfavorable characters.

E. Paterniani

(C) A special study was made of the reliability of characters for use in the description of races, following the principle established by Brieger (1952), that only those quantitative characters should be used which can be measured easily and which permit statistical analysis of data. In order to obtain information about phenotypical variability and to identify the characters with strong heritability, several plantings were made successively and the data compared by analysis.

On the whole one may say, that characters with too much phenotypic variability (between successive plantings) or with coefficients of variation above 21% are not satisfactory for analytical purposes, and preference should be given to those with less than 16%.

Plant characters:- Height of plant and of ear, number of nodes above and below the ear, and time to flowering are characters with coefficients of variation of the size desired. Care must be taken, however, that comparisons are based only upon material grown under identical conditions, since these characters are phenotypically variable. The "internode pattern" of Anderson and Cutter should be considered only as a qualitative descriptive character, since a statistical analysis is not feasible, and, furthermore, the pattern is subject to phenotypical variation of some extent.

Tassel characters:- The characters measured include length of internode below first tassel branch, of branched portion of tassel and of unbranched tip and also of the total number of primary branches. All show on the whole only a tolerable variability from 10 to 21%. The number of branches of higher order is still more variable, and thus a qualitative indication of little, medium or heavy branching is sufficient. The condensation index of Anderson was not used, since the amount of labor is out of proportion to the eventual use as a descriptive character.

Ear characters:- Most of the characters used by Mangelsdorf, Wellhausen and Brieger, and their co-workers, were tested and found rather constant and thus of considerable value for distinguishing races. Total ear and cob diameter have a coefficient of variation below 10%. Length of ear, number of rows, rachis diameter between 10 to 20%, and diameter of the soft medulla have 10 to 35%. Measurements of the three dimensions of kernels are little variable. The number of husks, on the other hand, has only a tolerable variability and the length of shank is a highly variable character.

The use of ear diagrams, which has become very widespread recently, is quite justified as a demonstration of characters with a small amount of variability.

E. Paterniani

(D) General Report of the Brazilian Seed Center. The collection in the past year resulted in the following increase of the stocks: Indigenous races: Guianas-38 samples, mainly orange flint and some dent-flint infiltrates; Southern margin of Amazon Basin-19 samples from three tribes, all belonging to interlocked racial groups. Commercial races:

Argentina-55 samples of the main types Colorado, Amarillo, Cuarenton and Amargo, Southern States of Brasil- Parana and St. Catarina 100 samples and Rio Grande do Sul 790 samples, Sao Paulo State 800 samples. Not all these samples have been classsified yet, but the total in our collection has grown from 826 in last year's report to about 2,700.

F. G. Brieger
J. T. A. Gurgel
E. Paterniani

2. Breeding work.

(A) Commercial races in Southern Brasil. A fairly large job of collecting commercial races has been carried out, to a great extent with the help of colleagues from other Institutions and the Extension Services. Dr. Gurgel thus verified the following for the most southern State, Rio Grande do Sul: predominant type yellow dent with 14 rows and sometimes large and long ears, frequency about 40%; yellow dent with pronounced infiltration from orange flint, frequency 20%; white dent, 13%; others such as orange flint, and pop corn, 3% each with a total in all of about 27%. In the States of Parana and St. Catarina the situation is more or less the same, again with a pronounced predominance of dents or of dents infiltrated by orange flints. In the State of Sao Paulo until recently, it has been the current opinion, that the orange flint "Cateto" was the most cultivated race. We do not know whether this opinion was really incorrect or whether there has been a pronounced change in the last 15 years from flint to dent. In any case, it seems that dent types are now predominating. The origin of these dents cannot be explained in detail and with convincing documentary evidence. The native Caingang dent has apparently been used very little, though some cases of cultivation of Caingang Dent, infiltrated strongly by orange flint have been noted. The primary source for dent corn however was represented by a number of successive introductions from the United States, in several periods and both under Government action or through farmers. These imported types lacked natural adaptation to the local climate, and thus accidental infiltration from the adapted local yellow flint gave beneficial results thus giving rise to the large class of "hard dents", which are still unstable and segregate, but are gaining over the older flints because of better productivity and over imported dents because of better adaptation. Thus it seems, that the situation in these southern states of Brasil is not too different from the one which existed in the U.S.A., when the combination of southern Gourd Seed and northeastern Little Flint gave origin to modern Corn Belt Dent. In both cases a new commercial race of higher productivity was introduced and adaptation and improvement of type was obtained by crossing to a local old, but unproductive, race. In both cases the very pronounced hybrid vigor of flint-dent crosses was used, in spite of the fact that there is no explication available for the outstanding interpopulational combining ability of flint-dent crosses.

The samples collected may thus offer very promising material for new breeding projects designed to obtain substitutes for the few double hybrids now existing, which are either pure orange flint or flint-dent double hybrids. In order to make the first preliminary field test and to eliminate the less promising original types, 508 samples were planted out in a specially designed experiment.

