E. G. Anderson

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25-1951

MAIZE GENETICS COÖPERATION

NEWS LETTER

25

March 17, 1951

The data presented here are not to be used in publications without the consent of the authors.

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

CONTENTS

E. G. Anderson

I. ANNOUNCEMENTS

1. 1951 Meeting

It is planned to have a get-together of those interested in maize genetics at the AIBS meetings in September. The meetings will be held in Minneapolis and Dr. Charles R. Burnham will schedule the time of the maize meeting and have it printed in the regular program of events.

2. Genes wanted.

C. R. Burnham, University of Minnesota, University Farm, St. Paul 1, Minn. - *PP bp bp*, bt_3, $zb_4 br$, *ts* v_4, *d* lg_2, $lg_2 ts_4$, *d* ts_4, *in* v_5 *gl*, *Og*, *A C R Pr* (with *g*?).

H. B. Creighton, Wellesley College, Wellesley 8, Mass. - *pr pr* v_2 v_2 (A_1 A_2 *C Ri*) and A_1 A_1 A_2 A_2 *C C R R i i Wx Wx Pr Pr* V_2 V_2.

Maize Genetics Cooperation, Department of Plant Breeding, Cornell University, Ithaca, N. Y. -- Any new genes or particularly useful combinations of genes.

3. Back numbers of News Letter available.

Vol. 4 - Dec. 18, 1933 - 4 copies
Vol. 10 - Mar. 4, 1936 - 2 copies
Vol. 11 - Mar. 23, 1937 - 4 copies
Vol. 12 - Mar. 6, 1938 - 45 copies
Vol. 13 - Apr. 15, 1939 - 48 copies
Vol. 24 - Mar. 17, 1950 - 22 copies

H. H. Smith

II. REPORTS FROM COOPERATORS

California Institute of Technology and
United States Department of Agriculture
Pasadena, California

1. Translocations.

A list is being prepared for publication of all translocations isolated since the 1935 list up to "Crossroad project." This covers the isolation, identification of chromosomes involved and the cytological location of breaks.

E. G. Anderson and A. E. Longley

2. Glossies.

Intercross tests for allelism have been made both with previously- numbered glossies and with new glossy lines obtained from other sources, chiefly by mutations. The tests indicate that the gl_8 is the same (or an allelel of) gl_6 and that gl_{10} is the same as gl_5. A stock listed under the symbol of gl_x is also the same as gl_5. The stock listed as gl_9 showed no glossy which could be recognized under our conditions. Among our new mutants we have obtained several recurrences of gl_1, gl_5 and gl_7 and one each of gl_2, and gl_4. One additional glossy has been obtained. These results will be repeated for confirmation. We shall also be glad to check any glossy stocks sent to us. Stocks of the three widely used gl_1, gl_2 and gl_3 are probably all reliable. But, as our present tests do not conform to the information given in the linkage summary of Emerson, Beadle, and Fraser, 1935, it would be well to have all stocks of gl_4 to gl_{10} checked. We have verified the reported linkage of gl_8 with genes from chrom. 5.

Anderson, et al

Quantitative determinations of the wax on the surface of seedling leaves are being made. The glossies differ from each other, but all have less than the normals. Glossy$_2$ appears to have about one-half the normal amount of wax and gl_1 less than one-fourth.

Edward Kurtz

3. Dwarf 1.

One of the dwarfs obtained from the Bikini test material is an allele of d_1. It is somewhat larger and more vigorous than the original d_1 but with the same compact growth, unlike the larger and more elongated intermediate allele found by Dr. Brink. It is very satisfactory as a seedling character. It was present in the L289/I205 single cross material used for the Bikini tests.

E. G. Anderson

4. A non-liguleless allele of liguleless.

One F_2 culture from a Bikini outcross segregated plants with the characteristic erect leaves of liguleless 1. Unlike $\underline{lg_1}$ the leaves of the new type possess a ligule and auricles. The sheath together with the ligule remain tightly wrapped as in the normal. But the midrib continues vertically upward instead of coming out at an angle from the top of the sheath, The seedlings look superficially like those of $\underline{lg_1}$ but the classification must be based upon the leaf angle only, Intercrosses with $\underline{lg_1}$ give seedlings typical of the new type, showing allelism. Since there is no weakening of the stem, the character has one advantage over $\underline{lg_1}$ but its comparative usefulness as a gene marker remains to be determined.

E. E. Dale and E. G. Anderson

5. Virescent-19.

This virescent appears to be rather widespread among genetic stocks. It has turned up in the stock of glossy$_5$, in some of Dr. Roman's stocks of B chromosome translocations, and in several other cultures of mixed ancestry all involving recent crosses to Cornell genetic stock. These items all suggest that the source may be some early stock widely used by Dr. Emerson and his students and co-workers at the time much of the genetic stock material was being built. As a genetic marker, $\underline{v_{19}}$ is fairly good in greenhouse seedling tests, but greens up too readily to be classified in the field under our conditions. Where specific seedling chlorophyll notes are not being taken, it could be tided along indefinitely in stocks used for other purposes.

E. E. Dale and E. G. Anderson

6. Oil yel.

A deep "oily" yellow seedling type which becomes green or golden-green as a mature plant, answering closely the description of Eysters oil yellow. An excellent seedling character easily classified throughout seedling stage and often recognizable even in the mature plant. Viability good. Chromosome 10. Loosely linked to R on the basis of seedling tests as follows:

Crosses with colored aleurone gave F_1s which on selfing gave 9-7 segregation of aleurone. These segregated for oil yellow in the following percentages:

	normal	oil yel	per cent
colored seeds	607	105	14.5
colorless seeds	377	166	30.6

This corresponds to about 25 to 30% of crossing over between oil yel and either C or R. Cultures segregating for oil yellow and waxy showed no linkage.

Pollinations by TB-9b gave only green seedlings thus eliminating the distal half of the short arm of chromosome 9. Pollinations by TB-10a likewise eliminated the distal part of the long arm of chromosome 10. Thus the data would indicate a locus near the central portion of chromosome 10, possibly not far from golden or lineate. For most purposes it is a better marker gene than either of these.

E. G. Anderson

7. Albino seedlings.

A series of nine albino mutants characterized by a complete lack of both chlorophyll and beta-carotene, a deficiency of carotinoid pigment in the endosperm and a tendency to premature germination were intercrossed to test for allelism. Two of these tested proved to be allelic to the others and were eliminated. Data obtained from twenty of the possible twenty-one intercrosses between the remaining seven indicate that six of the seven genes are probably non allelic with one combination yet to be tested.

D. S. Robertson and E.G. Anderson

8. Viviparous.

The studies of the viviparous mutants of corn have yielded some information as to the loci of the genes involved.

Indications are that the mutants vp_1 and vp_4 obtained from Cornell are allelic. Linkage studies give no indications of this gene being located on the short arm of chromosome nine or the long arm of chromosome ten. These are the loci for vp_4 and vp_1 respectively, reported in the literature. Crosses of stocks of this mutant with translocations B-9a, B-9b and B-10 have revealed that the gene is not within the regions included in these translocations. Crosses with C, R, wx and sh give no indication of linkage with any of these genes. Apparent linkage with aleurone color, previously reported for this mutant, seems to be the result of the inhibition of color development when the gene is present in the homozygous condition.

A backcross of vp_2 has yielded 29.5% crossing over between vp_2 and pr, which is in good agreement with values previously reported.

Previous crosses of vp_5 with translocation B-1b had indicated that this mutant was in the short arm of chromosome one. A backcross of an F_1 heterozygous for vp_5 and translocation 1-9a indicate 29.9% crossing over between the mutant and the translocation.

A three point test of vp_7, pr and gl_8 indicates the following order and map distances: vp_7 14.6 pr 1.0 gl_8. This data is in agreement with the order of these genes indicated by Dr. Sprague.

Viviparous$_8$ had previously been located in the long arm of chromosome one with the aid of translocation B-1a. Backcrosses of F_1 plants heterozygous for this mutant, br, bm_2 and translocation 1-7c indicate the following order and map distances: (br) T 32.5 vp_8 13.2 bm_2. No crossovers were obtained between br and the translocation out of 103 plants observed.

F_2 data from plants heterozygous for vp_9 and translocation 7-9a-76 indicate that this mutant is on chromosome seven. Crosses with translocation B-7b give no evidence of the gene being included in the translocated portion of chromosome seven, thus the gene is probably proximal to the break in this chromosome.

Physiological studies of normal and viviparous embryos seem to indicate that the combination of low oxygen tension and high CO_2 tension is responsible for preventing germination of normal embryos during the development of the caryopsis. Concentrations of approximately 1% O_2, 30% CO_2 and 69% N_2 will greatly retard the elongation of the plumule of excised normal embryos of immature seed without inhibiting the enlargement of the scutellum which will elongate from .5 to 1.5 mm in six days under these conditions. The plumules of vp_5 embryos, obtained from the same selfed ear as the normals mentioned above, are not inhibited by these gas concentrations. This would suggest that embryos of this mutant germinate prematurely because they are capable of plumule elongation under conditions of low and high CO_2, which possibly exist within the pericarp of developing seeds.

D. S. Robertson

9. Phototropic sensitivity of coleoptiles of albino corn.

The mutant strain ofcorn, viviparous 5, is characterized by the production of seeds with white endosperm, which upon germination yield paper-white seedlings. Analysis of the coleoptiles of this mutant showed that they contained as much riboflavin as the normal but no detectable carotenoid pigments. Use was therefore made of the mutant in an attempt to decide between carotenoid pigments and riboflavin as the light receptor for phototropic curvature. Results showed that the mutant coleoptiles curved about one-half as much as the normals when exposed to blue light of sufficient intensity to elicit the first positive curvature in the normals. These results are interpreted to support the contention of Galston and co-workers that riboflavin is a light receptor pigment for phototropic curvature.

R. S. Bandurski and A. W. Galston

10. Indoleacetic acid response of corn coleoptiles.

In view of the extensive work with Avena coleoptiles, it was surprising to find that no one had reported the effects of indoleacetic acid (IAA) on corn coleoptile elongation. A few simple experiments were therefore carried out. Corn seeds were germinated on the dark and when the tip beyond the first node was 1 to

1.2 mm. long, 5 mm. sections were cut with parallel razor blades beginning 2 to 3 mm. back from the tip. The primary leaf was withdrawn and batches of ten to twenty coleoptile sections floated on buffered sucrose solutions to which IAA was added. The average increase in length over controls was 0-25 mm./10 sections for the range of .1 to 3 mg. IAA per liter, a definitely usable sensitivity, which could probably be increased by rejecting 5 mm. of tip instead of 2-3 mm. The results are reported here since they suggest the possibility of using corn coleoptiles for IAA assay as well as their application in the study of coleoptiles of mutants in which differences of IAA metabolism are suspected.

Howard J. Boroughs

11. Water-soluble pigments in corn.

The work carried out at the University of Missouri on the constitution of water-soluble pigments in various genotypes of corn is being continued at the California Institute of Technology.

The purple tissues of corn plants containing a full complement of dominant genes for anthocyanin production ($\underline{A_1}$ $\underline{A_2 B}$ *Pl* $\underline{r^r}$ *Pr* *Bz*) were found chromatographically to have three anthocyanin pigments one of which is chrysanthemin, in accordance with the finding of Sando (1920). The other pigments are believed to be derivatives of chrysanthemin, since mild hydrolysis results in formation of a single pigment. In plants recessive for *b* gene, anthocyanin pigments can be produced through the action of gene $\underline{r^r}$ (r^{ch} allele was tested exclusively), when leaf tissues are supplied with excess of sugar. The pigments induced in leaf sections of such plants by floating them on glucose solutions were found to be identical with those produced naturally in leaf sheaths of plants containing dominant *B* gene.

The sun-red plants, homozygous recessive for the *pl* gene, were found to have three pigments chromatographically identical with those produced in purple plants, but much reduced in quantity. The same three pigment fractions in reduced amounts were found in plants containing various alleles of gene *A* (*A-D4*, $\underline{A^d\text{-}41}$, A^d-31), and in plants homozygous for recessive $\underline{b_z}$ gene.

In two families, purple plants were found to segregate a factor responsible for production of a single anthocyanin pigment instead of the usual three fractions. The single pigment was found to be chrysanthemin. The factor behaves as a simple recessive gene. Chromosomal location of this gene and its action when in combination with other genes controlling pigment production is being studied.

	Plants Analyzed	Plants (3-Pigment)	Plants (1-Pigment)
Original Family Percentage	75	53 70.3 %	22 29.3%
F_1: 1-pigment plant selfed	9	0	9
1-pigment plant selfed	18	0	18
3-pigment plant selfed	11	11	0
3-pigment plant selfed	11	8	3
1-pigment plant crossed to 3-pigment plant	12	12	0
F_2: 1-pigment plant selfed	23	0	23

Chromatographic work reveals the presence of a large number of water soluble substances in plants where anthocyanin production has been decreased by substitution of gene *A* by any of its alleles, such as A^{d}-41, a^{p}, and *a*. Most of these substances are believed to be flavonoid or phenolic in nature. They are detected in chromatograms by means of their fluorescence in ultra-violet light. Determination of the chemical nature of these substances in plants containing the A^{d}-41 gene, in the presence of other complementary genes, is in progress.

Katerina Zarudnaya

12. Tryptophane, niacin, indoleacetic acid in sugary and starch.

Interrelationships of tryptophane, indoleacetic acid, and niacin reported in various plants prompted extending assays for these substances to developmental stages of the corn kernel and determining carbohydrates in the same samples for more direct comparison.

In the first series of tests, starchy kernels were obtained from an inbred line KYS and sugary kernels from a closely related sugary KYS conversion having an average of 15/16ths of its germ plasm from KYS.

