MAIZE GENETICS COOPERATION

NEWS LETTER

20

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

CONTENTS

ANNOUNCEMENT

Arrangements have been made to continue the Maize Genetics Coöperation at Cornell University for a period of not less than three years. Professor R. L. Cushing, who has been responsible for the work done during the past few years, will help initiate Professor H. H. Smith who will have charge of the work in the immediate future. The undersigned will enjoy looking on from the outside and offering gratuitous advice as usual.

R. A. Emerson

I. REPORTS FROM COÖPERATORS

Connecticut Agricultural Experiment Station
New Haven, Connecticut

1. In the second generation from crosses of deviating lines with the original normal line, mono-factorial segregation is indicated by dwarf plant, pale top and crooked stalk. (Backcrossed ratio 52 tall; 32 dwarf where 42:42 were expected. F_2 selfed 49 green straight, 9 green crooked, 23 pale straight, 3 pale crooked where 47:15:15: 5 were expected.) Narrow leaf cannot be separated clearly from normal in individual plants. F_3 progenies ranged in average leaf width from 74 to 93 mm compared to 72 for narrow and 92 for normal under similar conditions. Average height ranged from 92 to 103 inches compared with 91 for narrow and 95 for normal. In previous tests narrow leaf plants have been slightly taller than normal. Both the extracted homozygous normals and deviates have come out of the cross slightly enlarged, an indication that other factors are involved. Further testing is necessary to establish the significance of these differences.

Blotched leaf and late-flowering types have not yet been compared after extraction from the cross with normal.

In view of the fact that the long inbred Leaming lines continued to decline in yield during 20 generations it is quite possible that these lines which have not been selfed continuously for this length of time are still segregating for minor physiological changes along with the visible morphological changes which seem to be mutations.

The normal lines, in the two cases tested, show no increases when crossed with the same normal lines from which they have been separate for many generations. Therefore, the possibility of accumulation of dominant genes from both parents seems to be ruled out. Further testing of this point is needed.

There is the possibility of mutations or delayed segregations affecting combining ability that have no visible effect in the homozygous condition or in crosses with the same line from other sources. Three of the long inbred Leaming lines selfed for eight and nine generations were separated into two sub lines each and maintained separately for seven additional generations of self-fertilization. During this period they showed no visible differences but when intercrossed they all gave significant increases in some measurable character.

Two of these lines were again separated in the 17th and 22nd generations and further self-fertilized for eleven and six generations. When the first generation crosses between these sub lines were compared with their normal parents no significant differences were obtained. In one of these cases the parental lines differed slightly in visible characters. All of this evidence indicates delayed segregation from an enforced heterozygous complex.

Five of the six deviating lines which show heterosis when crossed back to the normal line have been tested in outcrosses with unrelated lines. No significant differences in yield of grain were obtained between crosses of normal by unrelated normal compared to deviating line by the same unrelated normal. For practical purposes it is important that there were no decreases in yield.

D. F. Jones

2. A method for making smears of root tip chromosomes. Frequently it is necessary to have counts of root tip chromosomes, but the paraffin method for making preparations is laborious and time consuming. However, excellent figures can be obtained quickly and easily by the following technique. Fix young root tips in Carnoy's fluid for 6-24 hours. Change to 70% alcohol. (The material can be kept here until it is convenient to make the smears). Transfer to equal parts of hydrochloric acid and 95% alcohol for five minutes, then to 70% alcohol for at least five minutes. Put a thin cross-section slice of the root tip into a drop of aceto-carmine on a slide, and tease the material apart with needles, or flatten it with a scalpel. Put on a clean cover glass and press gently with the eraser end of a pencil. Heat slide several times by passing through a flame. Examine to see whether there are sufficient division figures. If not, make a smear from a different section of the root, or from a different root. A good preparation has the cells well separated but intact, with many well-stained division figures. Temporary mounts can be sealed with a gum-mastic-paraffin mixture and kept in a cool place for several weeks. Or the slides may be made permanent by McClintock's method for making sporocyte smears permanent.

Jeannette Lowe

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<u>Ga_4 and pericarp-color ratios.</u> In two earlier News Letters (17: 8-10, 1943 and 18: 7-8, 1944), aberrant pericarp-color ratios were reported and a gamete factor, Ga_4, was postulated as interfering with the functioning of pollen carrying it. There are now available more data like those previously reported and also a few of more nearly crucial importance. The records here assembled include both the new and most of the previously reported data.