F. G. Brieger

(B) Theoretical studies on population structure. The theoretical conditions considered include: (a) The presence of heterotic gene pairs vs. recessive subviable genes, and (b) Continued selfing vs. random mating. The total survival value of the populations or the loss caused by selection on total productivity were taken into consideration. Under the conditions considered, the minimum loss and at the same time the highest total survival value of the population will be found with heterotic gene pairs, if at least one of the alleles present has a survival value of homozygotes not very different from the maximum value represented by that of the heterozygotes. Under such conditions the survival and productivity of indigenous races or synthetics can be explained perfectly, and also the positive effects of populational selection. Thus actually the situation with the presence of heterotic genes may not differ very much from that, where the heterotic allele with high survival value is substituted by a dominant gene at a subviable locus. This conclusion makes it rather difficult to design decisive tests to distinguish experimentally between the heterosis theory and the dominance theory. These considerations are being published in more detail in the "Handbuch fur Pflanzenzuchtung", Berlin.

F. G. Brieger

3. Genetical Studies.

(A) Distribution of genes for alueorne color.- The analysis of several indigenous Mexican races, all crossed to the standard tester "Negrito", has been concluded. The results agree in a general way with those obtained earlier with Colombian races. Segregation for purple aleurone follows either a 3:1 or 9:7 ratio, with frequent changes in proportion of colorless from 25% up to 35% in the former and from 43% up to 60% in the latter, owing to dosage effects and incomplete dominance of the anthocyanin factors. The occurrence of a three factor segregation giving a 27-37 ratio cannot be excluded. Crosses with linkage testers have been started in order to identify the loci involved. The test has been extended now also to a South-American race, White Caingang Dent, and the F_2 ears obtained will be analyzed. They seem to confirm the results obtained earlier with the two other racial groups.

F. G. Brieger and
F. Taborda.

(B) Cross-sterility factors in South American pop corn races:- Since we found cases of cross-sterility in pop corn of the type described earlier by Demerec, a test was planted out in 1953 including 20 South American races, as reported last year. Unfavorable conditions caused the loss of this experiment. It is being repeated this year with about 100 strains of different origin. We also obtained testers for the super-gametophytic factor from Oliver Nelson, Purdue University.

The presence of such gametophyte factors, which impedes crossing in normally random mating populations, will require special explanations from the viewpoint of population genetics. It should be remembered that we reported earlier some exceptions in the behavior of pop corn after inbreeding, indicating a special case of population genetics.

F. G. Brieger and
J. T. A. Gurgel

(C) Linkage Tester.- The work of purifying and adapting linkage testers continues and new material was received from Dr. E. Patterson.

J. T. A. Gurgel

UNIVERSITY OF WISCONSIN
Madison 6, Wisconsin

1. Increased chromosome breakage in endosperm tissue associated with the variegated pericarp.

As reported in the 1954 Maize News Letter the frequency of waxy sectors in Wx wx wx endosperms is significantly higher in kernels carrying a P^{VV} allele (medium variegated pericarp) than in those carrying a P^{WR} allele (stable colorless pericarp). Further studies showed that at least part of these Wx losses are due to the loss to the nucleus of a chromosome segment during mitosis in the endosperm tissue.

Three near-isogenic stocks were used as pollen parents, each differing in the genetic constitution for pericarp: F336 was heterozygous medium variegated (P^{VV}/P^{WW}), F337 was heterozygous light variegated (P^{VV}/P^{WW} + tr-Mp, the transposed modulator together with P^{VV} giving the light variegated phenotype), and F341, a P^{WW}/P^{WW} control. All three stocks also were homozygous A r C Wx. Pollen from them was put on the silks of the tester stock A R c wx, resulting in colored aleurone and non waxy endosperms. C (colored aleurone) losses were scored under a binocular microscope as colorless sectors on the otherwise colored kernels. These colorless sectors were then classified for waxy. Since C and Wx are linked, C being distal to Wx on the short arm of chromosome 9, colorless sectors

showing also the waxy phenotype could be interpreted as due to losses of chromosome 9 segments including both the C and the Wx loci. The frequencies of these c wx sectors are summarized in Table I. Sectors smaller than 0.25 mm. in length are not included.

Table I. Mean frequencies of colorless and waxy endosperm sectors per 100 kernels from different variegated and non-variegated pollen parents.

Family of male plant	Pericarp phenotype	Male genotype	No. of colorless endosperm sectors: Colorless non waxy	Colorless waxy	Total
F336	medium variegated	$P^{VV}*/P^{WW}$	231.4±59.1	142.7±11.6	369.4±50.0
F337	light variegated	P^{VV}/P^{WW} +	234.0±75.5	280.0±48.9	538.1±89.8
F341	colorless	P^{WW}/P^{WW} tr-Mp	70.6±45.2	48.6±23.5	119.2±59.3
			54.1%	45.9%	100%

* $P^{VV} = \overline{P}^{RRMP}$

The last column in Table I shows that both the medium variegated and light variegated plants gave higher frequencies of colorless sectors (C losses) than the near-isogenic P^{WW} inbred. Approximately 46% of the sectors showed simultaneous losses for both C and Wx. The simultaneous loss of linked dominant markers indicates the loss of a chromosome segment with the breakage point proximal to the Wx locus. In the remaining 54% of the sectors C alone was lost. These may or may not result from chromosome breakage. Included in the latter group of 4147 colorless sectors (54%) were 32 sectors large enough to show mottling of waxy also, in a pattern suggesting the breakage-fusion-bridge cycle. This pattern could arise from an initial break removing the C locus only, followed by breakage-fusion-bridge cycles resulting in secondary breaks during subsequent cell generations, eventually affecting the Wx locus also.