As work proceeded, irregularities in the results were suspected to be due to differences in the "physiological age" of the kernels from the two types of plants. Differences could be due both to individual plant variation, and to systematic differences between kernels produced on starchy and sugary parent plants. Since starchy and sugary seeds cannot be distinguished until about maturity neither of these sources of error could be eliminated by taking samples from ordinary segregating ears. However, yellow and white seeds can be classified on segregating ears by about the 16th day from pollination. By use of an R4 conversion of translocation 4-6a carrying su and y the two types of seeds were separated on the basis of endosperm color with only about 4.5 per cent error due to crossing over.

Carbohydrate patterns were essentially similar in the two series, although KYS apparently as a later maturing line attained peaks of the various components from four-eight days later than the R4. Reducing sugars were higher in sugary than starchy and were highest in both genotypes at 20 and 28 days, the dropped more rapidly in starchy than in sugary; sucrose was consistently higher in sugary then starchy and decreased sharply after 24 and 32 days; water soluble polysaccharides accumulated rapidly in sugary from 18 to 32 or 34 days, then decreased slightly at maturity; very little water soluble polysaccharide was found in starchy samples at any stage. Carbohydrate patterns are thus in general agreement with published ones.

Niacin increased considerably in starchy between 18 and 24 days, then decreased toward maturity. In sugary it increased somewhat more rapidly to a higher peak at 28 and 32 days and decreased less than starchy at later dates. Indoleacetic acid was also higher in sugary than starchy, although in the KYS series there were points of overlap. Highest indoleacetic acid levels were at 28 and 32 days. At maturity the values were almost identical in starch and sugary for both series. Tryptophane levels were irrgeular in KYS and overlapped. In the R4 seriestryptophane was higher for sugary from 20 days through maturity.

These data are consistent with a catalytic role for niacin in carbohydrate metabolism. However, they provide no proof for such a role. The amounts of tryptophane are sufficiently high previous to the rise of niacin and indoleacetic acid levels to account for the quantities of the latter two substances by tryptophane conversion.

H. Teas, Anna Newton, J. W. Cameron,
and E. G. Anderson

13. Chemical and physiological studies on indoleacetic acid.

Previous work demonstrated the close interrelation of tryptophane and indole-3-acetic acid (IAA) in the developing corn kernel. Associated with these meterials is a substance, now called auxin complex (AC), found to be present in large quantities in the kernel, and apparently capable of completely inactivating IAA for its usual role in the growth of the plant. In consideration of its probable importance in the growth and metabolism of the plant, work was begun on its isolation. Extensive solvent and chromotographic techniques were utilized to increase the AC concentration from 0.04 to 10% on the basis of total IAA content.

Paper chromotography resolved the AC into two substances, both of which gave a color reaction for IAA and growth activity after hydrolysis. Apparently, therefore, the AC is a mixture of two compounds both of which contain IAA - possibly several isomers of the same substance exist.

Recent alkaline hydrolysis procedures on the AC concentrate indicate the release of at least three substances - methyl anthranilate, IAA, and a sugar. The interrelation of these substances, if any, remains to be established.

Mutants having a colored aleurone layer were utilized to help in establishing the site in the kernel for the production of the AC. Preliminary work indicates that the gradient of AC concentration decreases from the aleurone layer inward into the endosperm as well as from the base to the top of the endosperm.

Extensive investigation to establish the presence of an enzyme system capable of transforming tryptophane to IAA was done using a dialysis technique to reduce the IAA and AC background. Results indicate that such a system does exist in the kernel, but is of very low acticity.

Melvin Stehsel

Charles F. Ketterimg Foundation
Yellow Springs, Ohio

1. Catalase activity in corn.

a. The catalase activity of leaf tissue of various chloroplast pigment deficient types of corn seedlings growing in a greenhouse was determined by the "catalase tube" method of Knott. The catalase activity of albino seedlings averaged 1.54 ml. of O_2 in five-minute interval, that of yellow seedlings 2.83 ml. and that of green seedlings 10.14 ml.

b. The same chloroplast pigment-deficient types of corn seedlings grown in the dark showed a catalase activity which was surprisingly high in all cases and which was approximately the same for all of the three types.

c. When the dark-grown seedlings were exposed to light there was a rapid photo-oxidation of catalase, so that catalase values approached that of similar aged light(greenhouse) grown albinos, yellow seedlings and green seedlings, respectively.

d. A series of hybrid strains of corn arranged from darkest green to lightest green showed progressively less catalase activity.

e. Catalase in leaves of corn seedlings was destroyed by temperatures at or above 55°C.

f. A comparison of the temperature effects on etiolated and green seedlings of approximately the same age showed the catalase in green ones to be slightly the more heat-labile or destructible.

g. There seems to ne a common thermal effect on catalase, starch synthesis enzyme, and chlorophyll synthesis enzyme. 55° is the critical temperature above which all three enzymes are destroyed. A plausible explanation for this enzymatic destruction is that these enzymes are proteinaceous and are subject to identical thermal denaturation.

h. The catalase activity was found to be quite high in chlorotic corn seedlings grown in greenhouse at 10°C, but did increase somewhat in ones transferred to 25°C.

2. Polyembryomy in corn.

Pedigree 481 produced a small proportion of Siamese twin stalks from a single kernel. 13 sets of twins and 1 triplet are recorded in a series of progeny tests involving 216 progenies in 481 pedigree and 8885 sown kernels. This is 1 multiple embryo per every 635. Only two progenies so far have revealed more than one multiple embryo, two sets of twins in 481(164), three sets of twins in 481(211). I would gladly furnish seeds to anyone interested in performing a more intensive study of this matter. Presently I am inclined to think that the tendency for multiple embryo may be inherited and thatin strains possessing the tendency, the frequency for twins is low.

3. The report two years ago (Maize Genetic Cooperation News Letter 23:4) that green seedlings grown from yellow seeds seemed to be significantly taller at end of 21 days than green seedlings grown from white seeds in same progeny has been further investigated. Not all progenies which segregate yellow and white seeds in 481 pedigree show this growth difference in seedlings. Several other pedigrees tested did not show any difference in stature between seedlings from yellow seeds and those from white seeds in same progenies. So it would seem that this difference is not due to presence of carotene in yellow seeds but is due rather to a gene or set of genes for increased vigor and that this gene or set of genes is linked in coupling phase with gene for yellow endosperm (most likely Y_1, on chromosome 6, but not for certain). Several progenies in pedigree 481 showed this interesting correlation.

4. The tassel-like ear (reported in Maize Genetics Cooperation News Letter 23:4) in pedigree 4812 is associated with bright green color. I have some homozygous strains of tassel-like ear (bright green color) for anyone interested.

5. I have homozygous $zebra_2$ for anyone interested in this character. zb_2 is still not located.

H. C. Eyster

Chicago Natural History Museum
Chicago 5, Illinois

Fully podded corn in the Old Southwest.

The Museum's 1950 Southwest Archeological Expedition excavated Tularosa Cave, a dry cave on the upper Gila River watershed in New Mexico. Of the large assortment of plant remains unearthed, the most interesting and abundant is the corn. There are more than 30,000 cobs, cob fragments, many ears with grains, tassels, and plant fragments. In the lowest levels some of the ears are as fully podded as some of the Tu ears grown today, while the majority are the less conspicuously podded weak tunicate forms already described by Mangelsdorf from another New Mexico Cave. It is believed that the lowest levels of Tularosa Cave are more than 4,000 years old for the artifacts associated with these levels are similar to those found in a nearby site which has been dated by the Carbon 14 method as about 4,500 years old. Carbon 14 tests are being run on the Tularosa Cave material.

This is the second record of ancient fully podded corn in the Southwest. The first, a solitary ear from northern Arizona, is of little significance for there is little information on the associated corn or the level at which the ear was discovered.

Besides corn, there are many squash stems (pepo), kidney beans, *Cucurbita foetidissima* fruits, grasses and parts of the local wild plants which the cave dwellers used. Since the cave was occupied until about 1200 A.D., this collection will give a relatively complete history of corn for more than 3200 years.

Hugh C. Cutler

Connecticut Agricultural Experiment Station
New Haven 4, Connecticut

1. Cytoplasmic sterility in corn.

Pollen sterility resulting from a transmissible condition in the cytoplasm has been reported to occur in corn from several widely different sources. The material described by Rhoades (1933) obtained from collections by Emerson and Richey in North America has apparently been lost. The material that we received from the U. S. Department of Agriculture in 1944, and understood was the Rhoades stock, we have later learned originated in teopod crossed by a linkage tester (letter received from Dr. M. T. Jenkins). In the middle thirties Dr. P. C. Mangelsdorf, at the Texas Agricultural Experiment Station found male sterile plants in Mexican June and in its derivatives, Golden June and Honey June, which later proved to be cytoplasmic. Gini (1939) has described cytoplasmic sterile types in corn from Argentina and Brieger from Brazil. Josephson and Jenkins (1948) listed several inbreds that are fertile but produce partially sterile hybrids. The U. S. Department of Agriculture, Texas and Brazilian sources have been compared in the same inbreds after backcrossing. The Texas sterile seems to be more completely sterile than the other two sources, although the inbreds have not been completely converted to type in each case.

Restored pollen fertility resulting from gene action has been maintained during three generations of self-fertilization. In this material cytoplasmic sterility segregates as a gene-controlled, recessive character and would be considered to be entirely nuclear until crossed with plants that do not have pollen-restoring genes. This may account for the "scatter grain" sterility shown by hybrids produced from self-fertile inbreds.

2. Yields of sterile and fertile hybrids.

Cytoplasmic sterility has no detrimental effect on yield of grain. In 1950 this was compared in 12 hybrid combinations made on sterile and fertile single crosses and grown in a replicated yield test. The sterile crosses averaged 154 bushels and the fertile 145 in grain yields. The range in average yield of the steriles was 109 to 196 bushels compared with a range of 89 to 167 for the fertiles. The difference of 9 bushels in the averages us not significant, but is suggestive that the steriles might have a somewhat higher yielding ability. A regional test of three hybrids, comparing steriles and fertiles, in five locations showed two of the pairs higher in yield for the sterile.

D. F. Jones

3. Glumeless hybrid sweet corn.

Work with Sprague's vestigial glume (Vg) gene in developing a technique for its practical use as a quality factor in hybrid sweet corn has continued. In the process of backcrossing the Vg gene into several sweet corn seed parents, Vg modified types with tassel glumes 1/3 and 2/3 normal length appeared. Since these tassels shed pollen almost as abundantly as a normal tassel, homozygous Vg Vg inbreds may easily be established, The somewhat complicated technique outlined in the 1950 volume of the News Letter for obtaining Vg pollen becomes unnecessary with the use of the modifiers. The glume on the ear of the modified types is, at most, not long enough to form obnoxious chaff. By the proper application of genetic technique, the use of Vg in hybrid sweet corn is now feasible.

In case it is found that the modified Vg pollen shedder tassels do not produce sufficient pollen in the farmer's field to give a good ear set, some seed of a normal glumed hybrid would have to be mixed in with the final seed product. This pollinator variety should have a distinctive ear type or color so that its ears can be picked out from the glumeless hybrid ears during the routine sorting process.

4. Genetic control of floral structures in corn-grass.

A series of genetic modifiers for the corn-grass have been discovered. The resultant genetic types form a continuous series from a proliferous non-flowering mass of tillers on one extreme to a single stalked corn plant typical of modern maize on the other end. This series under direct genetic control is similar to the one which Dr. W. R. Singleton found would develop in the unmodified stocks when grown under special environmental conditions. The extreme types of corn-grass involve the fundamental plan of development of Zea Mays and so point out the importance of Mendelian genes in the control of important taxonomic differences.

W. C. Galinat

5. Variation in combining ability of an inbred maintained at several locations.

Samples of the inbreds Ind. Wf9 and Ill. Hy. were collected from several stations and a few commercial sources. Variations in plant characteristics such as plant height, ear height, stalk strength and maturity were striking, especially between the Hy lines. In order to test the effect, if any, of the variations on the combining ability of these Hy selections, crosses were made using pollen from a single ear to row planting of the Connecticut inbred C103. Six of the crosses involving lines originally obtained from Illinois (maintained several generations in Connecticut), U.S.D.A., Ohio A.E.S., Pioneer Seed Co., E. W. Doubet, and Illinois A.E.S., and showing greatest phenotypic differences in the Connecticut inbred nursery were grown in 6 x 6 Latin squares in two locations in 1950. The trial of F_1 hybrids grown in Connecticut showed significant differences in plant heights, ear heights, per cent moisture at time of harvest, number of plants surviving entire season (initially thinned to uniform stand), and yield corrected to 15.5% moisture content. The second trial, grown in Delaware, yielded similar results. Analysis of covariance eliminating the stand factor from the recorded yields removed significance in the case of the Connecticut test, but the Delaware yields remained significantly different at the 1% level. Variations revealed in these field trials show clearly the mutability of at least one so-called inbred and indicate strongly that not only are phenotypic characteristics of the inbred altered but also the factors involved with heterosis of F_1 hybrid combinations are changed. Practical demands of maintaining named inbreds, as well as plant breeding techniques which utilize the mutability of plant materials are directly affected by these data.

6. Electrical potentials.

Earlier reports from Connecticut Agricultural Experiment Station and recent evidence from the University of Florida suggest that electrical potential is correlated positively with general plant vigor. There is another correlation which has been consistent throughout a large number of electrical potential determinations. The following data indicate a correlation between the measurable electrical potential in maize seed and the original moisture content of the seeds prior to the soaking period required by the usual measuring techniques. Table I presents potential readings obtained in 1947 on seed from several lines of the inbred maize line, Early Butler. Determinations for relative content of Nitrogen, Phosphorus and Potassium were made through a cooperative program with the Eastern States Farmers' Exchange and protein and moisture determinations were made on samples of seed from the same plants used in the N P K analyses. A positive correlation between moisture content and potential reading is evident (r= 898*).

* Significant at 5% level.