The study involves crosses of lines having red pericarp and cob with lines having colorless pericarp and either white or red cob color. In this account, cob color will be disregarded, except in one section where its designation is essential. In general red and colorless (white) pericarp will be designated, respectively, by R and W. When reference to both pericarp and cob colors is made, the following symbols will be used for the three alleles:

R-R = red pericarp, red cob
W-R = white pericarp, red cob
W-W = white pericarp, white cob

Certain plants with heterozygous red pericarp, when selfed or used as pollen parents in crosses with white, give progenies with an excess of white-eared individuals, instead of the respective 3-1 and 1-1 ratios ordinarily observed. When, however, the same red eared plants are used as pistillate parents in crosses with white, normal ratios result. The ratios of red to white that have been observed to date in all aberrant cultures of whatever generations are given in the tabular statement below, together with first and later generations of crosses in which heterozygous reds were used as pistillate parents.

Parent plants		Progenies			
Type	Number	Number plants Red	White	Ratio R W	% Red
W/R (x)	49	1251	1085	1.15:1	53.6
W/(W/R)	25	491	1822	1:3.71	21.2
(W/R)/W	18	437	453	1:1.04	49.1

Not all red eared plants of cultures with an excess of whites, give aberrant ratios in the next generation. Of 42 plants tested from cultures resulting from W/(W/R), line 2 of the above table, 29 gave aberrant and 13 normal ratios in the following generations. Reds of aberrant cultures, which give normal ratios in later generations, are assumed to have lost Ga 4 by crossing over. But the relative numbers of aberrant and normal progenies resulting is not a measure of the percent of crossing over, because crossover pollen lacking Ga 4 is more likely to function in fertilization than pollen carrying Ga 4.

Of red eared F_2 plants lacking Ga 4, two out of three in general are expected to be homozygous. Of 61 such red eared plants of aberrant cultures, only 5 were homozygous, a ratio of 11.2:1 instead of the normal 2-1 ratio. Here again, this ratio is not a measure of percent of crossing over between red and Ga 4 alone or of percent of functioning Ga 4 pollen alone, for both variables are involved together.

Of red eared plants of normal cultures resulting from (W/R)/W, line 3 of the table above (like those of the reciprocal cross W/(W/R), line 2), some have normal and some aberrant progenies in the next generation. Of 28 such reds tested, 23 gave aberrant and 5 normal ratios in the following generation. Since there is here no question of pollen differentials, the percent of normal cultures should measure the percent of crossing over in megasporogenesis. The percent of crossing over indicated is 17.9, but the number of plants tested is far too small to give reliable results.

Of the homozygous red eared plants occurring in aberrant cultures, one was crossed reciprocally with white and two others were used only as pollen parents in crosses with white. The progenies were all red eared, but, of course, segregated in the next generation. The ratios of red to white in the segregating generation indicated that the three homozygous red parents were heterozygous for <u>Ga</u> 4. The available data are summarized in the following table.

Type of cross		Number	Progenies	
			Red	White
W/ [(W/W)/(R/R)]		7	292	901
		8	260	263
[(W/W)/(R/R)]	(x)	2	40	31
		13	729	263
[(R/R)/(W/W)]	(x)	5	98	69
		6	112	38

Of 30 segregating cultures from crosses involving homozygous red as pollen parents, 9 exhibited aberrant and 21 normal ratios. Of 11 segregating cultures from the one cross in which homozygous red was used as pistillate parent, 5 gave aberrant and 6 normal ratios. The second of these two catagories (homozygous red as pistillate parent) should include equal numbers of aberrantly and normally segregating cultures, since, in homozygous red, crossing over with <u>Ga</u> 4 is not detectable and because <u>Ga</u> 4 was not present in the white pollen parent. The 5-6 ratio is as near equality as is possible with a total of eleven.

The first of the two catagories (homozygous red as pollen parent) should, however, afford a direct measure of the percent of functioning <u>Ga</u> 4 pollen. Here crossing over in microsporogenesis cannot be detected and should have no effect on the ratio of aberrant to normal segregating cultures in the succeeding generation. Of the 30 F_1 plants tested, 9 gave aberrant and 21 normal segregation ratios. This 9-21 ratio indicates that 30 percent of the functioning pollen carried <u>Ga</u> 4, where 50 percent would be expected if this gene did not work to the disadvantage of the pollen carrying it.