How does the P^{VV} (or P^{RRMP}) allele, normally on chromosome 1, induce breakage in the short arm of chromosome 9? The fact that P^{VV} "activates" McClintock's Dissociation in producing chromosome breakage at the locus of Ds suggests that perhaps there are relatively weak dissociation-like elements scattered along chromosome 9, and probably elsewhere in the genome also, and that increased chromosome breakage at these sites occurs under the action of P^{VV}.

The data in Table I also show that the light variegated male plants gave larger increases in the frequency of endosperm sectoring than the medium variegated plants. The difference is statistically significant. This increase of endosperm sectoring or the dosage effect of the transposed Modulator is contrary to the known suppressing effect of transposed Modulator on pericarp variegation and on Dissociation. No explanation is apparent.

In a similar experiment, involving the Pr locus instead of the Wx locus, there was a Modulator dosage effect of the expected kind. That is, the frequency of pr-sectors in the light variegated group was reduced as compared with the medium variegated group. These data are summarized in Table II, which includes the results from two separate experiments involving different inbred strains.

Table II. The dosage effect of Modulator on the frequency of pr sectors.

Family of male plants	Pericarp phenotype	Male genotype	No. pr sectors per 1000 kernels
F 302	medium variegated	P^{VV}/p^{WW}	225.5 ± 28.9
F 301	light variegated	P^{VV}/p^{WW} + tr-Mp	129.9 ± 39.0
F 304	colorless	p^{WW}/p^{WW}	94.7 ± 17.5
F 305	homozygous medium variegated	P^{VV}/P^{VV}	456.5 ± 75.5
Estimated	medium variegated	P^{VV}/P^{WR}	272.4
F 306*	light variegated	P^{VV}/P^{WR} + tr-Mp	164.4 ± 40.5
F 307	colorless	P^{WR}/P^{WR}	88.3 ± 29.6

* The transposed Modulator in the light variegated appeared to be closely linked with P^{VV}. The 1953 family gave 9 light variegateds only and a duplicate family in 1954 gave 7 light variegateds and no medium variegateds.

Cheng-Mei Fradkin

2. Stability of self-red mutations from variegated pericarp.

Variegated pericarp frequently mutates sufficiently early in the development of the ear to give rise to kernels, and patches consisting of a number of kernels, which are self-colored (red). A number of such mutations have been studied, with the object of determining possible differences in stability.

In order to insure about the same genetic background for the P^{RR} allele (red pericarp and cob), comparisons were made between families derived from independent mutant spots on the same variegated ear. The stability of the mutants was measured by counting the number of back mutations to light orange, variegated, and colorless pericarp.

The results show that independent self-red mutations on the same ear, from variegated to red pericarp, give rise to self-reds which may differ significantly in back mutation rate.

G. Howard Clark

3. Distribution of transposed modulator in red and light variegated twin mutations from medium variegated pericarp.

Dr. Nilan and I (Genetics 37:519-544) postulated in 1952 that twin mutations to red and light variegated pericarp on medium variegated ears heterozygous for a stable allele (e.g., $\underline{P}^{VV}/\underline{P}^{WR}$ could be accounted for in the following terms: (a) The $\underline{P}^{VV}$ allele is a dual structure comprising $\underline{P}^{RR}$, the gene for red pericarp, and Modulator (Mp) which, when present at the P locus, suppresses the pigment-producing action of $\underline{P}^{RR}$. (b) Mp is a transposable unit, and the mutation of $\underline{P}^{VV}$ to $\underline{P}^{RR}$ consists in the loss of this element from the P locus. (c) The light variegated genotype is $\underline{P}^{VV}/\underline{P}^{WR}$ + Mp, that is to say, it differs from medium variegated in carrying an extra dose of Modulator at some position in the genome other than the P locus. (d) Twin mutations result from a mitosis in which $\underline{P}^{VV}$ divides to give $\underline{P}^{RR}$ and $\underline{P}^{VV}$, and the Modulator unit lost from the former chromatid passes to the same daughter nucleus as the latter chromatid.

Evidence obtained in 1954 on the distribution of Modulator in the red component of such twin mutations shows that this explanation is inadequate. The test made was whether the red member of the twin pair regularly lacks Modulator, as called for on the above hypothesis.