Table I

Early Butler Line	Averaged Potential Reading	% Moisture	Protein	N	K	P
172-A26	31.7	8.90	12.70	0	2	2
172-A29	25.3	8.50	13.10	3	1	3
172-A52	25.2	8.30	12.90	0	0	3
172-A43	19.3	8.45	11.95	0	0	2
172-A42	12.7	8.15	11.80	2	1	4
172A- 3	8.3	8.10	14.40	3	2	2

Other tests of seed from ears on which several different pollen sources (marked by endosperm color Y/y and carbohydrate content Su/su factors) were used showed a tendency for the field corn or starchy crosses to have relatively higher electrical potential readings than the sweet corn or sugary crosses. No indication of maternal inheritance was obtained as might be expected if electrical potentials were primary in the maize plant's growth and development. Moisture content tended to be higher in the starchy kernels, and hence, again correlated to potentials.

Electric potential has been shown in previous publications to be associated with a favorable, vigorous germ plasm. The indication of a second positive correlation with moisture content presented here links seed potential to plant development via the moisture content. Interpretation of electrical potential as a primary force in plant pattern formation may thus be altered to present such potentials as secondary or caused by-products of cellular activity. This does not necessarily mean that potential measurements are no longer considered as indicative of basic differences between one maize seed of high potential and another of relatively low potential. However, it does seem essential that initial water content be taken into consideration in interpreting electrical potential variations in lines of maize.

H. L. Everett

Hokkaido University
Faculty of Agriculture
Sapporo, Hokkaido, Japan

Studies of sugar production in corn stalks.

Single crosses produced in Japan from United States inbreds yielded very well in comparison with local standard varieties. However, these hybrids were a little late in maturity. Table I presents production data from one of the trials in Japan while Table II shows stalk sugar content in the single cross Tl x C103 and the effect of ear removal.

The observations to date may be summarized as follows: In view of aiming toward a dual crop, the lowering of stalk sugar content in the hybrid is an important problem. I am afraid that any C103 hybrid combination, irrespective of high sugar readings of parent inbreds, would always produce low sugar content stalks at maturity because of its vigorous productivity of ear. Opinion on this question as well as seed of promising inbreds or hybrids for ear and sugar production will be gratefully received at Hokkaido.

Table I

Entry	Silking days	Height (cm)	No. of ears	Plant wt. (gr)	Dried ear (gr)	Dried seed (gr)	Yield per10A (kg)
Tl x C103	92	272.6	1.3	1575.0	372.5	293.3	1056
W22 x C103	88	282.2	1.1	1765.5	333.3	267.8	964
Long Fellow	80	233.4	1.3	1046.0	190.0	155.0	588
Yellow Dent	84	257.0	1.1	1074.0	268.6	228.6	823
Wis. 12	83	248.2	1.0	948.6	198.3	165.7	597

Planted May 12

Table II

	Aug. 7 (earing stage)	Aug. 24	Aug. 31	Sept. 11	Sept. 21	Sept. 29 (maturing stage)
	%	%	%	%	%	%
Tl x C103 (normal)	4.0	7.5	9.6	5.0	4.0	4.0
Tl x C103 (ear removed)	-	ear removed	13.5	14.5	16.0	16.5
Tl x C103 (ear removed)	-	-	ear removed	12.4	15.8	16.0

Tsunetoshi Shibuya
(communicated by
Herbert L. Everett,
Connecticut)

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Corn monoploids.

During the period from the fall of 1948 through the summer of 1950, 1327 monoploid sporophytes (haploids) have been isolated from various types of corn. Of these 282 died before maturity and 44 were cut up or put aside for special studies. Of the remaining 1001 plants it was possible to self pollinate 453. Of these 178 yielded self seed. From the 178 seed progenies about 105 homozygous diploid lines have been established. About half of these are sweet corn lines, the other half dents.

S. S. Chase

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1. The John Innes Moves.

The move from our previous site at Merton, Surrey, less than ten miles southwest from London's Centre to the above address at Hertford, situated at twenty miles north of London has meant that the quantity of maize grown in 1950 was on a limited scale. In addition the present writer was away sick for nearly a year.

Mr. M. B. Crane, F.R.S. maintained a small plot of material we have been inbreeding and also multiplied up stocks of Extra Early Bantam, inbred C_{13} and their hybrid. Some of the inbreds from Canada Gold are now approaching uniformity and in 1951 it is proposed to make top-cross hybrids between Early Golden Market and these imbreds. These would represent 'reciprocals' of top-cross hybrid "Canada Cross" (Syn. John Innes Hybrid No: 2) which does well in England.

2. Frit-fly problems.

The final analysis of our frit-fly data has shown that all varieties of sweet corn are susceptible to damage, some varieties and hybrids more than others. There is a possible genetical basis as some American breeders have produced less susceptible types than others. Susceptibility is not associated with the suitability of varieties to English conditions nor to their maturity rating. It has been found that sowing sweet corn at different dates influences the severity of attacks and peaks vary according to variety and from year to year. Later sowings seem preferable. Frit-flies attack a crop of any one variety at random but there is a suggestion that plants in stringers radiating from a central mass are damaged more in the direction of the prevailing winds, but there is no regular decrease in incidence with distance from the central mass.

3. Pollination studies.

Using an experimental design of Dr. A. J. Bateman it was possible to make a study of sweet corn pollination and seed-setting from a source. It was found that log of seed-setting (y) dropped off with distance (x) according to the formula $Y = a \pm 6x$. This information will be of use in planning hybrid seed plots in England. It was shown that in small hybrid seed plots row direction is not important even though wind-direction influences seed-setting.

4. Demonstration material.

An attempt is being made by Dr. D. Lewis of the Genetics Department to grow corn material for demonstrating gene inheritance to students of the John Innes Summer School. Depredations by birds and the lateness of some of the genetical material in 1951 has slowed this down but the work will be continued in 1952.

Gordon Haskell

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St. Louis, Missouri
Department of Plant Breeding
Pioneer Hi-Bred Corn Company, Johnston, Iowa

The standard exotics

The chief project of the maize laboratory at the Missouri Botanical Garden for the past ten years has been to work at the problem of a natural classification for Zea Mays. We have attempted to study the maize of the world, living and prehistoric, and on the basis of comparative morphology, to work out as many types and sub-types as we could recognize. For Eastern North America the problem is virtually completed, and for Latin America as a whole it is further advanced than we would have dared to hope ten years ago, largely because a number of other individuals and institutions have taken an ever-increasing interest in such surveys.

One of the by-products of this project is the set of peculiar varieties which we have named the "standard exotics." These are ten varieties of maize which, of the sorts which can fairly readily be grown in the U.S. Cornbelt, come closest to demonstrating the extremes of variation in Zea Mays. Believing that they may ultimately be of wide usefulness in some practical problems as well as in many theoretical investigations, we are increasing our seed stocks of these ten varieties and putting them into cold storage. As long as the supply lasts, they will be available to maize geneticists and maize breeders upon request. Since the main seed stock is being held in Des Moines, requests for seeds should ordinarily be addressed to Dr. Brown. Ultimately, we hope to publish a sort of atlas, illustrating the plant type, kernel type, ear type, and cytological peculiarities of these ten varieties. In anticipation of this publication, we will appreciate any genetical or cytological information which any of those who grow the varieties may be able to supply. Several of the varieties have already been turned over to various investigators. They should ultimately be an important source of materials for a cooperative attack upon the genetics of quantitative characters.

LONGFELLOW FLINT. A typical yellow 8-rowed Northern Flint. Can be grown as far south as Saint Louis.

PAPAGO FLOUR CORN. Obtained from the Papago Indians in the desert south of Tucson, Arizona. A yellow flour corn of high quality for human food. Drought resistant. Early maturing in late plantings. Slender leaves, long mesocotyl.

ZAPALUTA CHICA. From southern Mexico, but easy to grow as far north as Minnesota because it is comparatively independent of length of day. 8 to 10 rowed. Very short ears. Very dented kernel.

LADYFINGER. A late-maturing, prolific, high quality popcorn, very similar to the ancient popcorns of Peruvian graves.

TOM THUMB. An article differentiating this and the previous variety is now in the press. Very early and small-eared. Does well only in the north. Excellent for greenhouse experiments in the winter time.

PURPLE TAMA. Essentially a northern flint variety from the Sac and Fox Indians in Iowa. Slightly mixed with Great Plains maize. Does better in the Corn Belt than any other northern flint. Colored endosperm.

ARGENTINE POP. A small-eared tiny kernelled, prolific variety from the Argentine. Easy to manipulate by pulling out tassel and covering the 5 to 7 small ears with a single kraft bag. Red pericarp. Similar to the grave popcorns of Argentina.

JAPANESE HULL-LESS. Neither Japanese nor hull-less. High quality rice popcorn very similar to the ancient popcorns of Mexico City. Low knob numbers. Difficult to smear. High row number, ears more or less fasciated.

MAIZE CHAPOLOTE. Primitive popcorn from western Mexico. Shows close similarity to teosinte in various characters. Narrow cob, irregular kernel shape, brown pericarp. Large knobs, variable in number from plant to plant.

GOURDSEED. The extreme white dent corn from the southern U.S., which is one of the ancestors of modern U.S. varieties.

Edgar Anderson
William L. Brown

Missouri Botanical Garden
and
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A survey of kernel texture in Zea Mays.

The fundamental genetics of texture in Maize, though of great economic and theoretical importance has scarcely advanced beyond the pioneer efforts of East and Hayes. Our understanding of the chemical composition of the maize kernel is advancing rapidly at the present time. For the most effective use of this information we need broad surveys of the gross morphology of the kernel in all kinds of maize.

The classification of field varieties of maize into flints, flours, dents, and pops is almost wholly artificial. Though once useful as a cataloguing device in the United States, it is now inadequate even within that restricted area. Recent work has revealed the peculiar features in the history of the U. S. corn which led Sturtevant and his predecessors into the belief that flints, dents, and pops were such fundamentally different kinds of maize. The general maize picture of commercial U. S. corns by the second half of the19th century was a simple one, which could have been matched at no other place in the world. Across the northern part of the country and extending well down into what is now the corn belt was a widespread and uniform race of maize, the Northern flints spreading up from Mexico and already being actively mixed with the flints was a very different group of varieties, the old white southern dents. Though there were hundreds of varieties of maize in the eastern U.S. nearly all of them came from these two very different and quite well-marked races. The popcorn picture too, was simpler then than now. Most of the varieties were either different strains of White Rice, or some of its various hybrids. Sweet corns (which we now know to be due to a single gene had originally been introduced into commercial cultivation on a northern flint background and were still prevailingly of that general growth type. Along the Gulf Coast a few Caribbean Flints complicated the picture as did occasional collections made among the Indians of the southwest and the Great Plains. Therefore, in the 80's when Sturtevant grew and studied all the types of maize he could find in the trade, or obtained from collectors, his collection did fall quite naturally into sweets, flints, dents, flours, and pops. It was not until the work progressed and he began to receive more collections from Mexico and elsewhere, that he began to see the more complicated picture presented by Zea Mays in its entirety. In the N.Y. Agricultural Experiment Station report for 1885 after he had grown his first large Mexican collection, we find him writing "With less material for study, these races would show a well marked separation, as illustrated in my classificatory attempt in 1884. While it is deplorable to have to change one's views as radically as this present offering shows, yet it is more deplorable to think that enlarged collections may in time overset the present classification."

The special collection of maize types assembled in the herbarium of the Missouri Botanical Garden was utilized for the survey, From the examination of endosperm composition in this collection it is clear that there is one general endosperm pattern in Zea Mays, a central column of soft starch surrounded by a collar or cap of hard starch. Even in those kinds which are usually thought of as being entirely flinty, or entirely starchy, there are many of the former which have a small area of soft starch near the germ and of the latter which have a thin layer of hard starch over the entire endosperm or a small and sometimes interrupted collar of hard starch on the side away from the germ.

In making the survey, kernel sections were examined mounted on modeling clay under a dissecting microscope. Longitudinal sections were made at right angles to each other (bisecting the embryo and parallel with the embryo) as well as a series of cross sections. After a preliminary survey it was found that one cross section in the middle of the kernel was sufficient if combined with the two longitudinal sections. Well-developed kernels were selected from the mid-ear region, a precaution partocularly necessary in varieties from Mexico and Central America where there is some variation in kernel texture on different parts of the ear. Several kernels were examined and an average condition selected for record. Most of the kernels were sectioned without any previous treatment. A few of the flintier ones were soaked for about an hour until they were easier to cut. Drawings were made on cross-section paper at six times natural size. The chief dimensions of each section were measured and the entire drawing was carefully made to scale. The reliability of the method was checked by resampling various ears at intervals of about a fortright.

It is not possible to make dividing lines of any kind between flints, flours, pops, and dents. There is rather a continuous series from varieties with a heavy cap of hard starch tho those with a partial collar to those with a completely floury endosperm. Working directly with the entire collection of measured drawings it was possible to classify them roughly in ten grades.

It should be specifically pointed out that when the entire collection of kernels is examined there are no discontinuities anywhere in the entire range. Among the flour corns one passes from extremes in which entire varieties are without any hard starch,to varieties in which some of the ears bear either a small collar or an entire cap of hard starch. At the other extreme there are apparently no varieties of maize in which all the kernels are without any soft starch. There are some pointed popcorns in which there is very little soft starch and we have found a few ears in which there are none.

As soon as the relative amounts of hard and soft starch had been graded in our collection. it was apparent that denting of the kernel was dependent upon some other factor in addition to the proportion of hard starch. While all of the kernels which were clearly dented were in the intermediate classes for percentage of hard starch, the reverse was by no means true. There were many varieties with intermediate percentages of hard starch and no pronounced denting.

When the narrowness of the kernels was considered along with the percentage of hard starch in the endosperm, the relationship of these two variables to denting was clear. To be dented a kernel must have a complete or partial collar of hard starch (it may have a thin cap of hard starch as well) and it must be narrow. For kernels with an intermediate degree of hard starch, denting is proportional to the comparative length of the kernel. All the narrow kernels in these classes are dented, none of the broad ones are dented, and in general the narrower the kernel the more extreme the dent.