When, in heterozygous red, the Ga 4 gene is lost from red-carrying gametes, it should be picked up in an equal number of instances by gametes carrying white. For this study, a third allele, colorless pericarp with red cob, W-R, may be used. When plants heterozygous for R-R and W-W are crossed with W-R. the red eared plants are W-R/R-R or R-R/W-R and the colorless eared plants are W-R/W-W or W-W/W-R. Data involving the first of these catagories have been presented without reference to cob color. In the second catagory, pericarp is colorless throughout, but it is perhaps less confusing to designate both pericarp and cob color by symbols for the three alleles involved.

When, by crossing over, Ga 4 is shifted from association with R-R to the W-W allele, segregating progenies should show a deficiency of white. In the studies of crosses of R-R with W-W, out-crosses with W-R, as either pollen or pistillate parent, have afforded tests of 137 W-R plants. Their progenies, classified as having normal or aberrant segregation ratios of red to white cob, are summarized as follows.

			Progenies		Ratio	%
		Number	W-R	W-W	W-R:W-W	W-W
[W-W/W-R and W-R/W-W]	(x)	117	2880	1016	2.83:1	26.1
		20	705	44	16.02:1	5.9

In these cob-color studies, as in the pericarp-color work reported earlier in this account, when heterozygous red (R-R/W-W or W-W/R-R) is used as the pollen parent in crosses with W-R, there are involved both variables, namely, percent of functioning Ga 4 pollen and percent of crossing over. It is, therefore, impossible to evaluate either one of them. When, however, heterozygous red with heterozygous Ga 4 is used as the pistillate parent and homozygous W-R as the pollen parent, differential fertilization becamse of Ga 4 is eliminated, and the percent of crossing over in megasporogenesis should be indicated by the relative numbers of normally and aberrantly segregating cultures in the succeeding generation. Data are available for 32 such eultures, as follows.

		Progenies of W-W/W-R			
Type	No.	Red	White	Ratio Red White	% White
$\left(\frac{W\text{-}W}{R\text{-}R}\ \frac{+}{Ga\ 4}/W\text{-}R\right)(x)$	28	693	232	2.99:1	25.1
	4	114	5	22.8 :1	4.2

Here the ratio of normal to aberrant progenies is 28:4, or 7:1. The percent of aberrant progenies — equivalent to percent of crossing over — is 12.5. It will be recalled that the study of segregating red pericarp, reported earlier in this account, involving 23 aberrant to 5 normal progenies, indicated a percent of crossing over of 17.9. The percent calculated from both the pericarp-color and the cob-color lots, 60 progenies in all, is 15.0. It will be recalled also that crosses of white with homozygous red pericarp, the latter as pollen parent, resulted in 21 normal and 9 aberrant cultures. This indicates that 30 percent of the functioning pollen carried Ga$_4$ and 70 percent carried its normal allele.

It remains now to see how nearly aberrant ratios correspond to ratios calculated from the indicated values of the two variables. The answer is easy. They do not fit at all well! It is realized that the number of progenies on which the evaluation of the two variables has been based is wholly inadequate — 60 for percent of crossing over and 30 for percent of functioning Ga$_4$ pollen.

One further method of evaluating the two variables is available. This method was used by Mangelsdorf and Jones (Genetics 11:423-455. 1926) in their study of the gamete factor in the fourth chromosome. By the use of data involving two genes both linked with Ga, they were able to evaluate the two variables simultaneously. This method can be used with data presented previously. (News Letter 17: 8-10. 1943). These are backcross data involving pericarp color and ms 17, with a total of 206 plants. The method of Mangelsdorf and Jones applied to these data indicates approximately 13 percent crossing over between Ga$_4$ and pericarp color — not far from that calculated by the method of eliminating one variable — but only 5 — instead of 30 — percent of the effective pollen carrying Ga$_4$. These percentages, when applied to the data summarized in this account, show a much better fit to observed ratios than do those obtained from evaluation of the two variables independently as presented earlier in this account. A comparison of the two methods is given in the following table.

	Ratios		
		Calculated	
		13 % crossing over	15
	Observed	5 % Ga 4 pollen	30
Coupling —			
B-C — Red to white	1 - 3.7	1 - 5.1	1 - 1.8
F_2 — Red to white	1.2 - 1	1.4 - 1	2.1 - 1
F_2 — Hetero- to homozygous red	11.2 - 1	6.2 - 1	2.8 - 1
Repulsion			
F_2 — Red to white	16.0 - 1	11.3 - 1	3.6 - 1

The data presented in the 1943 News Letter indicate that Ga_4 is to the left of ms_{17}. On the assumption of 13 percent crossing over between *P* and Ga_4, the map may be given tentatively as below.

sr ←----- Ga_4 ←----- 10 -----→ ms_{17} ←----- 3 -----→ *P* ----- *br*

A further study, involving Ga_4 with *sr*, ms_{17}, *P*, and zb_4, is underway, but little further evidence can be obtained short of two more years.