The fact that Modulator, like McClintock's Activator (Ac), incites Ds chromosome breakage (Barclay and Brink, PNAS 40: 1118-1125) makes it possible, by appropriate testcrosses, to score for the presence of Modulator wherever in the genome Mp is located. Plants grown from the red kernels in 18 independently occurring red-light variegated twin mutations on medium variegated ears were tested. Modulator was found to be absent from all the plants from this class of kernels in seven twins. (The numbers of individuals per family scored ranged from 6 to 20, and averaged 13.) These data are in accord with expectation on the basis of the hypothesis outlined. In the remaining 11 twins, however, some of the plants grown from the red kernels gave a positive test for Modulator. In five of these cases the distribution clearly indicated linkage between Mp and $\underline{P}^{RR}$, in the other six, the two factors appeared to assort independently.

The mechanism whereby both the red and light variegated components of this second class of twins acquire a transposed Modulator is not known.

R. A. Brink

4. An Isoallele of colorless pericarp and cob ($\underline{P}^{WW}$) arising from medium variegated ($\underline{P}^{VV}$).

Among 1215 non-$\underline{P}^{WR}$ offspring from three groups of matings of the type $\underline{P}^{VV}/\underline{P}^{WR}$ x $\underline{P}^{VV}$ (the $\underline{P}^{VV}$ allele being from a common source) the following distribution was observed:

Medium variegated	pericarp	and	cob	--	1080
Light variegated	"	"	"	--	51
Red	"	"	"	--	73
Colorless	"	"	"	--	11
					1215

On further testing of the initially colorless mutations arising from variegateds some were found to be very low grade variegateds; others bred true for colorless. Tests involving 1772 plants descended from one such colorless mutation (which first appeared as an unpigmented patch of kernels on a medium variegated ear) have disclosed no mutations to $\underline{P}^{RR}$. This mutant isoallele for colorless can be distinguished from ordinary colorless ($\underline{P}^{WW}$) in two ways (i) it markedly reduces the grade of variegation in heterozygotes with typical $\underline{P}^{VV}$ alleles and (ii) like all the $\underline{P}^{VV}$ alleles tested, but not ordinary colorless, it promotes Ds chromosome breakage.

R. A. Brink

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1. The frequency of chlorophyll-defective seedlings in varieties of maize as a measure of close hybridization.

The frequency of white, yellow, and white-and-yellow-striped seedlings in farmer's fields planted with indigenous varieties, in valleys of Yugoslavia enclosed by mountains, has been studied. The investigations have been made in 72 climatically different places and on many hundreds of different ecotypes. The number of chlorophyll-defective seedlings has varied from 3 to 87 among 1000 seedlings in single varieties. The frequency of chlorophyll-defective seedlings is greater: (a) on the smaller fields, i.e., those belonging to small farmers, and (b) on fields planted with kernels from a few selected ears. From the varieties with a greater frequency of defective seedlings, it was possible after a few years of self-fertilization, to obtain inbreds in which the genetical variation was very low. It seems that the frequency of chlorophyll-defective seedlings can be taken as a rough measure of closeness of inbreeding.

A. Tavcar

2. Cold tolerance of the flint maize from high altitude and with higher content of anthocyanin.

Indigenous varieties from the region of 800 to 1000 m in the Julian Alps are of flint type and have mostly a light orange color of

the pericarp. The germination of the kernels with this pericarp color has been, under conditions of 10°C. for 28 days, from 9 to 15% higher than kernels with colorless pericarp. The seedlings from the kernels with light orange pericarp have also been more resistant to late frost in the spring. A greater cold resistance is associated with and perhaps due to a higher content of anthocyanin in the seedlings.

A. Tavcar

3. Mutation from tu to Tu.

In an indigenous flint variety of maize, cultivated by a farmer near Zagreb, I found among many thousands of ears with uncovered kernels one on which the kernels were covered to 2/3 of their length with glumes. The offspring of the kernels of that ear consisted of plants with (a) uncovered kernels, (b) partly covered kernels, and (c) kernels of the tunicata type. The next generation was of the following constitution: (a) from uncovered kernels, plants with uncovered kernels have again developed, (b) from partly covered kernels have developed plants with uncovered, partly covered and covered kernels, and (c) from covered kernels plants with covered and partly covered kernels have grown.

The appearance of the ear with partly covered kernels in the above-mentioned indigenous variety must have been due to a mutation. The plants with covered and partly covered kernels have now been crossed with some testers for further genetical analysis.

M. Kump

5. Pollen sterility due to chromosomal aberration in maize of short-day type with proliferation of tassels.

Many different abnormal divisions at mitosis and meiosis as well as chromosomal aberrations have been observed. These cause abnormal development of the mentioned plants and a high pollen sterility.

A. Tavcar

III. BROOKHAVEN SYMPOSIUM IN BIOLOGY NO. 8 - MUTATION

The annual summer conference sponsored by the Biology Department of the Brookhaven National Laboratory, Upton, N. Y. will take place June 15 through 17, 1955. Those planning to attend should notify Dr. R. C. King at the above address by May 21, 1955. If you are not a citizen of the United States, please indicate your nationality.