A comparison of 17 inbred lines and 17 of the single crosses derived from them was of particular interest. While the subject has apparently never been discussed in print, it is well known to most corn breeders that the inbred lines derived from U.S. corn belt dents are less dented than the open pollinated varieties from which they came. It is furthermore well known that crosses between some of these inbreds (but by no means all of them) are much more dented than either parent. The comparison suggests some of the factors which are at work in this complex situation. It is clear that the single crosses, on the average, are much narrower than the inbreds from which they were derived. This migh well be a direct effect of hybrid vigor. A more vigorous plant would produce a much larger seed and unless the entire plant were proportionately larger the seed would of necessity have to be longer, and hence would be narrower in relation to its size. Single crosses tend to be more deeply dented than their parental inbreds because they tend to have longer seeds.

The genetics of texture in maize is complex. There are evidently many genes which affect it and preliminary results indicate some of these have complimentary effects. Understanding the relationship between length of kernal and denting should make it somewhat easier to work out the genetics of kernel texture.

Comparison of kernel grades for 17 inbred lines and 17 of their derived crosses

Grade of hard starch:	3	4	5	6	7	8
crosses	3	4	4	2	2	2
inbreds	0	1	11	4	1	0

Length of kernels:	0.5 0.8	0.9 1.2	1.3 1.6	1.7 2.0	2.1 2.4
crosses	0	1	7	8	1
inbreds	2	3	12	0	0

Grade of denting:	1	2	3	4
crosses	2	5	5	4
inbreds	5	6	6	0

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Degree of Dominance.

An estimate of 1.64 for the degree of dominance of genes affecting yield of grain in prolific corn was obtained by Robinson, et al. (Agron. Jour. 41: 353-359, 1949). C. O. Gardner (unpublished), using a different procedure, has recently obtained an estimate of 1.51 for the genes conditioning the same character. These estimates involved the ratio of the variance due to dominance deviations, σ^2_d, and the additive genetic variance σ^2_g. The estimates were computed as $\frac{2\sigma^2_d}{\sigma^2_g}$. With gene frequencies (q) of $\frac{1}{2}$ (as obtained in the unselected populations from a cross of homozygous lines used in the work cited above) and no linkage effects $\frac{2\sigma^2_d}{\sigma^2_g} = 1.0$ if dominance is complete at all loci and greater than 1.0 if there is a preponderance of overdominance. Recent work at this institution has indicated that certain linkage effects in the material used in these investigations may result in values of the magnitude obtained with no more than complete dominance.

If dominance is complete but $q > \frac{1}{2}$, $\frac{2\sigma^2_d}{\sigma^2_g} > 1.0$. Hence assuming q's over $\frac{1}{2}$ in open-pollinated varieties (Crow, J. F., Genetics 33:477-487, 1948) one would anticipate $\frac{2\hat{\sigma}^2_d}{\hat{\sigma}^2_g}$ considerably above 1.0 even with complete dominance. Any linkage out of phase equilibrium would further increase the ratio.

Additive genetic variance and dominance variance have been estimated for yield of grain from an extensive investigation in 1950 utilizing biparental crosses in two open-pollinated varieties of corn. The ratio $\frac{2\sigma^2_d}{\sigma^2_g}$ was 1.01 in Jarvis and 1.15 in Weekley. These estimates would indicate complete dominance if one assumed gene frequencies were $\frac{1}{2}$, and no more than partial dominance if the intensive selection to which these varieties have been subjected has resulted in the accumulation of more favorable genes for yield.

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<u>Response to amino acids and vitamins by excised maize inbred and hybrid embryos cultured in vitro.</u>

Through the use of aseptic techniques (described in Bot. Gaz. 112:52-57) the effect of 10 amino acids and 4 B vitamins on growth of young seedlings grown from excised embryos of Inbreds 38-11, K64, and WF9 and their reciprocal hybrids was measured. The amino acids were added at final concentrations of M/5000 to artificial culture medium and the vitamins were added at the rate of 2 p.p.m. This method whereby the young embryos are divorced very early from their endosperm reserves and grown on a chemically defined medium should simplify the investigation of certain metabolic processes in maize. The objective of these experiments was to determine if any relationship exists between the effects of these growth substances and heterosis.

Due to the small number of replications and the high degree of variability (coefficients of variability commonly ranged from 40 - 60 %), statistical significance could not be shown for many of the differences between growth on control medium and that on supplemented media. However, certain of these differences seemed consistent enough to indicate biological significance. A response by increased growth was shown by some strains but not by others to certain of the growth substances. Moreover, these differences in response were fairly constant between inbred and hybrid strains. Therefore, some of the data seem to serve as a possible clue to the biochemical basis of heterosis.

In some cases inbred lines showed a response to a particular supplement and hybrids involving these strains also showed increased growth on media supplemented with the same substance. This result was obtained with the amino acid arginine. In almost all cases Inbred 38-11, as well as the hybrids involving it, responded to arginine by showing increased growth, In some of the cases this response was statistically significant. On the other hand, Inbred WF9 made no response to arginine and Inbred K64 showed a non-significant increased growth in thosecultures receiving arginine in only one of two groups of data. The hybrid between the latter two inbreds showed no response to arginine. Representative data are shown in the accompanying table.

Thiamin promoted better growth for Inbred WF9 while neither of the other inbreds showed a response to this vitamin. The hybrids involving WF9 as the maternal parent also showed a response to thiamin. Tryptophane seemed stimulatory only to K64 of the inbreds while hybrids involving it showed increased growth on media supplemented with this substance.

These data were interpreted to mean that the inbreds transmit to their hybrid seedlings the ability for increased utilization of the particular metabolites. It would be desirable to relate determinations of the amounts of these substances in the endosperm with the above type of data.

Some of the data seemed to be interpreted best on the basis that hybrid superiority results from the ability of the hybrid to synthesize certain of the metabolites in greater quantities than their component inbreds. In these cases inbred parents showed better growth on media supplemented with certain growth substances while their hybrids showed no response to these same supplements. This result was obtained with riboflavin. Inbreds 38-11 and K64 showed increased growth on media supplemented with this substance while neither of the reciprocal hybrids between them showed a response to it. WF9, on the other hand, showed no response to this supplement.

Further data involving greater numbers of replications is needed before conclusions can be drawn from these experiments. It might also be desirable to determine the effects of these amino acids and vitamins when added in groups. More experiments of this type are planned.

Table I

Effect of arginine on growth in 10 days by maize inbred and hybrid embryos.

Maize Inbreds or Hybrids	Age in Days of Embryo When Excised	No. of Replications	Mean Dry Weights of Seedlings in mg.	
			Control (No Supplement)	Control + Arginine (M/5000)
WF9 (x)	18	5	8.6 ± 1.4	8.9 ± 0.7
WF9 x K64	18	10	8.1 ± 1.0	7.2 ± 1.2
K64 (x)	18	5	6.3 ± 1.8	8.0 ± 0.9
K64 x 38-11	18	5	10.4 ± 3.2	9.6 ± 0.5
38-11 x K64	18	5	7.3 ± 1.1	11.1 ± 2.6
38-11 (x)	18	5	6.2 ± 0.4	11.3 ± 1.7
38-11 (x)	19	4	9.0 ± 0.2	10.8 ± 0.5
38-11 x WF9	19	4	14.6 ± 1.8	16.7 ± 1.9
38-11 (x)	21	4	14.0 ± 2.4	14.5 ± 1.7
WF9 x 38-11	21	10	15.7 ± 1.6	20.1 ± 2.3

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1. Studies on the Hm locus.

In 1948 a single cross (K61 x Pr) which was hm/hm was crossed by a number of translocation stocks, 20 x R-20, -41, and -50 (from Conn.) and 1-5, 1-7, 1-7a, and 1-9b (from Cal. Tech.). All translocations involved chromosome 1, and in all but 20 x R-50 the point of interchange was in the long arm of this chromosome.

In 1949 the F_1 progenies were grown in rows of 45 plants and inoculated with a spore suspension of Helminthosporium carbonum Race I when about one foot tall. Plants were rated for resistance one week after inoculation, 3 weeks after inoculation and again when mature. Since susceptibility to infection by this fungus is inherited as a single recessive factor it might be expected that the F_1 progenies (Hm hm) would be completely resistant. This expectation was realized in all but one case, hm/hm x 1-7. In this progeny it was apparent at the first scoring that all plants were more susceptible than is usual in heterozygous material, and that some plants were quite susceptible. The critical factor in scoring was size of lesions, and a scale was used where 10 = complete susceptibility (of the K61 x Pr type) and 1 = complete resistance. On this basis all mature plants in the above progeny had a rating of 2 or more with some plants being as high as 6.

Since limited observations showed the translocation parent (1-7) to be completely resistant, and the F_1 progeny to show an intermediate degree of resistance, and the break in chromosome 1 was on the long arm in the vicinity of the Hm locus, it seemed possible that a position effect of the Dubinin type might be involved. To check this hypothesis, many F_1 plants of various degrees of intermediate resistance were back-crossed by the susceptible parent (K61 x Pr). If the position effect hypothesis were tenable some completely resistant plants should be found in the back-cross progeny. They would arise from crossing-over between the locus of hm and the point of translocation so as to put the Hm allele in a normal chromosome where presumably it would function as a complete dominant. The back-cross progeny would then consist of (1) semi-sterile plants of intermediate resistance and (2) fertile plants of complete susceptibility in the non-crossover group; and (1) fertile plants of complete resistance and (2) semi-sterile plants of complete suceptibility in the cross-over group. Our findings in 1950, however, showed that the fertile plants that were not completely susceptible were of intermediate resistance, just are the majority of their semi-sterile sibs, rather than completely resistant as a position effect hypothesis would demand. Thus this explanation is ruled out. In 1950 the back-cross progenies (T Hm/+hm)x(+hm/+hm) were inoculated when about 1 foot high and scored three times during the growing season. The final ratings are summarized in table 1 as to numbers of plants falling into each class (where 10 = complete susceptibility and 1 = complete resistance). It is apparent for the first four progenies that the expectation of approximately fifty per cent homozygous hm/hm (completely susceptible) plants is realized. As was found in the previous year the majority of the heterozyotes were not of complete resistance but of the intermediate type. In 1950, 59 plants of the translocation (1-7) were inoculated and all were found to be completely resistant. The rating of plants of intermediate reaction was independent of the location of Hm in a normal or translocation (as has been mentioned above). This can be inferred from the fact that the 11 plants that had normal pollen and were not completely susceptible (cross-over types) were intermediate in resistance. The ratings of these 11 plants were 6, 5, 7, 3, 5, 7, 1, 4, 4, 7, and 1. Had the intermediate ratings of the F_1 plants

Table I

Back-cross Progenies (T Hm/+hm) x +hm/+hm. 1950

Rows	Rating of F_1 in 1949	Distribution of plants in different classes Classes of Resistance										Total
		1	2	3	4	5	6	7	8	9	10	
2245-48	6	3	2		2	3	6	2	6	0	29	56
2249-51	6	0	2		2	3	2	1	0	0	27	40
2252-64	5	7	21		19	9	9	5	2	0	94	199
2265-79	5	12	27		8	6	6	0	0	0	97	176
2280-94	2	37	22		15	13	14	13	24	0	62	214

been due to the proximity of Hm to the point of translocation, the plants above resulting from cross-overs should all have had a rating of 1. The intermediate phenotype of the heterozygous plants (both in F_1 and back-cross progenies) may be ascribed to one of two alternative explanations which cannot be differentiated. The translocation parent (1-7) may be carrying an Hm iso-allele- a different allele but distinguishable only by special tests - such that Hm'/Hm' is resistant but Hm'/hm is intermediate in reaction. The other explanation is that 1-7 is carrying the allele for resistance Hm with closely linked modifiers working towards susceptibility so that Hm mod./Hm mod. is resistant while Hm mod./hm is intermediate. This second hypothesis while explaining the observed data as well as the first does not seem to be as sound.

An interesting situation is found in regard to the fifth back-cross progeny in Table 1. Although the F_1 parent had a low disease rating of 2, it showed a greater percentage of intermediate plants than any other progeny and a significant deficiency of completely susceptible plants. Quite a different picture is obtained if the results of the first and second scoring are tabulated with the third scoring as in Table 2. It is obvious that the 51 plants (113-62) first scored as susceptible later had a lower disease rating, some plants changing in score as much as 9 points on the scale.

Table 2

Backcross Progeny (THm/+hm) x (+hm/+hm) 1950

Rows	Rating of F_1 in 1949	Distribution of plants in different classes Classes of Resistance										Total
		1	2	3	4	5	6	7	8	9	10	
2280-94 1/	2	72	10	9	5	2	6	3	0	0	113	214
2280-9A 2/	2	59	18	9	9	7	12	8	27	0	65	214
2280-9A 3/	2	37	22	14	15	13	14	13	24	0	62	214

1/ As classified at first scoring.

2/ As classified at second scoring.

3/ As classified at third scoring.

With a further grouping of the intermediate from line 3 of Table 2 into two groups - 1-2 and 3-8, the following situation is found at the third scoring:

Completely susceptible	62
Susceptible changing to intermediate	51
Intermeduate	48
Resistant or nearly so	53

In the light of the above data it is suggested that the F_1 parent of Rows 2280-9A was heterozygous for a single dominant factor not linked to the locus hm and which is rather effective in modifying the phenotype towards resistance as the plant grows older.

A composite of all back-cross progenies gives 642 plants of which 34 were cross-over types giving an estimate of 5.30% recombination between the hm locus and the point of translocation in chromosome 1 in 1-7.