R. A. Emerson

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Regression Analyses of Yields of Hybrid Corn and Inbred Parent Lines.-- 1. Derivation of a theoretical regression function. For n loci let the basic effect of a gene substitution be d, dominance effect kd, proportions of loci AA in P_1 and P_2 be u and w, the multiple recessive phenotype T, and gene action additive.

$$\begin{aligned}
P_1 &= 2und + T, \qquad P_2 = 2wd + T, \\
F_1 &= 2uwnd + [u(1-w) + w(1-u)] \quad (nd + nkd) + T, \\
F_1 &= (1 + k + kT/nd) \quad (P_1 + P_2)/2-(k/2nd)P_1P_2-(k/2nd)T^2-kT, \\
F_1 &= b_1 P - b_2P_1P_2 + C_1, \text{ where } P = (P_1+ P_2)/2
\end{aligned}$$

With each generation of selfing 1/2 of dominance effects disappear. Divide each term in k by 2 for each time selfed to obtain the general function for Fn. This function is a surface which is curved if there is any dominance (k not zero). (Regression of F_1 on mean of parents neglects the second term of the function. A plane is fitted where a curved surface provides a closer fit if there is dominance).

Regression of F_1 on P_2 with constant P_1 (any single F_1 column in Stringfield's table below) is obtained by treating P_1 as a constant in the main function.

$$F_1 = [1/2 + k/2 - k(P_1 - T)/2nd] \quad P_2 + C_2$$

The partial regression coefficient bp is contained in the brackets. Its value manifestly depends upon the value of constant P_1. P_2 is the independent variable. Substitution of AA for aa at one locus in P_2 provides an increment 2d. The corresponding increment of F_1 is $[1/2 + k/2 - k(P_1 - T)/2nd]$ 2d. The first term of this expression, (1/2)2d = d, accounts for the basic effect of an additional A allele in F_1 coming from P_2. The second term, (k/2)2d = kd, provides a dominance effect. If, however, P_1 is AA at that locus no dominance effect will be added to F_1 by the substitution, and the one already there will disappear. P_1 is AA at u loci, and $(P_1 - T)/2nd = u$. The third term adds $[-k(P_1 - T)/2nd]$ 2d = -2ukd.

Under the assumptions, our main function calculates exactly mean F_1 for any type pair of parent values. Variance from such means, or deviations from the regression surface are due solely to variations in degree of heterozygosity. This portion of the variance is beyond parent criteria. Present parent criteria $\bar{P}$ and P_1P_2 together provide maximum estimation of F_1 by parent criteria. It is clear that the mean degree of heterozygosity is greater in crosses of good x poor lines than in crosses of medium x medium lines and that the product of parents P_1P_2 is included to measure that variation. It must also be clear that the various genetic interpretations inserted along have not been employed in the mathematical derivations. For the most part they were not recognized until after completion of the algebraic formulations.

Finally regression of bp on P_1 is given by the formula for bp. The regression coefficient is $(-k/2nd)$ which is b_2 of the main function. It will be labeled b_2 here also since the two coefficients are identical.

2. Fitting the functions to data. An unpublished table kindly furnished by Mr. G. H. Stringfield is included to illustrate the process of fitting. Values of bp at the bottom are simply regressions of F_1 of the respective columns on P_2. Regression of the values of bp at the bottom of the table on the values of P_1 at the top is -0.015, and the correlation is -0.98 which is highly significant.

F_1 and parents, bushels per acre, (G. H. Stringfield, unpublished)

P_1 P_2	4-8 13.6	90 28.2	Hy 29.8	02 46.1	WF9 51.4	51 55.3
4-8, 13.6		76.7	96.3	91.0	100.7	106.1
90, 28.2	76.7		81.4	94.2	97.9	86.4
Hy, 29.8	96.3	81.4		108.9	109.8	94.7
02, 46.1	91.0	94.2	108.9		104.0	100.8
WF9 51.4	100.7	97.9	109.8	104.0		103.4
51, 55.3	106.1	86.4	94.7	100.8	103.4	
bp	.68 .6947	.408 .4060	.3433	.2314	.0516	.048 .0512
Mean P_2	42.0	39.2	38.8	35.6	34.6	33.8
Mean F_1	94.2	87.2	98.2	99.8	103.2	98.2

From this regression the estimated value of P_1 for $bp = 0$ is 57.1 bushels per acre which is just beyond the range of the data. The same process has been applied to the other sets of data listed in the second table. Where significant values of b_2 have been obtained the main multiple regression function has also been fitted. In each case the second estimate of b_2 agreed closely with the first one, which provides a computation check since the two are algebraically identical also in the computation formulas.