The program includes the following speakers and topics: S. Benzer, Genetic fine structure and its relation to the DNA molecule; A. D. Hershey, The chemical organization of virus genetic material; J. G. Gall, The ultrastructure of chromosomes; A. W. Ravin, The properties of bacterial transforming systems; G. Bertani, The role of phage in bacterial heredity; Barbara McClintock, Intranuclear systems controlling gene action and mutation; M. Demerec and Zlata Demerec, Factors determining the effectiveness of certain mutagens; H. B. Newcombe, The timing of the induced mutation process in Streptomyces spores; N. H. Giles, Jr., Forward and back mutation at specific loci in Neurospora; H. J. Muller, The relation between chromosome changes and gene mutation; J. S. Kirby-Smith, Effects on the genetic material due to radiations of different linear energy transfer; H. B. Glass, Properties of genetic material manifested by changed mutability during different stages of gametogenesis; W. L. Russell, The mutational characteristics of specific loci; W. S. Stone, Indirect effects of radiation on genetic material; W. K. Baker, The oxygen effect and the mutation process; and A. Novick, Mutagens and antimutagens. R. D. Hotchkiss, K. Sax, W. R. Singleton, A. H. Sparrow, A. Srb, and K. G. Stern are chairmen. The Symposium Committee consists of R. C. King, V. W. Woodward, A. H. Sparrow, Marian E. Koshland and H. J. Curtis.

IV. REPORT ON MAIZE COOPERATIVE

Extensive collections of Maize Cooperative genetic stocks have been grown for the past two summers at Urbana. The primary emphasis thus far has been on collecting and preserving valuable genetic traits and on increasing the seed supplies. Since many of the stocks are quite weak as a result of prolonged inbreeding and are in some cases poorly adapted to much of the corn belt, an effort was made in the summer of 1953 to cross all stocks to the inbred lines M14, W23, and Oh51A. It is planned that the stocks will be converted eventually to these lines. During the past summer, F_2's from many of these crosses were obtained. With some of the multiple gene stocks, especially, it has been necessary to make various supplementary types of crosses to maintain supplies and to increase the vigor of the stocks until they can be extracted from crosses to the inbreds and their genetic constitutions can be confirmed. Many of the F_1's from crosses of unplaced genes to chromosome rearrangements marked with closely-linked endosperm or seedling traits were selfed this past summer. Those F_2's segregating for unplaced endosperm or seedling traits are being checked for linkages this winter.

During the past year about two dozen additional stocks have been added to the collection. We are especially anxious to receive additional chromosome tester stocks, multiple dominants, and multiple recessives, particularly those which have been selected for vigor. We would also appreciate obtaining stocks of new traits or more favorable combinations of traits already in the collection.

Requests for stocks should be sent to the Botany Department, University of Illinois, Urbana, Illinois. The available Cooperation stocks are as follows:

Chromosome 1 stocks

as
bm_2; probably seg v_{19}
Hm
Kn
lw_1
ms_{17}
prr ad_1 bm_2
prr an_1 bm_2; seg br_1, ad_1
Prr bm_2; seg ad_1
seg Prr br_1 an_1 gs_1 bm_2 (in coupling)
pvv
pwr gs_1 bm_2
pwr bm_2
pww br_1 f_1 bm_2
pww; may seg ts_2, bm_2

p^{ww}; may seg ts_2, br_1
p^{ww}; may seg zb_4, bm_2
p^{ww}; may seg zb_4, br_1
p^{ww}; seg zb_4 ts_2
sr p^{wr} an_1 bm_2
may seg ts_2 p^{ww} br_1
Ts_6
Vg
vp_5
zb_4 ms_{17} p^{ww}
zb_4 p^{ww} bm_2
may seg zb_4, p^{ww}, br_1, bm_2
zb_4 ts_2 p^{wr}

Chromosome 2 stocks

al lg_1
ba_2
fl_1
lg_1; seg al, gl_2
lg_1; seg al, gl_2, v_4
lg_1 gl_2; seg ws_3 B
lg_1 gl_2 b; seg ws_3
lg_1 gl_2 b; seg ws_3, fl_1, v_4
lg_1 gl_2 b fl_1 v_4
lg_1 gl_2 B sk v_4
seg lg_1 gl_2 b sk v_4 (in coupling)
lg_1 gl_2 b v_4
lg_1 gl_2 b v_4 Ch; may seg sk