O. E. Nelson and A. J. Ullstrup

2. Endosperm characteristics with Su_1 Su_2 and Du

For the past several seasons we have attempted to isolate and recognize the twelve true breeding genotypes involving the three loci Su su^{am} su, Su_2 su_2, and Du du. It is believed that all twelve stocks have now been isolated although final tests have not been completed. It appears to us at present that three testers will distinguish between the stocks. The following reactions are expected:

Genotype to be identified	Selfed appearance	Appearance on Female Tester Stock		
		su_2	su^{am} du	su du
Su Su_2 Du	Dent	Dent	Dent	Dent
Su Su_2 du	Dent	Dent	Translucent Slightly wrinkled	Dent
Su Su_2 Du	Dull surface	Dull surface	Dent	Dent
Su su_2 du	Translucent Slightly wrinkled	Dull surface	Translucent Slightly wrinkled	Dent
su^{am} Su_2 Du	Dent	Dent	Dent	Semi opaque Slightly wrinkled
su^{am} Su_2 du	Translucent Wrinkled	Dent	Translucent Wrinkled	Translucent Wrinkled
su^{am} su_2 Du	Translucent Wrinkled	Dull surface	Dent	Translucent Slightly wrinkled
su^{am} su_2 du	Translucent Wrinkled	Dull surface	Translucent Wrinkled	Translucent Wrinkled
su Su_2 Du	Strongly wrinkled	Dent	Dent	Strongly wrinkled
su Su_2 du	Strongly wrinkled	Dent	Translucent Wrinkled	Strongly wrinkled
su su_2 Du	Strongly wrinkled	Dull surface	Dent to Slightly wrinkled	Strongly wrinkled
su su_2 du	Strongly wrinkled	Slightly wrinkled	Translucent wrinkled	Strongly wrinkled

During the past season, the 64 possible endosperm genotypes involving Su su, Su_2 su_2 and Du du were produced and are in the process of being analyzed for amylose content, water soluble polysaccharides, and starch content. A program of combining the wx and wx^a alleles with certain of the twelve genotypes has been undertaken with the hope of elucidating more fully, the sequence of gene action in determining amylose content in the endosperm.

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1. Further studies on A^b.

The factor for shrunken endosperm (sh_2) is reported by E. B. Mains to be in the third linkage group about one-quarter of one unit from a_1. Because of its favorable location it is being used as a marker gene in the current studies on the compound nature of A^b.

From the cross A^b Sh et/a sh Et x a sh twenty-four crossovers in the a-et segment were obtained and survived testing. Seven of these strands carried A^b and all seven were A^b sh Et. Seventeen carried a and of these fifteen were a Sh et and two were a Sh Et. These data indicate that sh_2 is distal to A_1, that is, between A_1 and Et.

In past experiments the occurrence of a large majority of A^d (pale) derivatives from A^b/a plants has been associated with crossing over in the a-et segment, the isolated pales being linked with the et allele carried on the a chromosome of the tested plants. It was argued that these crossovers occur within the A^b "locus" the A^d derivative representing a proxiimal component of A^b. Since sh_2 is distal to A and so close to it, its use in these experiments should allow a localization of this crossover event.

From A^b Sh/a plants 27 A^d cases have been analyzed. Twenty-three of these were A^d sh and the remaining 4 were A^d Sh;only 1 out of 400 A^d cases are expected to be linked with sh if there is no crossover basis for their origin. Hence this crossover event is localized within a segment less than one unit in length.

The four A^d Sh cases from A^b Sh/a sh plants suggest that A^d may arise without crossing over at the A^b locus. This is confirmed from studies of plants carrying A^b on one chromosome and a deficiency on the homologue and designated A^b/a-XI (the deficient piece is now known to include Sh_2 also). The occurrence of A^d here could not result from crossing over involving homologues. Among 32,000 tested gametes from such plants one A^d case has been found. Analysis has ruled out illegitimate bases for its origin. It could have resulted following mutation of the residual component of A^b to a null form but it is not possible to rule out the alternative explanation of sister chromatid exchange which in this case would have be be unequal.

2. Pales from other compounds involving A^b.

Fifteen pale mutants were obtained from A^b/A plants. These are similar in level of color to A^d and further tests are required to determine whether they are similar in other respects. The plants which gave these mutants were heterzygous for et. Twelve of the fifteen pales carried the et gene which was linked with A in the egg parents suggesting that the occurrence of pales in this compound is related to crossing over.

A similar result has been obtained with compounds of the type A^b/a^b. Here too the large majority of pales carry the et alleles which was linked with a^b in the parents. There is the suggestion, however, that these pales are of different levels. The occurrence of pales of different levels from this compound and not from others that have been tested may well be related to the peculiar action of a^b which has a strong competitive effect. If the varied nature of these pales is confirmed their origin may, for hypothetical purposes, be viewed as a consequence of different local synaptic patterns be viewed as a consequence of different local synaptic patterns at the A "locus" in these compounds and further may require that a^b itself has components separable by crossing over.

John R. Laughnan

3. Linkage relations of duplicate genes pg_{11} and pg_{12} which give a pale green phenotype.

The pg_{11} locus is between Y and Pl in chromosome 6 while pg_{12} falls to the right of wx in the long arm of chromosome 9.

F_2 data from self-pollination of $\frac{Y\ Pg_{11}}{y\ pg_{11}}\ \frac{Sh\ Wx\ Pg_{12}}{sh\ wx\ pg_{12}}$

The Y locus in chromosome 6 is independent of the Sh and Wx loci in chromosome 9 but Y, Sh and Wx all show linkage with the pale green character since it is due to duplicate genes, one of them being in chromosome 6 and the second in chromosome 9.

Y	Y	Y	Y	Y	Y	Y	Y	y	y	y	y	y	y	y	y
Sh	Sh	sh	sh	Sh	Sh	sh	sh	Sh	Sh	sh	sh	Sh	Sh	sh	sh
Wx	Wx	Wx	Wx	wx	wx	wx	wx	Wx	Wx	Wx	Wx	wx	wx	wx	wx
Pg	pg	Pg	pg	Pg	pg	Pg	pg	Pg	pg	Pg	pg	Pg	pg	Pg	pg
810	6	119	0	87	13	123	17	252	7	30	2	17	18	23	28

Total 1552

Y- Pg_{11} = 22% recombination
Sh- Pg_{12} = 25% recombination
Sh- Wx = 22% recombination
Wx- Pg_{12} = 7% recombination
Y- Sh = 50% recombanation
Y- Wx = 48% recombination
linear order is Sh-Wx-Pg_{12}

M. M. Rhoades

4. Linkage of a new glossy character in chromosome 5.

This new glossy gives a semi-dwarf plant with transverse bands of necrotic tissue. The absence of recombinations with brittle-1 indicates it lies close to the centromere of chromosome 5. McClintock's failure to find glossy sectors in her studies with ring chromosomes composed of proximal portions of the short arm of 5 would suggest that this new glossy gene lies in the long arm of 5.

F_2 data from Bt gl/bt Gl plants. Pr is segregating as is A_2 but an aleurone ratio of 27:37 indicates three aleurone genes are segregating.

Pr Bt		pr Bt		Pr bt		pr bt		wh Bt		wh bt		
Gl	gl	Gl	gl	Gl	gl	Gl	gl	Gl	gl	Gl	gl	
464	264	91	9	6	0	10	0	409	216	318	0	Total 1787

M. M. Rhoades and Ellen Dempsey

5. Gamete factor

A male gametophyte factor, Ga_g, has been found on the short arm of chromosome 9. Linkage with the waxy locus is very close. Self-pollination of Gawx/gaWx plants yield 47.5% waxy kernels. The slight deviation from a 1:1 backcross ratio may be due to some functioning of ga pollen, crossing-over resulting in GaWx pollen grains, or both. To date no crossovers have been recovered.

Drew Schwartz

6. "Tassel-like ear" and ramosa.

Eyster's "tassel-like ear" (Maize News Letters 23 and 24) appears to be identical with ra_1. The F_1 between the two stocks has the typical ramosa ear and tassel.

A small quantity of seed of a ramosa stock carrying V_g (vestigial glume) is available. We are using this stock to facilitate study of the developmental morphology of the ramosa ear and tassel.

Earl R. Leng

7. Illinois chemical strains.

A new high in oil content in Illinois High Oil and a new low in protein content in Illinois Low Protein were reached in the 50th generation of selection in the Illinois chemical strains of corn (1949). As has been true for a number of generations, the chemical analyses of Illinois Low Oil and Illinois High Protein showed little change. Analyses of the 1949 crop are shown below. (See Maize News Letters 23 and 24 for preceding years' analyses).

	% oil		% protein
Ill. High Oil	15.36	Ill. High Protein	19.45
Ill. Low Oil	1.01	Ill. Low Protein	4.91

Summaries of the progress attained by 50 generations of selection in this experiment are being published, and should be available by late this year.

Earl R. Leng and C. M. Woodworth

8. Dwarf and short plants.

a. Classification of genes controlling reduced plant height was continued on a considerable scale during the 1950 season. Twenty-six stocks carrying unidentified and unlocated dwarfing genes were grown. Some of these stocks ("Oakes dwarf," "Hy dwarf," "R4 dwarf" and others) have previously been described in the Maize News Letter; others are new.

b. The designation brachytic-2 (br_2 is suggested for the major gene controlling reduced internode length in the "Oakes dwarf" and "R4 dwarf" stocks. This mutant gene is apparently of rather frequent independent occurrence, since Singleton reports several additional stocks which carry it. "Oakes dwarf" and "R4 dwarf" differ phenotypically in that the former has all internodes greatly shortened, while the "R4 dwarf" and related stocks ("Hahn 6" and others) have short internodes only below the ear. The F_1 between the two stocks shows the same internode length pattern as "R4 dwarf." It thus appears that one major gene and one or more modifiers are involved, though we cannot at present exclude the possibility of multiple allelomorphism. F_2 data are so far inconclusive.

c. Six new short mutants, five of which were found in standard inbred lines, have been found to be genetically different from br_1, br_2, Singleton's rd, and the "Hy dwarf" gene. Further tests are in progress.

d. F_2 of "W8 dwarf" x br_2 shows a segregation of 13 apparently normal: 3 "W8 dwarf" type in the seedling stage. "W8 dwarf" type segregates can easily be classified in this stage, since elongation of the leaf sheaths is greatly reduced. At maturity, normal height plants, both short types and the double dwarf can be classified, giving a close fit to a 9 : 3 : 3 : 1 ratio.

e. Both "W8 dwarf" and "07 dwarf" type segregates can easily be classified in the seedling stage. F_2 populations of both these mutants with multiple-chromosome testers from Stadler and Mangelsdorf have been studied intensively in the greenhouse this winter. The "W8 dwarf" gene is quite definitely not linked with $\underline{lg}_1$. (Chrom. 2), $\underline{a}$ (Chrom. 3), $\underline{gl}_1$ (Chrom.7) or $\underline{g}_1$ (Chrom.10). There is a possibility that it is loosely linked with $\underline{su}_1$ (Chrom, 4), but more precise tests are needed.

Earl R. Leng and M. L. Vineyard

9. Unpaired row-number.

In 1946 a nine-rowed ear of corn was found by I. W. Hepperly and reported (Jour. Hered. 40: 62-64, 1949). Seed was obtained from this source for studies of the inheritance and developmental morphology of this character.

Hepperly described the type as odd-rowed. This is only partly true, since the condition is caused by the failure of one spikelet of each pair to develop from branch primordia which normally produce two spikelets. This results in an ear with half the number of rows normally expected; i.e., a normally 18-rowed ear would be 9-rowed, a normally 16-rowed ear would be 8-rowed. The unpaired condition of the spikelets also occurs in the tassel.

Inheritance of the unpaired spikelet condition was originally believed to be controlled by a single recessive gene. My studies have shown that inheritance is more complex. F_1 populations between the unpaired-spikelet type and Roman's translocation testers T.B.-1a (9-70 B 1-1), T.B.-4a (9-72A-1), and T.B.-9b (8-193-2) have been grown. F_1's from crosses with testers 4a and 9b had unpaired rows, but the F_1 with 1a tester had unpaired rows only on the tips of the ears.

Other F_1 populations showing unpaired spikelets were those from crosses of an unpaired-row selection with multiple testers from Stadler and Mangelsdorf individual chromosome testers 1 and 2. No ears with unpaired rows were found in the F_1 between the unpaired-row selection and Mangelsdorf's chromosome 9 tester.

Wesley C. Wilcox

University of Minnesota
University Farm, St. Paul 1,Minn.

1. Nitrogen mustard.

One of the partially- sterile lines from nitrogen mustard treatment of pollen (News Letter 1950) has a typical ring of four chromosomes plus 8 pairs.

2. Corn borer resistance.

Studies are in progress using translocations to determine what chromosomes in a resistant Minnesota inbred are carrying the factors for corn borer resistance.

M. A. Ibrahim

3. Deficiencies

Crosses between translocations involving the same two chromosomes were studied for genetic and cytological ecidence of intercalary deficiency or duplication. The crosses of T1-7a x b and T4-5c x T4-5d had essentially normal pollen and ovules. The former when crossed with f produced about 11% of fine - striped plants in F$_1$ indicating a viable deficiency for this locus. It was not transmitted through the pollen. In all the F$_1$ plants of T1-7a x b there was a short deficiency (indicated by a loop) in the long arm of 7 near the centromere. Although expected, there was no corresponding loop in chromosome 1.

The F$_1$ of T3-7a x b when crossed with floury-2 gave some floury grains. This unlinked gene should be in the long arm of either 3 or 7.

Other crosses giving 25 to 35 per cent abortion in F$_1$ were: T1-9a x c, T2-6b x T2-6 (6049) and T5-7a x c. In all of these F$_1$'s, there were 10 "bivalents" at diakinesis.

D. M. Gopinath (Bangalor 4, India)
and C. R. Burnham

4. Ga factors

Tests are being run for the presence of different Ga factors in the Black Beauty Pop variety. Ten different plants had a factor for the Ga effect on bt. Only one plant had a factor having an effect on su. For a, c, r, occasional plants had medium, low or high ratios which may or may not be chance variations.