The last five items in the table were then computed by quadratic solution of the multiple regression function on the assumption that where P_1 and P_2 are both completely aa or completely AA, $P_1 = P_2 = F_1 = F_2$. Roots thus obtained are estimates of the bottom recessive and top dominant.

3. Interpretation. First I must note that I have never had any notion that yield of corn could depend upon a multiple set of genes with uniform d and kd from locus to locus. Variation of d and of kd must contribute to the variance of F_1 and thus provide additional variance from the present regression surface. Beyond that I doubt that variation of d and kd could confuse present analyses.

Evidence here for overdominance (no dominance, $k = 0$; complete dominance $k = \pm 1$; overdominance k numerically greater than one) seems to lie in the estimated values of P_1 for zero partial regression. If dominance is <u>complete</u>, zero partial regression will obtain only when P_1 is the top dominant. This statement agrees with long held genetic philosophy of prepotence. That it is mathematically true in present theory may be seen by setting $bp = 0$ and $k = 1$ in the partial regression coefficient formula and solving to find $(P_1 - T)/2nd = u = 1$. Note also that with complete dominance the top dominant and top heterozygote are equal. Since for present data, values of completely prepotent P_1, $(bp = 0)$, are far below mean F_1, the only direct interpretation is overdominance, see values of k estimated from the data. It would seem to make no difference whether the genes of P_1 and P_2 are completely linked or completely independent, so far as immediate contributions to F_1 are concerned.

Fisher, (Genetical Theory of Natural Selection) gives the condition for equilibrium where the heterozygote has selective advantage over both homozygotes for one pair. His mathematical condition is identical with the present one for $bp = 0$ for any value of k (Selective advantage) except that his condition is in terms of the proportions of a and A alleles in the population at equilibrium. The present condition is in terms of u, the proportion of loci AA in P_1. If many loci are all at Fisher equilibrium in a cross breeding variety the expected value of u for a homozygote derived without bias is identical with $\bar{q}$ for the variety. Or if $\bar{u}$ for a group of lines is identical with $\bar{q}$ for equilibrium the lines as a set are at equilibrium. Every line, good or poor, will then have the same general combining ability as measured by the average of its crosses with all of the other lines. Equilibrium for each locus is at the instant where a and A alleles combine equally well with the field.

REGRESSION ANALYSES OF YIELDS OF HYBRID CORN AND INBRED PARENT LINES

	Mean partial regression	b_2	Estimated P for bp = 0	Mean F_1 or F_2	Bottom recessive (T)	Top dominant	Maximum F_1 of homozygous parents	Maximum open-pollinating variety	k
Stringfield,[1] F_1	0.30	-0.015**	57.1	96.8	-44.2	88.5	146.3	102.0	1.87
F_2	0.34	-0.009**	76.7	69.9	-48.9	82.7	159.1		2.16
Kinman & Sprague,[2] F_1	0.42	-0.015*	54.2	79.9	-29.5	76.2	120.0	91.2	1.64
F2	0.42	+0.005	–	50.8	–	–	–	–	–
Jorgensen & Brewbaker[3]	0.04	-0.002	210.1	372.5					
Nilsson-Leissner,[4]									
Dent I	0.28	-0.008**	154.9	314.5	-44.6	224.1	369.9	324.5	2.08
Dent II	0.22	-0.004	130.5	291.4					
Flint I	0.36	-0.0002	2430.2						
Flint II	0.62	-0.0008	888.3						
Jenkins,[5]									
white '26	0.65	+0.018							
early yellow, '26	0.38	-0.052**							
later yellow, '26	0.10	+0.037							
white, '27	-0.09	+0.153							
yellow, '27	0.07	-0.002							

1. Unpublished, see text.
2. Jour. Am. Soc. Agron., May, 1945
3. " " " " Sept., 1927
4. " " " " May, 1927
5. Jour.Agr. Res. Nov. 1, 1929

* Significant
** Highly significant

Jenkins (1929) almost attained that condition (last 3 entries in present table). For those data the partial regressions are nearly as frequently negative as positive and almost uniformly small numerically. After much selection Stringfield, and Kinman and Sprague studied groups of lines which show recession from the equilibrium which well selected varieties had closely approached 20 years or more ago. Recession may be due to mixing lines from different sources in one group and probably to selection for specific combining ability (more than average heterozygosity). The ceiling for hybrids is higher if one line has fewer AA loci, but this point can hardly be fully demonstrated without a 3-dimensional figure.