Chromosome 3 stocks

a_1 et; A_2 A_3 C R; seg Dt
a_1 sh_2; A_2 A_3 C R dt
a_1 sh_2; A_2 A_3 C R; seg Dt
A^d-3l; A_2 A_3 C R
$\frac{A^d\text{-}3l\ Sh_2}{a_1 \quad sh_2}$; A_2 A_3 C R; seg Dt
$\frac{A^d\text{-}3l}{a_{x}\text{-}1}$; A_2 A_3 C R
a^p et; A_2 A_3 C R; may seg Dt
$\frac{a^p\ Sh_2\ (et)}{a_1\ sh_2\ Et}$; A_2 A_3 C R; carries Dt
$\frac{a^p \quad (et)}{a_x\text{-}1\ (Et)}$; A_2 A_3 C R; may carry Dt
$\frac{a_{x}\text{-}1\ --}{a_1 \quad sh_2}$; A_2 A_3 C R; seg Dt
cr_1 ts_4 na_1

d_1
d_1; seg Lg_3
d_1; seg Lg_3, Rg (in repulsion)
d_1; seg Rg
d_1 ts_4 lg_2
d_2
g_2
gl_6
gl_6 lg_2 a_1 et; seg Dt (C, R not homozygous)
gl_6 v_{17}
gl_7
lg_2 a_1 et; A_2 A_3 C R Dt
lg_2 a_1 sh_2 et; A_2 A_3 C R
lg_2 A^b et; A_2 A_3 C R
Lg_3
seg Lg_3, R
ms_3
pg_2
pm
ra_2
ra_2 lg_2; seg pm
Rg
rt
sh_2
ts_4 na_1
vp_1

Chromosome 4 stocks

bm_3
bt_2
de(1 or 16?)
$\underline{Ga_1\ Su_1}$
ga_1 su_1
gl_3
la su_1 gl_3
lo
lw_4; lw_3
o_1
$\underline{sp_1\ Lo\ su_1}$
Sp_1 lo Su_1
$\underline{sp_1\ Su_1}$
Sp_1 su_1
st
su_1 am
su_1 bm_3

Chromosome 4 stocks (Cont.)

su_1 gl_3
su_1 gl_4
su_1 Tu gl_3
su zb_6
seg su_1, zb_6, Tu, gl(3)
Ts_5
Tu gl_3
v_8

Chromosome 5 stocks

a_2 bm_1 bt_1 bv_1 pr; A_1 A_3 C R
a_2 bm_1 pr v_2 ; "
a_2 bt_1 pr ; "
a_2 bt_1 pr ; " ; seg bm_1, bv_1; may seg ys_1
a_2 pr ; "
bm_1 pr ; A_1 A_2 A_3 C R
bm_1 pr; seg ys_1
bm_1 yg_1
seg bm_1, ys_1
seg bm_1, ys_1 v_2
bt_1
Ga Bt_1
ga bt_1
gl_5
gl_8
lw_2
lw_3; lw_4
ms_{18}
pr; A_1 A_2 A_3 C R
pr; " ; seg bm_1, v_2; probably seg ys_1
pr; " ; seg "sh_3", bm_1, ys_1, intensifier linked to "sh_3"
pr; " ; seg vp_2
pr; " ; seg ys_1
"sh_3" (allele of bt_1)
"sh_3" pr; A_1 A_2 A_3 C R
"sh_3" pr; " ; seg intensifier linked to "sh_3"; carries ys_1
tn
v_3 pr; A_1 A_2 A_3 C R
v_{12}
seg vp_2, gl_8 (in repulsion)
seg vp_2, pr (in repulsion); A_1 A_2 A_3 C R
seg vp_7
ys_1; seg bm_1
ys_1; seg "sh_3", intensifier linked to "sh_3", bm_1, pr; $A_1A_2A_3$ CR

Chromosome 6 stocks

seg Pl, sm, may seg py (all in coupling); A_1 A_2 b, seg P^{rr}
po
seg Y at si (all in coupling)
y, seg Pl, seg Bh; c sh_1 wx A_1 A_2 A_3 R b
Y, seg Pl, may seg py; A_1 A_2 b P^{rr}
Y, seg Pl sm py (in coupling); A_1 A_2 b, seg P^{rr}
y; seg w_1
y; seg w_1, luteus on chromosome 6; carries P^{rr}
Y L_{10} pl; A_1 A_2 b
y l_{10}
y ms (1?)
Y Pl; A_1 A_2 b P^{rr}
y Pl, seg luteus on chromosome 6; A_1 A_2 b
Y pl, seg w_1
y Pl, seg w_1; A_1 A_2 b P^{rr}
y pl, seg w_1; seg yellow seedling (luteus?); A_1 A_2 b
y Pl, seg w_1; seg yellow seedling (luteus?); A_1 A_2 b P^{rr}
y Pl; seg w_1, luteus on chromosome 6; A_1 A_2 b
y su_2
Y v_7
y Pl Bh; A_1 A_2 B sh_1 wx
y pg_{11} pl; A_1 A_2 wx pg_{12}
y Pl (py); seg a luteus; A_1 A_2 b; carries P^{rr}
Y Pl sm, may seg py; A_1 A_2 b; seg P^{rr}
Y Pl (sm), may seg py; A_1 A_2 b P^{rr}
Y Pl sm py; A_1 A_2 b; carries P^{rr}