E. Clark

5. Brittles and other genes.

Our stock of bt$_4$ is the same as bt$_1$; agreeing with the report in an earlier News Letter. Other brittles are being tested. I understand that bt$_3$ has been lost (does anyone have it?)

The following characters appearing in the corn breeding project and in other material are established:

An excellent white-striped character - different from j, sr, f; brittle endosperm; upright tassel, expanded tassel glumes, su_2 type endosperm, vivipary, glossy.

Identity and linkage tests are in progress.

K. Das, A. A. Fleming, E. Clark
A. H. Corzo, M. Hashim

6. Crossing over differences in reciprocal crosses with T5-9a.

As reported in the 1950 News Letter, plants heterozygous for T5-9a show a much higher recombination value when used as the ♂ than when used as the ♀ parent. Progeny from these crosses were grown and similar differences were found in reciprocal crosses, regardless of whether the plants tested were from the cross giving high or low crossover values.

C. R. Burnham

7. Studies on purple and red aleurone pigments.

Field observations, paper chromatography, and anthocyanin color tests were used in a study of Pr and pr seeds and their pigments. Four widely different lines of each genptype were selected and grown in the field in 1950. As only distinct purple and red types were used, the results may not hold for all modifications of purple and red aleurone.

a. The color first appeared 23-27 days after pollination. A distinct layer of aleurone tissue was present before the pigment appeared. In seeds just turning color, the inner endosperm beneath the colored aleurone area was usually firm, nearly hard; elsewhere soft and milky.

b. In agreement with the report of McClary (CNL, 1942), purple aleurone contains a cyandin derivative, red a pelargonidin derivative. Within the limits of the paper chromatographic method, it may be said that only one of the two pigments occurs in any one seed--they are not mixed. Pr is chemically as well as phenotypically dominant--only cyanidin occurs in seeds with one or more doses of Pr. It should be pointed out that the only chemical difference between the two pigments is the extra hydroxyl group on cyanidin.

c. Available evidence indicates that the naturally-occurring pigments are 3-monosides of the two anthocyanidins. There is suggestive evidence that these are complexed with one or more organic acids.

d. Intense red (pr in) aleurone apparently differs from dilute red only in concentration of pigment.

e. Color test for separation of *Pr* from *pr* seeds in questionable cases: (Cyanidin derivatives give a blue ferric reaction in dilute acid, pelargonidin derivatives do not). The pericarp is scraped off in a small area with a knife. The aleorone is scraped through in order to provide both ruptured cells and a white or yellow endosperm background against which to observe the colors. A very small amount of weak (about 1%) HCl is applied, and agitated slightly until the scarlet solution obtained shows that sufficient anthocyanin has dissolved. The change observed with the addition of a drop of 2% $FeCl_3$ solution is to a blue-purple if *Pr*, indeterminate if *pr*. The test is not as clear as that for waxy, but comparison with known *Pr* or *pr* makes it satisfactory. It is suggested that the test might be used especially well in separating *Pr* from *pr in*. The writer would appreciate hearing of any aberrant results obtained with this test.

E. H. Coe, Jr. (Now Univ. of Illinois)

8. Quantitative inheritance and pollen grain size.

In the 1950 Corn News Letter, the pollen of inbreds was reported to be larger and more uniform than that of cross-bred material. Further work included a study of environmental effects on pollen size, of segregation for pollen size in hybrids and of the inheritance of pollen size and its relation to combining ability

Environmental effects (4 plants each group, 25 pollen grains per plant):

		Group No.	larger diameter *	Comparison of	diff. S.E.
Hybrid V_3 x Oh51A	greenhouse pots	1	70.53 ± .30	1 and 2	0.56
"	" floor bed	2	70.75 ± .26	2 and 3	2.17*
"	Field	3	71.60 ± .29	1 and 3	2.52*
Inbred Al 58	greenhouse	4	70.40 ± .27	4 and 5	1.29
"	Field	5	69.79 ± .39		
Starved plants in greenhouse pots (30 cm. tall)			70.98 ±		

*measurements in divisions of micrometer scale, 1 div. = 1.2 μ

9. Segregation of pollen size in translocation heterozygotes.

Plants heterozygous for T1-5-6-7 (giving a ring of 8 chromosomes) were used; 200 pollen grains measured per plant, 5 plants of each stock. Three of 10 F_1 plants showed bimodal curves for pollen size (larger diameter) and one tended toward bimodality. No bimodality was noted in the normal or the homozygous translocation parents; or in normal material in other experiments. If growth factors tend to be expressed in the gametophyte generation, bimodality might be expected for pollen in certain of the crosses with translocation stocks giving larger rings.

10. Pollen size inheritance and correlation with combining ability.

Twenty-three F_8 inbreds selected from 3 different single crosses (according to the scheme AxB, BxC, AxC) and the original parental inbreds were analyzed for pollen size. Twenty-five pollen grains per plant and 6 plants per inbred were studied (except in lines 1, 6, 8, 9, and 25 with only 4, 4, 5, 2, and 5 plants respectively.

All the F_8 inbreds resulted from random selection in F_2 and F_3. After F_3, selection was applied with the intention of keeping representative samples of the total segregation from each cross (for plant characters).

The means for each inbred and the significance of differences between inbreds are:

	Group from P_1 x P_2						Group from P_1 x P_3				
Inbred no.	2	3	4	5	6	7	10	11	12	13	14
Ave. short x long diameter*	100	110	119	114	111	115	102	107	105	98	110

F=17.98 $\sigma = 3.909$ C.V. = 3.64 L.S.D. = 4.514 P= 0.05

*This product is proportional to the area of an ellipse with these diameters

Number of significant differences in group P_1 P_2 - 12/15 = 80%
" " " " " " P_1 P_3 - 7/10 = 70%
" " " " " " P_1 P_2 and P_1 P_3 - 22/30 = 73%
Total 41/55 = 74%

The average pollen size of the parents and that of the inbreds selected from crosses between them and also the test cross yields for each are:

	Pollen large diameter x short diameter	Order of pollen size and yield	Test-cross yield production
P_1	100	3rd	53.2
P_2	115	1st	62.5
P_3	113	2nd	57.1

			Larger Diameter	Test-crosses yield in Bu./acre
Low x high	average	P_1 P_2	69.50±.52	57.85
"	"	F_8 from P_1 x P_2	70.15±.32	57.90
Low x med.	"	P_1 P_3	68.66±.52	55.10
x	"	F_8 from P_1 x P_3	68.13±.32	56.80
High x med.	"	P_2 P_3	70.41±.28	59.80
"	"	F_8 from P_2 x P_3	70.48±.33	57.80

The correlation coefficients between pollen size and test-cross yields are:

	Inbreds from P_1 x P_2	Inbreds from P_1 x P_3	Inbreds from P_2 x P_3	Total
r value	+.94*	+.23	+.11	+.24
Probability to be by chance	.01	.6-.5	.05	.10- .05

* Pollen size was expressed as the product of diameters. Very little difference was found when average diameter was used.

For the total the r value approaches significance but not very important. There seems to be some relation between pollen size and yield of test-crosses, possibly high for inbreds selected from some crosses, not for others.

When combining ability was expressed as a performance index, which attempts to correct the yields for the relation between maturity and yield, no significant correlation was found.

Further studies are in progress, and crosses between these lines will be studied.

We wish to express our deep gratitude to Drs. Hayes, Rinke and Pinnell for the inbreds and the data on combining ability, and for advice, suggestions and discussions.

José L. Blanco (and M. L. Blanco)
(Now at Galicia, Spain)

11. Effects of first brood corn borer on yield.

Recovered lines, out of crosses between Minnesota lines and lines from other states which were reported to have low borer ratings were grown in their F_6 generation under manual infestation conditions. Five highly resistant and five highly susceptible lines were selected on their reaction to leaf feeding by the first brood larvae. Crosses were made between resistant x resistant, R x R, resistant x susceptible, R x S, and susceptible x susceptible, S X S, lines. Eight randomized blocks of the 10 inbred parents, and eight randomized blocks of 30 single crosses between these lines and 6 standard single crosses or double crosses were grown under manual infestation and also under non-infested conditions.

Individual plant ratings for leaf feeding and overall injury have been taken. Agronomic characters, e.g. yield, ear moisture, good ears per plant, ear length, kernel ear rows, stalk breakage, and smut infection have also been studied.

The resistant inbreds and the R x R crosses were rather highly resistant. In fact, the F_1 crosses averaged slightly higher in resistance than the inbred parents. The susceptible lines and the crosses of S x S were highly susceptible while the R x S crosses were intermediate in borer injury.

By comparing the yields of the various types of crosses under manual infestation and in non-infested trials in adjacent areas, it was learned that R x R crosses yield about the same, on the average when tested under the two conditions. However, manually infested R x S crosses yielded 6% less than the non-infested, and infested S x S crosses yielded 10% less on the average than the same crosses under non-infested conditions. Ears on the ground and ears from broken stalks are included in the yield data. In these trials infestation as shown by leaf feeding in the normally non-infested plots was very small. As there was practically no infestation by the 2nd brood borer in

Minnesota in 1950, this study represents the effect of the 1st brood borer only.

Rameshwar Singh and H. K. Hayes

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A highly mutable allele of A_1.

A new a_1 like allele, which is extremely mutable in the presence of the gene Dt but like a_1 is stable with dt dt, was found as a single seed on a selfed ear of A_1/a_1 Dt Dt. It can best be described by comparison with a_1, as reported by Rhoades (1941).

In the presence of Dt, the more mutable a (a^m) mutates to A_1 alleles in all tissues which can be tested, giving many dots on the aleurone, a few red pericarp streaks with P, and many purple plant sectors with B and Pl. When the aleurone dots of a^m and a were compared, on sib seeds of a^m a^s a^s Dt Dt Dt and a a^s a^s Dt Dt Dt constitution, the following differences were evident. The a seeds had an average dot number of 47 while the a^m seeds had 1500± (this count is the nearest estimate because the a^m dots were so frequent that many adjoined and could easily have been miscounted). The standard a dots were circular, regular in outline, relatively uniform in size, and mostly rather dark. The a^m dots, on the other hand, were angular, irregular in outline, and ranged widely in size, from single colored cells, through all intermediate sizes up to whole seed cases. Four cases have been found where the colored sectors included 1/8 to 1/4 of an ear. Most of the a^m dots also had a sharply defined border, and were distinctly lighter than full colored (including, however, some very dark and some very light ones). There was also a rather high frequency of colorless non dotted partial seed sectors representing somatic mutations to a^s.

These differences in frequency, size, color, etc., of aleurone dots, have a parallel occurrence in other tissues (such as sheath, husks, and anthers), when compared in sib a^m a^m Dt Dt and a a Dt Dt plants. The sectors conform to cell lineage and are so frequent in a^m Dt plants as to give a blending effect on the sheath. The pericarp, however, shows little difference, both genotypes having a few small red sectors on each brown pericarp ear.

A great number of independent mutants of diverse types have been obtained from a^m through anther sectors, ear sectors, and single seed cases. Most of these have not been tested, and in many cases exist only as single seeds.

Eleven colored mutants obtained from anther sectors have been tested for plant and pericarp color. These included two A's, three A^{rb}'s five A^{br}'s, and two A^{lt}'s. This sample, though small, is in contrast with the twenty nine mutants obtained from a, by Rhoades, which included 27 A's, 1 A^{rb}, and 1 A^{br}. It indicates that the mutants from a^m group about a level near A^{br}

and are considerably below the level of most of those from *a*. This agrees with the previous observation that a^m dots are mostly less than full colored and that there is little difference in the frequency of red pericarp sectors from *a* and a^m.

The majority of mutant alleles seen have been stable. Tests of the lighter *A*'s, for dotting, in the presence of Dt, showed complete stability in all but two cases. These two single seeds from a cross of a^s a^s *Dt Dt* by a^m a^m *Dt Dt* had a typical solid pale background (one was very dark) with frequent (180+) clear dark dots and with a few colorless dots. One of the colorless sectors was large enough to include three full colored dots within its borders, indicating a possible mutation back to a mutable form of *a*.

The full colored mutants could not be tested for dotting but their germinal mutation rate to *a* could be measured. A test of five of these extracted *A*'s gave no *a* mutants in 47,755 gametes.

Five large ears, two from one a^s mutant and one each from three others, were carefully examined under a microscope, and not a single colored cell was found.

There occurred also a second type of unstable allele. Nine independent, less mutable a^m seeds (designated a^{m-}) which had 150-300 dots on each instead of the usual 1500+ have been found. These, however, could be mutants of *Dt* to *dt* in the female germ cells giving rise to a *dt dt Dt* endosperm.

To determine the frequency of occurrence of the various mutant levels seen, a cross of a^m a^m *Dt Dt* by a^s a^s *Dt Dt* was made. The ears were examined for single seed cases, avoiding grouped mutants which would indicate a sector. Of 15,000 gametes tested, 57 were *A* (this included the classes *A*, A^{rb}, A^{br}, and some of A^{lt}, all of which would appear as fully colored seeds in this cross), 4 were clearly A^{lt}, 2 a^{br}, 7 a^{m-}, and 20 a^s.

M. Gerald Nuffer

Nebraska Agricultural Experiment Station
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Spontaneous mutations.

Four different spontaneously-occurring mutations in maize have been noted in the course of the genetics studies at Nebraska. All trace to lines secured from Dr. John H. Lonnquist's breeding material. These matters have been temporarily designated dp-Nl, pg-Nl, v-Nl, and bt_1-Nl. We will be glad to furnish seed carrying these mutations to anyone on request.

dp-Nl. This mutant appeared in the F_2 from crosses of CC5 x recovered L289. The tassels of a portion of the plants had been irradiated. Fifty-six of 103 F_2 families segregated for an abnormal type of plant, designated dp-Nl. Since the mutant plants occurred independently of treatment, including occurrence in some of the control cultures, the possibility of an irradiation-induced mutation is excluded.