From the 3-dimensional figure for overdominance of the degree indicated ($k = 2$) it is clear that the F_1 trend for increasing P_1 and P_2 rises steeply over most of the range of present corn breeding experience which just laps over the crest. Beyond the trend is downwards. Beyond we have hardly gone, partly because of linkage as visioned by Jones and partly because present practice requires slight recession from the crest to another equilibrium between selection for specific combining ability and selection for general combining ability and excellence of lines themselves.

Present interpretations must remain in some degree tentative until lines well beyond the crest to provide significant negative partial regressions have been obtained. Before such evidence any alternative interpretation of complex, non-additive gene action would stand entirely refuted, I think. Excess of any heterozygote over the top dominant would seem to be overdominance by definition. The possibility of explaining present results by non-additive action without overdominance is very small insofar as I can tell but space does not permit more to be said here. Neither does space permit listing of every point where overdominance theory agrees with corn breeding experience more closely than does dominance theory. I have found no discrepancies and so must say that the evidence for overdominance must seem overwhelming but not crucial to any unprejudiced mind. It will be appreciated if any discrepancies are pointed out.

The same analysis has been employed with data on other characters of Jenkins (loc. cit.) with no evidence of overdominance and in most cases slight evidence of any dominance at all. Height of plant is an exception, but it depends largely on vigor. No data on ear dimensions have been available.

Fred H. Hull

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1. Pod Corn. We now have fertile, true-breeding inbred lines of pod corn. These were obtained by selecting for minus modifiers of the tunicate condition. In these stocks the glumes show about the same development in the homozygous condition as is usually found in other stocks in the heterozygous condition. Seed of these inbred tunicate lines is now available in considerable quantity.

Varieties and inbred strains of maize differ greatly in their modifier complexes with respect to the tunicate character. When varieties and inbreds are crossed to the same stock of tunicate there is in the F_1, considerable variation in the development of the glumes. Paraguayan and Bolivian varieties have strong minus modifier complexes. Guatemalan varieties have plus modifiers or at least are lacking in minus modifiers. North American inbred strains cover the entire range. Iowa 701 has a strong plus modifier complex while Minn. A158 is so strongly minus that in some crosses with pod corn the tunicate ears are scarcely distinguishable from non-tunicate.

2. Modifiers of Secondary Pistillate Florets. The occurrence of varieties of maize in Bolivia in which there is a partial or complete development of the secondary pistillate floret , as in Country Gentleman sweet corn, suggests that this may be a primitive character. If this is the case, then there may well be differences in maize varieties in their modifier complexes with respect to this character. Preliminary studies made by crossing with an inbred strain of Country Gentleman indicate that Guatemalan varieties have strongly minus modifier complexes with respect to the development of secondary pistillate florets while Bolivian varieties have plus modifiers or are neutral. The results so far as they go, can be interpreted in terms of Tripsacum contamination in Guatemalan varieties and its absence in Bolivian varieties.

3. Nature of the Maize Ear. The hybrids of pod corn and Guarany maize, previously reported, which have been useful in demonstrating the nature of the ear of maize, have produced an additional useful abnormality. In 1945 several plants were found in which one or more ears were normal while other ears on the same stalks produced greatly elongated shanks. When this occurs the ear is more or less naked and the shucks which usually surround the ear become normal leaves spaced at intervals on an elongated lateral stem. There is no doubt that the ear was originally the terminal inflorescence of a lateral branch.

4. Derivatives of maize-teosinte crosses. The segments of chromatin or blocks of genes which distinguish various types of teosinte from maize have been transferred individually by repeated backcrossing to a uniform inbred strain of maize. Stocks derived by this procedure show that the segment which occurs on chromosome No. 4 in Florida teosinte has almost identical counterparts in Durango, Nobogame and "New" teosintes. Whether these counterparts occur on chromosome 4 in each of these teosintes remains to be determined.

These stocks are also useful for testing the effect of teosinte germplasm upon the yield of maize. Preliminary tests indicate that a small amount of teosinte germplasm may improve grain yield. When two or more segments are present, however, even in the heterozygous condition, grain yields are definitely depressed although forage yields may be somewhat improved.