Chromosome 7 stocks

(Bn)
gl_1; y A_1 A_2 A_3 C R pr
gl_1; Y wx A_1 A_2 A_3 C R Pr
seg gl_1 sl (Bn)
Hs
o_2
o_2 ra_1 gl_1
o_2 v_5 ra_1 gl_1
o_2 v_5 ra_1 gl_1; seg Hs
ra_1 gl_1
Tp_1
va_1
vp_9 gl_1; wx

Chromosome 8 stocks

v_{16} j_1, seg ms_8; l_1

Chromosome 9 stocks

au_1 au_2
bk_2
c; seg wx, bk_2; A_1 A_2 A_3 R
c wx; y A_1 A_2 A_3 R b Pl
c sh_1 wx; y A_1 A_2 A_3 R b, seg Pl
c sh_1 wx gl_4 (Coop) A_1 A_2 A_3 R
c sh_1 wx gl^H; A_1 A_2 A_3 R
da_1; seg sa, ms_2, wx; may seg ar
Dt_1 (See chromosome 3 stocks)
gl_{10} (Coop)
gl_{10} (Sprague)
I wx; A_1 A_2 A_3 R Pr B pl
I wx; A_1 A_2 A_3 R pr B pl
l_7
ms_2
ms_{20}
sh_1 l_7
sh_1 ms_2
sh_1 wx d_3
seg sh_1, d_3, l_6
sh_1 wx pg_{12}; y A_1 A_2 B pl pg_{11}
Wc, seg bk_2, may carry ms_{20}
Wc; may seg bk_2, ms_{20}
Wc; carries ms_{20}, may carry bk_2
wx^a
wx da_1 (C, R may segregate); seg ar, sa; may seg ms_2
wx g_4
wx l_6
wx pg_{12}; y A_1 A_2 B pl pg_{11}
wx v_1; seg sh_1

Chromosome 10 stocks

a_3 g_1 R; A_1 A_2 C
du_1
g_1
g_1 r^g; A_1 A_2 A_3 C
gl_9 (Coop)
l_1; v_{16} ms_8 j_1
li g_1 R; A_1 A_2 A_3 C
li g_1 r; " "
li g_1 r; " ; may carry abnormal 10
na_2
nl_1 g_1 R; A_1 A_2 A_3 C
Og R; A_1 A_2 A_3 C B Pl; may carry B chromosomes
Rmb; A_1 A_2 A_3 C
R^{nj}; "
R^{st}; "
v_{18}
w_2
zn

Stocks of unplaced genes

an_2
at
bk_1
bk_2
bm_4
"bt_4" Singleton
cl
de_{17}
du_2
dv
dy
fl_2
gl_{11}
gl_{12}
gl_{13}
gl_{14}
gl_{15}
gl_{16}
gl_g
h
mn
ms_5
ms_6
ms_7
ms_9
ms_{10}
ms_{11}
ms_{12}
ms_{13}
ms_{14}
mottled aleurone
new starchy gene
pb_4
"ra_3" Perry
Rs_1
rs_2
"sh_4" Singleton
"sh_5" Singleton
Ts_3
tw_1
tw_2
v_{13}
v_{17}
vp_6
ws_1 ws_2
zb_1
zb_2
zb_3

Multiple gene stocks

A_1 A_2 A_3 C R Pr
(")Pr wx
(")Pr wx y
(")Pr wx Y gl_1
(")pr
(")pr wx
(")pr wx y
(")pr su_1
(")Pr B Pl; seg Og; may carry B Chromosomes
A_1 A_2 A_3 c R Pr su_1
(") y wx
(") y sh_1 wx
A_1 A_2 A_3 C r Pr su_1
(") su_1 y g_1
(") y wx
(") y sh_1 wx
wx lg_1 gl_2 b v_4
y su_1 ra_1 gl_1
y wx gl_1
lg_1 su_1 bm_1 y gl_1 j_1
su_1 y wx a_1 A_2 A_3 C Rg pr
colored scutellum

Combinations of endosperm genes

The combinations of genes affecting synthesis of endosperm starch listed in last year's News Letter are still available in our collection. However, Dr. Kramer, who is still working actively with this material in deriving new combinations and increasing vigor, has offered to supply improved stocks of these combinations to interested investigators. Requests should be addressed to Dr. Herbert H. Kramer, Agronomy Department, Purdue University, Lafayette, Indiana.

Stocks useful in studies of Ga factors

Hulless
South American
Ohio Yellow
Black Beauty
Red
Amber Pearl
Supergold

Exotics and varieties

Black Mexican Sweet Corn (without B chromosomes)
Black Mexican Sweet Corn (with B chromosomes)
Gourdseed
Maize chapolote
Papago Flour Corn
Parker's Flint
Tama Flint
Zapaluta chica

Stocks of primary trisomics

Stocks are available which will segregate for trisomics 3, 4, 5, 6, 7, 8, and 9. These stocks have been crossed once or twice by the inbred line W23. Thus far, trisomics 1, 2, and 10 have not appeared in the small number of plants examined.