Segregation **for** dp-N1 within a family varied from 1 in 4 plants to 1 in 18 plants with 98 abnormal plants in a total of 967 plants. At maturity, height of the mutant plants varied from 1/6 of the height of the normal sibs to almost normal height. The leaves were uniformly narrower and darker green than normal, with necrotic edges which frayed, giving a slashed appearance. The reproductive organs varied from plants producing both tassel and ear shoot to those lacking both. The tassels were small and bunched, but a superficial examination indicated that pollen was normal. Very limited cytological observations indicated the following: the various stages of meiosis were all present, but there was considerable deviation from the normal behavior of chromosomes. Some of the abnormalities observed were stickiness of chromosomes, delayed cell division, and aberrant spindle formation at meiosis II. Nevertheless, the resulting microspores and young pollen grains appeared normal for the most part.

pg-N1. In the same material as that in which dp-N1 appeared, but confined to the 4-minute nuclear-reactor treatment, approximately half of the families segregated for a yellow-green plant. The mutant plants died in an early stage of development. Segregating ratios within individual families were variable, but the 134 plants from the combined progenies gave a good fit to a ratio of 3 normal to 1 mutant. The possibility that the mutation was due to the treatment is remote since each of the 9 segregating families would have had to trace to the simultaneous occurrence of the same mutation in 9 different pollen grains. Neither could the mutation have been present in the male parent since the same plant was used in all the treatments . On the other hand, different plants were used as female for each treatment and they were descended from bulk selfed seed. The plant used as female parent in the 4-minute treatment must have been heterozygous for the recessive gene yg-N1. It is possible that the mutant plant may be due to one of the pg alleles which is lethal in its effect.

v-N1. This virescent can be traced to the heterozygous condition in a recovered L289 plant from selfed seed grown in 1948. In 5 segregating cultures grown in 1950, there was a good fit for a 3 normal : 1 mutant ratio for the entire population.

This mutation has a rather severe effect on the plant throughout its development. In addition to the virescent condition in the seedling stage the plants were noted to be about one-half as tall as the normal sibs at approximately 30 days and 60 days after planting. The leaves tended to be stiff and narrow toward the tips. At flowering time the plants were about two-thirds as tall as the normal sibs. The plants produced no kernels, even when allowed to open-pollinate.

bt_1-N1. This mutant occurred in K167, a line from an open-pollinated, yellow ~~dent~~ variety. It is conditioned by a single, recessive gene. The endosperm is similar to that described for bt_1. Extremely poor stands have been secured and the mutant plants are very late in flowering. Tests for genetic identity both by us and by Dr. E. G. Anderson at the California Institute of Technology indicate that this brittle is allelic to bt_1.

E. F. Frolik and Rosalind Morris

University of Tennessee
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Heterosis.

In Genetics 35:420, 1950, Dr. F. G. Brieger published as footnote 2 a comment which is largely unrelated to his main paper. In this footnote, Brieger questions Richey's (J. Herd. 36:243-244, 1946) giving Bruce priority in proposing the hypothesis of dominant favorable factors as a reason for heterosis, on the basis of Bruce's 1910 paper (reproduced in Richey, 1946).

Brieger states that Bruce "missed the essential point of the dominance hypothesis, namely the covering up, in hybrids, of all or most recessive genes by their respective dominant alleles, contributed in part by one or by the other parent." He states that it is shown by the formulae "that the mean frequency of heterozygotes in the hybrid population is inferior to the combined mean of the two parent populations." Actually this is the opposite of what the formulae show. Bruce demonstrates that the mean number of recessives (not heterozygotes) in the hybrid is less than the collective mean of the parent families. He then points out that the aggregate of the dominants and heterozygotes must be larger. It follows that the frequency of the heterozygotes must be greater, not less as Brieger concludes.

Brieger then states, "It would, however, be required that the hybrid population contains less homozygous recessives than either parent population individually, if we want to explain heterosis." Whether the number of expressed recessives in the hybrid population must be less than that in either parental population, or whether it must only be less than the number in the mean of the two parental populations, collectively, depends upon a definition of heterosis. If this term denotes a phenomenon in which the hybrid is more vigorous than the mean of the parents (a very common definition), it is only necessary that there are fewer expressed recessives in the hybrid than in the mean of the parents.

In reading my 1946 paper, I find that I have given greater priority to Bruce than I really intended. It was not my intention to belittle in any way the contribution of Keeble and Pellew (Jour. Genetics 1:47-56, 1910), even though I seem to have done so.

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Niacin inheritance in maize.

Niacin concentration in corn has been found to be primarily a function of the genetic constitution of the endosperm, with practically no influence by kernel size or by differences in the physiology of the seed parent plants as between Su su and su su plants. Within starchy corn, niacin concentration was inherited as a quantitative, multiple-factor character. Most crosses are basically intermediate between the parents with the seed parent exercising twice the influence of the pollen parent. Crosses among some inbreds resulted in concentrations definitely below those expected from parental values. This suggests that some lines are high in niacin because of recessive genes which are suppressed in the hybrid.

The sugary gene was simply recessive for high niacin to its starch allele, the concentration in sugary kernels averaging about 60% more than that of starchy sibs.

The niacin concentration of sweet corns was a poor criterion of what they transmitted to crosses with starchy corn, but this "inherent" niacin concentration of sweet corn could be estimated from crosses with starchy corn of know concentration.

The Su su locus interacted with the multiple-factor system in determining final niacin concentration. Thus, sugary segregates from crosses of sweet corn with high niacin starch corn had higher concentrations than corresponding sugary segregates from crosses with low-niacin starchy corn, the correlation for niacin in sweet and starchy kernels from segregating ears being 0.95 for 28 degrees of freedom.

The increase in niacin due to su was not strictly additive, that in the higher niacin strains being larger than that in the lower niacin strains, both absolutely and relatively. Different sweet inbreds differed in the degree to which they increased the niacin concentrations suggesting a possibility of su alleles differing in their niacin influence.

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Studies on Variegated Pericarp

1. The behavior of a variegated of a given origin in recurrent matings to inbred lines carrying either colorless pericarp, red cob (WR)[1] or colorless pericarp, white cob (WW) alleles.

In 1948 a single collection of pollen from a homozygous variegated pericarp plant, S1937-10, was placed on the silks of several highly inbred field corn lines including W8, W22, W23, M14 (red cob); 40B, and 4Co63 (white cob). The S1937 stock had been inbred to a degree equivalent to three selfings. The immediate parent of S1937-10 was a medium variegated plant heterozygous for colorless pericarp, white cob.

Each of the six resulting F_1 families grown in 1949 was relatively uniform in plant type as expected, but contained three discrete classes of offspring with reference to pericarp type. Among the 304 F_1 plants from which ears were harvested 11% were light variegated, 72% were medium variegated, and 16% were red. The proportions in which the three kinds of plants occurred in each F_1 family were similar. Plant S1937-10 had borne a light variegated ear, but it is assumed, on the basis of the progeny test, that the tassel was a chimera containing V_{lt} (light variegated[2]. V_m (medium variegated), and R (red) tissue. Presumably the ear shoot belonged to the V_{lt} portion of the plant.

Numerous plants within each F_1 hybrid family were backcrosses in 1949 to the corresponding inbred line. Fifty families were grown from these backcrosses in 1950, representing individual light variegated, medium variegated, and red ears, respectively, distributed over each of the six F_1 pedigrees.

Within sampling limits, one-half the plants in each backcross family bore ears in 1950 with colorless pericarp, as predicted. The progenies from the red ears contained about equal numbers of red and colorless pericarp plants.

The 41 families segregating variegated pericarp were scored first for grade of variegation against a set of arbitrarily designated standard ears varying from class 1 (very few red stripes) to class 7 (very heavily striped). As the variegated ears were being worked over, however, it became apparent that the distribution within each family was not continuous but actually more or less sharply discontinuous In addition to the few red ears (ca. 6%) which occurred in these families , variegateds of two grades only, light and medium, appeared to be present. This was unmistakably true for the 22 backcross families involving inbreds W8, W22, and 4Co63. It probably held for the remaining groups(W23, 40B and M14) also, although the separation into the two classes of ears, light and medium variegated, within them was judged "clear-cut" in 12 families, only "fairly certain" in six others, and "uncertain" in one. In the latter seven families the difficulty of classification usually involved the placement of only 1-4 ears. The general character of the results observed on classifying the material on the basis of the discontinuity in grade of variegation may be inferred from table 1 in which the distribution of offspring in the families involving inbred W8 are given.

1/ R. A. Emerson's simplified terminology for the P alleles is followed: VV = P^{VV}(variegated pericarp and cob); WR = P^{WR} (colorless pericarp, red cob); WW = P^{WW} (colorless pericarp, white cob); RR = P^{RR} (red pericarp, red cob).

2/ The terms "V_{lt}" and "V_m" are used in a phenotypic sense, and their employment is not intended to imply that these phenotypes are necessarily associated with corresponding alleles at the P locus.

Table 1

Distribution of progeny from light variegated and medium variegated F_1 ears backcrossed to inbred W8.

Family	Parent ear (F_1)	Number of Progeny V_{lt}	V_m	Red	Colorless	Per cent[1/] V_{lt}
6-70	V_{lt}	21	27	3	65	41.2
-71	"	25	22	1	48	52.1
-72	"	51	44	3	90	52.0
-73	"	38	48	3	96	42.7
-74	V_m	7	160	8	161	4.0
-75	"	9	141	9	124	5.7
-76	"	7	161	7	161	4.0
-77	"	2	134	5	131	1.4

[1/] Based on variegated and red ears.

Four points are noteworthy from a survey of the data from all the backcross families: (1) both light and medium variegated parent ears give the same two classes of variegated offspring, but with different frequencies; (2) within the respective V_{lt} and V_m parent ear groups there is considerable regularity from family to family within three backcross groups (W8, W23, 40o63) in the proportion of V_{lt} and V_m offspring. The W22 backcross families from V_{lt} (but not V_m) ears appear to be definitely irregular in this respect, and the families from the V_{lt} ears in the other two groups (40B, M14) are somewhat doubtful; (3) the frequency of V_{lt} offspring from V_{lt} parents is much higher than from V_m parents and *vice versa* (4) the same basic pattern of inheritance (with modifications superposed in some cases) appears to characterize each of the six backcross groups.

2. The phenotypic expression of variegated pericarp in VV/WR plants in which the WR allele was derived from two otherwise comparable classes of VV/WR heterozygotes, namely, light variegated and medium variegated.

It was demonstrated in 1929 by R. A. Emerson (Genetics 14:488-511) that following self-pollination of variegated pericarp corn plants heterozygous for colorless pericarp, red cob (VV/WR) the resulting VV/WR offspring regularly show a higher rate of somatic mutation of variegated to red pericarp than the VV/VV offspring. This relation held in spite of the fact that in the latter class of individuals there are present two VV alleles capable of such mutation as against only one in the former class. The conclusion was drawn that WR, or a gene closely linked with it, enhances the mutability of VV in VV/Wr hetero zygotes. Furthermore, Emerson reported data which led to the suggestion that the capacity of a given WR (or a closely linked gene) to "stimulate" mutation of variegated to red might be decreased as a result of association with VV in variegated heterozygotes of low grade (i.e., having a low rate of mutation of variegated to red). The present experiment was prompted by this seemingly valid and unaccountable fact.

A part of the same collection of pollen from plant S1937-10 as referred to in 1, above, was placed on the silks of the colorless pericarp, red cob inbred lines W22, W23, W28, W70 and M14. The resulting five F_1 families each comprised light variegated, medium variegated, and red pericarp individuals as a consequence of the previously noted fact that the tassel of S1937-10 was a chimera. The three sharply distinct classes of F_1 plants were used as the pistillate parents in crosses with individual variegated plants heterozygous for colorless pericarp, white cob (VV/WW) untelated to S1937-10. Series of 10-25 plants within a given F_1 family were pollinated with a single collection of pollen. This gave groups of light variegated and medium variegated outcrossed ears in which the seeds throughout each group had a common male parent. The F_1 red ears so pollinated were not tested further.

Essentially this procedure involved passing the WR alleles originally derived from the five inbred lines through a corresponding series of F_1's represented in each instance by otherwise closely comparable light variegated and medium variegated plants. The extracted WR alleles were then reassociated in F_2 with variegated pericarp from a different source.

Sixty-seven such F_2 families were grown in 1950. The variegated pericarp, red cob (VV/WR) ears from them were saved as constituting the sub-group applicable to the study. It will be evident that the WR alleles carried by these ears were derived from the light and medium variegated F_1 VV/WR plants; the VV genes now paired with the WR's were derived from quite unrelated stocks. These red-cobbed, variegated F_2 ears were then scored for grade of variegation against a set of standard ears. In addition, the number of mutations to red (covering about 1/5 kernel or more) was counted on the ears in 17 families.

The results showed that in 16 of the 17 paired comparisons which could be made, regard being given both to the origin of the WR allele and common male parentage, the variegated progeny carrying WR genes extracted from light variegated F_1 plants had a definitely lower mean grade of variegation than the VV/WR progeny which had received the WR allele from a medium variegated sib. The respective mean grades were similar in the single remaining comparison. The mean difference in grade throughout was a little less than one class on the arbitrary scale of standards employed. Moreover, the F_2 families corresponding to light variegated F_1's, on the average, exhibited significantly fewer mutations of variegated to red pericarp per 1000 kernels than the group of families from medium variegated parents.

Our results, when portrayed in this manner are seen to be in clear agreement with Emerson's conclusion relative to the effect on mutation of VV to RR of WR, or a closely linked gene, extracted from VV/WR heterozygotes of different variegation grades.