P. C. Mangelsdorf

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1. Sterility Studies:-- T_1-5-6-7. Mr. Constancio Lazaro has continued his study of this stock in Uruguay. He has identified the chromosomes involved in a series of semisterile plants derived from the cross: (.)8 x Normal. Of these, 16 are T_1-5 translocations, 6 are 1+5 or 7 (not 6) while only one is T6+(?). In addition to the derived semisterile lines, another derived type with about 65% pollen abortion and a ring of 6 chromosomes attached to the nucleolus was found here at Minnesota. Intercrosses are growing in the greenhouse to determine which chromosome pair has been lost from the ring of 8 chromosomes. Linkage tests with the (.)8 showed the following percentages of recombination: f - 22%; bm_2 - 50%; y - 16%; v_5 - 9%; bm - 8%; gl - 5%; ra - 3%. Recombination values and gene order in one T (1) ? -5 stock derived from the (.)8 are: bm ____30____ Pr ____8.7____ T; ys-T - 2%.

2. Yellow Endosperm.--One selfed ear had 112 deep yellow : 71 pale yellow : 14 white grains, a 9:6:1 ratio which may be interpreted as the interaction of two factors for pale yellow. Tassel-seed-4 was also segregating. The ratios for ts_4 in the three classes suggest linkage of ts_4 with one of the two pale yellow factors.

It should be possible eventually to identify stocks for the different yellow factors by their linkage with other characters, e.g. ms_1 for Y, al for one chromosome 2, vp for another, etc.

3. Chromosome 6 Linkage Studies.--A stock of ms pb has been established. The linkage of pb with Y is very close.

Classification for su_2 has not been very satisfactory in material grown here at Minnesota. The data reported by me in the Coop Letter of March 23, 1937 (p. 15) indicated the order y-pl-su_2, with about 8% recombination between su_2 and Pl. It was noted there that the separation for Yy was poor. Since then Horovitz et al. (Anales Inst. Fitotecn. S. Catalina 3:37, 1941) reported a su_x between Y and Pl. One backcross test with Pl using su_2 as the female parent indicated 15% recombination, but all the recombinations were found in the non-sugary class. One test of su_2 vs ms was set up as follows: $\left(\frac{ms\ \ +}{+\ \ su_2}\right)$ was crossed on a ms Su_2 Su_2 stock and the progeny grown. The open pollinated ears were examined to determine the number of homozygous Su_2 and heterozygous su_2 in the normal and ms classes, from which the per cent recombination can be calculated. The method seems to be usable. In this case, 32.8% recombination was observed between ms and su_2. These results are not satisfactory , however, since in the ms class there was 21.5% while in the non-ms class there was 45.4%. Intercrosses of su_2 with Horovitz's su_x have not been entirely satisfactory but they seem to indicate the two are the same.

Red glume collar in the tassel florets appears to show linkage with Pl in certain cultures, not in others.

A silky character is closely associated with antherless in the stock obtained from the Corn Coop. This silky vs *Y* showed 16.5% of recombination.

Trisomic tests for location of new factors in chromosome 6 : $\underline{ba}_s$ (barren stalk in a sweet corn), a new silky from a single cross, and a new stock of tinged (*tn*) show normal disomic ratios. The midget dwarf (*mi*) shows closer fit to a trisomic ratio than to disomic, although classification was not too certain.

C. R. Burnham

The following have assisted in the work at various periods: Gertrud Stanton, C. H. Li, T. J. Liang, and H. H. Highkin.

4. Miscellaneous Linkage Tests.-- For the new silky mentioned above, data from a small population suggest a linkage with *pr*. There is no close linkage indicated between narrow leaf-2 and: floury, yellow endosperm, colorless aleurone.

Linkage was reported previously between *pr* and $\underline{sh}_2$ - $\underline{sh}_2$ is closely linked with $\underline{a}_2$, no crossovers being found in an F_2 repulsion population of 1189.

There was a suggestion of linkage between yellow vs. pale yellow and the tinged mentioned above.

H. H. Highkin and C. R. Burnham

5. An "Oenothera" or Multiple Translocation Method of Establishing Homozygous Lines.-- A method by which a gametic combination could be made homozygous immediately should be of practical use to the plant breeder. One method, the utilization of haploids by doubling their chromosome number, has been suggested by many workers. It seems to be a feasible method in crops in which pollinations can be made on a large scale and genetic markers are available to aid in their recognition.