Reciprocal translocations marked with closely-linked genes for endosperm or seedling traits

A selected series of chromosome translocations, whose breakpoints mark most of the regions of the ten chromosomes, is being maintained. The majority of the translocations are closely linked to wx, with the remainder linked to su_1, y, or gl_2. The stocks are in general quite vigorous. In most cases, F_1's with MI4, W23, and Oh51A are available, and in a few instances F_2's have been obtained. The list of translocations is as follows:

wx 1-9 c
wx 1-9 4995-5
wx 2-9 b
wx 3-9 c
wx 3-9 5775-1
wx 4-9 b
wx 4-9 5657-2
wx 4-9 g
wx 5-9 a
wx 5-9 c
wx 5-9 4817-7
wx 5-9 5614-3
wx 6-9 a
wx 6-9 b
wx 6-9 4505-4
wx 8-9 d
wx 8-9 6673-6
wx 9-10 b

Reciprocal translocations (Cont.)

gl_1, wx 7-9 4363-1
su 1-4 a
su 1-4 d
su 4-5 j
su 4-8 a
y, su 4-6a
y 1-6 c
gl_2 2-3 c
gl_2 2-3 5304-3

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V. RECENT MAIZE PUBLICATIONS

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1. Efficient experiments in multigenics.

Inbred lines which may be repeatedly crossed in various or all combinations may provide sets of offspring and parents which may be tested year after year and in various situations sufficiently with almost identical genotypes to determine genetic-environment interactions. (Is the degree of dominance the same at all yield levels of corn, or at one intermediate level whether nitrogen, phosphorus or water is the main limiting factor?) Or the test may be repeated simply for more data on a questionable conclusion. Insofar as the parents are homozygous the offspring are of one genotype within one single cross, with no limit on number of such offspring; and dominance occurs only in offspring - parents are free of it.

Other "constant" parents such as clones and F_1's of homozygous lines if they may be often crossed, may also provide sets of offspring and parents with all of the above advantages, except, (1) offspring within one single cross are heterogeneous not homogenous in genotype, (2) parents are heterozygous - dominance must be counted in the phenotypes of parents - theoretical offspring-parent regression is much more complex than with homozygous parents.

These latter two points were apparently entirely obscure to Griffing (Gen. 35:303-321. 1950), and his Iowa advisors, or they would not have attempted to introduce the very inappropriate "constant parent regression" for what I have labeled bp in the regression of offspring on homozygous parents.

$F_1 = b_1P_i + b_1P_j - b_2P_iP_j$ is easily established as the theoretical function of Mendelian multigenics, with dominance bias. Previous to Hull the 3rd term was ignored in studies of regression of F_1 corn on inbred parents. The general form $y = ax + bz + cxz$ is a familiar one. Simplifying the analysis by holding either x or z constant must have been a commonplace in mathematics for more than a hundred years. I have not intended to claim originality for that even though Bruce and his advisors give it first rank over, (1) including the 3rd term of the function i.e. product of parents, and (2) using homozygous parents not just constant parents.

Hayman (Gen. 39:789-809. 1954) has recently stressed the diallel approach as the powerful one, largely ignoring points outlined here above.

I have used diallel data (Hull, MGNL 1946; "Heterosis", Chap. 28, 1952), simply because it was the only data available, and I think satisfactory enough. But we might draw a sample of 45 F_1's from many homozygous parents with any one parent included more than once being a rarity (nearly 90 parents) and thus obtain greater efficiency in some respects than with

a diallel of only 10 parents and 45 F_1's. Analysis would be to fit the above multiple regression function and estimate k from b_1 and b_2 as before. Partial regression coefficients for specific common parents would be inaccessible directly, but they could be estimated from b_1 and b_2 by commonplace procedures. Sorry I have failed to note before that the diallel is not a bulwark, just incidental, in my approach, which I supposed was obvious.

Without epistasis, but with any variation of dominance from locus to locus, partial regression of offspring on homozygous parent in a set of one common parent is linear in the Mendelian scheme, or even with linkage. Hayman (lc. page 795) has introduced non-linearity of partial regression and perhaps other bias by including parents on the diallel diagonal among offspring. This seems to be a very unlikely departure from random sampling. It may simplify the mathematics and the bias may then come out easily enough, but I am presently frustrated, though willing to be shown, if this be true. Anyhow, the partial regressions calculated by Hull from diallel data omitting parent diagonal are theoretically linear except for epistasis, but it is not clear if Hayman means to imply that they are not.

2. Evidence of overdominance in corn yield from low x low, low x high, and high x high.

With gene frequencies and degree of overdominance bias in the ranges indicated by previous analyses we may expect the mean of high x high above the mean of low x high, but that a greater genetic variance in low x high may allow 5% or less of low x high (the elites) above the best of high x high with 20 or more loci involved. Lonnquist (Agron. Jour. 45:539-542. 1953) has no counter evidence against overdominance at all loci in his few data although he and his statistical editor may prefer that conclusion supported by mis-interpretation of Hull ("Heterosis", pp. 465-466. 1952). There may be loci of course where overdominance does not obtain but evidence for that will not be so easily segregated.

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