The direction in which an explanation of this seemingly anomolous behavior is to be sought took a new turn, however, as one fact, not at first apparent to us, became evident. Re-examination of the present populations revealed that the distribution of variegated in the F_2 WR segregates actually was discontinuous rather than continuous as we had assumed in proceeding to score the ears against the standards. Except in three families in which the distributions appeared to overlap, two definitely recognizable classes of ears only were present in each progeny, light variegated and medium variegated. This observation seemed particularly significant in view of: (1) the similar character of the distribution of VV segregates in backcrosses to WR/WR of the same kinds of F_1 VV/WR plants, as reported in section 1, above, and (2) the fact that in the present instance we were dealing with the WR, rather than the VV, segregates from the light and medium variegated heterozygous parent plants.

Table 2

Distribution in F_2 and mean grade of light and medium variegated ears among the WR segregates feom light and medium variegated VV/WR F1 plants pollinated by VV/WW.

	F1 Farent ear		Variegated progeny					
			V_{1t}		V_m			
Family number	Pedigree	Phenotype	No.	Mean grade	No.	Mean grade	Total ears	Per cent V_{1t}
N- 30	VV/WR-22	V_{1t}	35	1.48	23	3.04	58	60.3
N- 36	"	V_m	9	1.44	41	3.12	50	18.0
N- 99	VV/WR-28	V_{1t}	13	1.69	19	3.15	34	40.6
N-102	"	V_m	7	1.71	43	3.04	50	14.0
N-118	VV/WR-70	V_{1t}	18	1.94	14	3.57	32	56.2
N-121	"	V_m	4	1.75	51	3.02	55	7.3
N-123	"	V_m	4	1.50	28	3.53	32	12.5

A representative sample of the data relating to the WR segregates from three different F_1 hybrids is presented in table 2. The pollen applied to the W22, W28 and W70 hybrids concerned was collected from three unrelated VV/WW plants, Attention may be called to the following points in the table:

1. Both light variegated and medium variegated F_1 parent VV/WR ears outcrossed to VV/WW give families containing WR segregates of these same two classes of variegation.

2. If a common VV/Ww pollen parent is used in matings with light and medium variegated F_1 VV/WR sibs, the light variegated WR offspring from the light variegated ears are similar in variegation grade to the same class of offspring from the medium variegated WR ears. This correspondence holds also for the medium variegated WR offspring of the two kinds of F_1 parents.

3. The proportion of light variegated WR offspring from light variegated F_1 VV/WR ears is much higher than from the medium variegated F_1 ears.

4. Points (2) and (3) above, when considered together, make it evident that the difference in mean grade of variegation in entire progenies of similarly bred light and medium variegated F_1 ears is due to the difference in proportion of these two classes of offspring.

3. A tentative hypothesis concerning the genetic basis of the difference between light variegated and medium variegated pericarp.

The parallel nature of the results obtained on testing the VV and WR segregates from the two classes of VV/WR F_1 plants, light and medium variegated, in sections 1 and 2 above, is evident. The data summarized in section 2 show that the genetic basis of the difference between light and medium variegated is readily separable from the VV locus itself. The critical fact is that the differential element, whatever it may prove to be, assorts with WR gametes as well as with VV gametes. Furthermore, the frequencies with which light and medium variegated plants appear among the respective VV and appropriately tested WR segregates from F_1 VV/WR plants of corresponding phenotype are parallel and apparently of similar magnitude.

The data already available reveal possibly important deviations in a few families from the pattern of inheritance which otherwise prevails. These apparent exceptions have not been included in the report, and they cannot be explained at present without recourse to wholly untested assumptions. Moreover, the omission of the red pericarp F_1 plants from the tests of the WR segregates leaves a gap in the evidence which it is essential to fill, especially in view of the known fact that the change from variegated to red involves mutation at the P locus. Any hypothesis advanced on the basis of the current evidence is to be considered tentative, therefore, any may call for more or less radical modification as additional facts are established.

It is assumed that a "modulator" locus distinct from the P locus, and probably remote from it, governs the level of phenotypic expression of variegated pericarp in these stocks. If a particular modulator allele, Mp_1, is present in a variegated plant the pericarp is light variegated; if mp_2 is substituted for Mp_1 the pericarp is medium variegated. Mp_1 and mp_2 mutate to each other in somatic tissue with relatively high frequency. The inbred WR lines used carry still other mp alleles, recessive to Mp_1, whose phenotypic effects on varegation are like those of mp_2. The modulator alleles in certain of the inbred lines appear to be stable; those in other lines possibly may be mutable since irregular ratios of light and medium variegated plants were observed in a few families.

On these assumptions: (1) the foundation plant, S1937-10, was a (mp_2/mp_2 VV/VV -- Mp_1/mp_2 VV/VV -- ?/? RR/VV) chimera and (2) the ratios in which light variegated and medium variegated plants appeared in the several families descended from S1937-10 are determined by the assortment of the particular modulator alleles present including those newly arisen by mutation.

Mutation of variegated to red at the P locus is related to the alleles at the modulator locus. This conclusion is in accord with the well recognized fact that the phenotypic differences between light variegated and medium variegated plants rests on a dissimilarity in frequency and distribution during development of VV to RR mutations at the P locus.

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R. A. Milan

4. Relation between size and position of self-colored (mutant) stripes and heritability in variegated pericarp corn.

An ear of corn either homozygous for VV or heterozygous for VV and a colorless P allele will show a wide range of expression of stripping among its component kernels. The range may include kernels with the entire pericarp colorless, kernels showing a few to a great many very fine stripes, kernels with one or more wide striped in addition to the fine ones, and kernels which are entirely self-red.

Variegated kernels with one wide stripe of self-red pericarp color were selected from VV/WR ears. These kernels were a sample of VV from a variety of sources. Comparable numbers of kernels showing only finely striped variegation were taken from the ears. The few entirely self-red kernsls on the ears were placed in a third category. Stripe width and position were recorded in units which represented 10 degree of arc, assuming that the crown of the kernal could be treated as a deformed circle. The zero point on the scale corresponded to the silk attachment which lies directly above the midline of the embryo. Successive 10 degree increments were marked on large scale models of variously shaped kernels with the numbering progressing in the counter-clockwise direction. Each parent kernel with a wide red stripe (covering 10 degree or more of arc) was scored against one of the models.

Kernels on which the stripe covered all or part of the embryo were subdivided into seven classes. Kernels on which the stripe was abgerminal were also divided into seven classes, such that any one class could be compared with the one diametrically opposite it on the embryo side. Two classes with the stripe restricted to the sides of the kernels were also selected.

The results are based upon 527 ears raised in 1949 and 1140 ears raised in 1950. Each kernel with a self-red stripe was planted and individually staked. The resulting plant was scored for pericarp color (red RR/WR, variegated VV/WR, or colorless WR/WR). Within sampling limits, one-half of the ears in each group were colorless, as expected. Three groups, each comprising seven classes, were available for comparison. Group I kernels had a stripe covering all or part of the embryo, and in addition the stripe included all or part of the comparable 60 degree arc on the abgerminal face. Group II kernels had a stripe covering all or part of the embryo, but the stripe did not extend over the comparable 60 degree arc on the abgerminal face. Group III kernels had a stripe which covered all or part of the 60 degree abgerminal arc, but did not extend over the embryo.

The results are summarized in tables 3 and 4. The finely striped variegated kernels, which may be considered the control for this experiment, gave 4.9% red ears. All classifications of kernels with wide self-red stripes showed percentages of red ears in excess of this. Kernels with the stripe confined to the side of the kernel showed an appropriate two-fold increase, and kernels which were entirely self-red produced only red-eared progeny. The probability of obtaining a red-eared plant from a variegated kernel with a self-red stripe 10 or more degrees of arc in width is significantly higher if the stripe covers all or part of the embryo (Groups I and II), rather than a corresponding area on the abgerminal face (Group III). The probability of obtaining a self-red ear is also significantly higher in a class in Group I than in the corresponding class in Group II.

Table 3

Distribution of progeny from groups of kernels (VV/WR) of differing variegation pattern (1950 data).

Group	Number of progeny			Per cent red 1/
	Red	Variegated	Colorless	
I Stripe on embryo, also on back	84	32	112	72.4
II Stripe on embryo, not on back	77	138	233	35.8
III Stripe on back, not on embryo	24	111	140	17.8
IV Stripe on side only	8	79	100	9.2
V Finely striped variegation	35	677	760	4.9
VI Entirely self-red	23	0	26	100.0

1/ Based on variegated and red ears.

Table 4

Percentage of red progeny in sections within Groups I, II, and III (1950 data)

Stripe position	Percent red 1/		
	Group I	Group II	Group III
Covering more than half of embryo or corresponding area on back	93.0	66.1	26.9
Covering half of embryo or corresponding area on back	70.7	28.4	19.5
Covering less than half of embryo or corresponding area on back	47.0	19.0	3.1

1/ Based on variegated and red ears.

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1. P^{rg}, an allel at the P locus.

In a strain of colorless pericarp a plant with kernels of colorless pericarp with a red 2 mm large girdle around the kernels in the pericarp was observed. Through self-pollination a homozygous genotype for this character was raised. Some plants of the mentioned character were crossed with homozygous genotypes: (a) colorless pericarp and (b) orange pericarp. In the F_1 generation the kernels of the cross to (a) have had a colorless pericarp with a red girdle and the kernels of the cross to (b) an orange pericarp with a red girdle.

The F_1 generation of the cross to (a) has been outcrossed with plants of colorless pericarp and of the cross to (b) with plants of orange pericarp. The symbol P^{rg} for the factor for kernels with red girdle was used.

Cross (a):

P_1 : P^{rg}/P^{rg} x P^{w}/P^{w}
F_1 : P^{rg}/P^{w}
F_1 outcrossed: P^{rg}/P^{w} x P^{w}/P^{w}

Progeny: P^{rg}/P^{w} - 486 colorless pericarp with a red girdle,
P^{w}/P^{w} - 471 colorless pericarp
Total - 957 plants

Cross (b):

P_1 : P^{rgo}/P^{rgo} x P^{o}/P^{o}
F_1 : P^{rgo}/P^{o}
F_1 outcrossed : P^{rgo}/P^{o} x P^{o}/P^{o}

Progeny : P^{rgo}/P^{o} - 623 orange pericarp with a red girdle,
P^{o}/P^{o} - 639 orange pericarp
Total -1262 plants

It follows that the character red girdle P^{rg} is allelomorphic to P^{w} and P^{o}, respectively.

2. The inheritance of the length of the ear and the length of the husks.

In some hybrid corn, as well as in some local varieties, the top of the ear from milk stage of the kernels and until maturity is not covered with husk, therefore, this part of the ear is often very badly damaged by birds. An attempt was made to find the hereditary connection between the length of the ear and the length of the husks. In our inbred stock two genotypes with longer husks than the ear and one with shorter husks than the ear were observed. For genetical studies the following crosses and backcrosses were made:

Generation	Cross					Remarks
P_1	longer x shorter	longer x shorter	normal x shorter	normal x shorter	normal x normal	
F_1	normal husks	normal husks	normal husks	normal husks	shorter husks	heterotic ears
F_1 outcrossed	F_1 x shorter	F_1 x longer	F_1 x shorter	F_1 x normal	F_1 x normal	
Progeny:						
husks longer %	0	38.8	0	0	17.5	
" normal %	58.3	61.2	32.6	100.0	82.5	
" shorter %	41.7	0	67.4	0	0	
Total	100.0	100.0	100.0	100.0	100.0	

From the above data it follows that the length of the ear and the length of the husks are due to different genetical factors which are probably only partly linked. Further studies are in progress.

A. Tavčar

III. MAIZE GENETICS COOPERATION

News Letter Chronology

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9	March 6, 1935	8	20 + maps	R. A. Emerson and	M. M. Rhoades
10	March 4, 1936	13	22	"	
11	March 23, 1937	10	26	"	D.G. Langham
12	March 6, 1938	10	38 + maps	"	D.G. Langham
13	April 15, 1939	9	22	"	D.G. Langham
14	March 5, 1940	12	56	"	G.A. Lebedeff
15	April 1, 1941	12	56	"	A. C. Fraser
16	Feb. 10, 1942	10	59	"	J.E. Welch
17	Feb. 15, 1943	12	51	"	J.E. Welch & M.J. Murray
18	Jan. 31, 1944	14	32	"	M.J. Murray & R. Morris
19	Feb. 15, 1945	12	50	"	R.L. Cushing & R. Morris
20	April 15, 1946	11	35	R.L. Cushing and	R. Morris
21	March 1, 1947	17	59	H. H. Smith and	J.E. Wright, Jr.
22	March 8, 1948	14	72	"	J.E. Wright, Jr.
23	March 10, 1949	18	78	"	J.E. Wright, Jr.
24	March 17, 1950	21	81	"	J.P. Craigmiles

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* For early history and information on volumes 1-8 see volume 14, page 56, 1940

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VI. SEED STOCKS PROPAGATED AND RECEIVED

This past summer 140 cultures were propagated to maintain our present genetic stocks, to increase new genes and to incorporate genes into new linkage testers. The use of inbred lines with wide range of adaptation has continued in outcrossing weak stocks to obtain vigor.

The Coöp has received the following new cultures:

Genes	Furnished by
v^{-}_{16}	C.R. Burnham
bm_3	Div. of Agronomy & Plant Genetics University of Minnesota University Farm St. Paul 1, Minnesota
A C r^g y p lg gl_2 sh wx multiple recessive combinations of endosperm and seedling loci.	R. A. Brink Department of Genetics University of Wisconsin Madison 6, Wisconsin
hm H. carbonum Race I	A. J. Ullstrup Department of Plant Pathology Purdue University Lafayette, Indiana (through L. J. Tyler, Cornell)
A A C C R r pr pr i i Mt mt	H. C. Eyster Charles F. Kettering Foundation Yellow Springs, Ohio

J. P. Craigmiles