A second method for obtaining such homozygous lines is one I am calling an "Oenothera" or multiple translocation method. In this method, all the chromosomes of the haploid set are to be involved in translocations in such a way that the F_1 of crosses with normal stocks will have at meiosis a ring containing the entire diploid number of chromosomes. Such a plant should produce two kinds of functional spores corresponding to the two parental gametic combinations of chromosomes. Among the offspring from selfing such a plant there would be the heterozygotes with the chromosome ring recognizable by high spore abortion; and in addition two types of normals, each homozygous for one of the two parental gametic combinations. These two types of normals would have normal pollen, the normal number of chromosome pairs, and could be distinguished by crossing them with standard normal stocks.

The normal type not carrying the translocations would constitute the homozygous line.

The degree of homozygosity in these lines thus isolated depends on the amount of crossing over which has occurred at meiosis in the formation of the functional spores. Crossovers in the differential segments result for the most part in spores carrying interchanges and would be eliminated. Crossovers in the outer or interchanged arms of the chromosomes would be the ones most likely to result in recombinations of characters between the two parental gametes. The amount of recombination may not be very large, since crossing over is usually greatly reduced in regions near the translocation points and reduced to a lesser degree in regions farther away. It might be necessary, however, to establish several normal sub-lines from each F_1 plant to eliminate, or at least to measure, heterozygosity from that source.

For practical use, the multiple translocation stock would be crossed with the heterozygous source being used for new gene combinations (e.g. a variety, or a single- or double-cross hybrid). Each F_1 plant then represents a different gametic combination from that source combined with the multiple translocation gamete, and is the starting point of a different homozygous line to be established in F_2. Selected lines thus isolated could be utilized in breeding tests similar to those used with lines heretofore established by continued inbreeding. The frequency of "superior" lines should correspond to the frequency of "superior" gametes in the heterozygous population being sampled. In this "Oenothera" method the gametic combination is established in homozygous condition immediately. In Stadler's "gamete selection" method, the selected gametic combination is combined with a gamete from an inbred line. Further breeding, selection and testing are necessary to isolate lines which carry at least part of the new germ plasm.

The "Oenothera" method has not been tried but crosses are under way by which it is hoped to eventually produce such a multiple translocation stock in corn. The plan of procedure is to choose for crossing only those translocations involving one chromosome in common in which the breaks in this common chromosome are far enough apart to furnish a "differential segment." A crossover in this segment will combine the two translocations in the same gamete.

Spore abortion will undoubtedly increase as more translocations are added, but it is hoped that it will not preclude dehiscence of the anthers or the production of sufficient seeds to utilize the method. It is possible that in the larger rings more of the disjunctions will fall into the zigzag type and thus reduce the degree of spore abortion.

C. R. Burnham

5. Notes on the Use of Maximum Likelihood Formulae for the Calculation of a Single Recombination Value for Data From Several Sources.— (As applied by Immer and Henderson, Genetics 28:419-440. 1943.) Two methods are available, one being to weight each value according to its standard error. The other method is to combine the separate maximum likelihood formulae for each source into one formula, place it equal to zero, and solve for a value of p which best satisfies this equation. In using the second method as outlined, difficulties were encountered which were finally solved with Immer's help. Two changes must be made in the method as outlined.

1. The separate maximum likelihood formulae must not be reduced by any factor common to that portion (since it is not common to the other formulae being added to make up the one combined formula).

2. The maximum likelihood formulae as set up apply to repulsion. When used for coupling, the entire formula for that portion must be multiplied by (-1) (as shown by redifferentiating the basic equations).

The maximum likelihood formulae for the various sources of data become for F_2 consisting of (3:1) (3:1):

1. for F_2 repulsion:

$$2p\left(\frac{a}{2+p^2}-\frac{b+c}{1-p^2}+\frac{d}{p^2}\right)\doteq 0$$

For F_2 coupling this is multiplied by (-1). It must also be remembered in substituting that in coupling p is the non-recombination fraction or (1- the recombination fraction).

2. For "singly dominant" F_2 plants classified into their genotypes in F_3, the formula for repulsion is:

$$\frac{k}{p}-\frac{2j+k}{1-p}+\frac{(j+k)2p}{1-p^2}=0,$$ the same as given in the paper.

For coupling the entire formula is multiplied by (-1).

3. For "doubly dominant" F_2 plants classified into the relative numbers of heterozygous and homozygous genotypes, the formula for repulsion is:

$$\frac{2e+f+g}{p}-\frac{f+g}{1-p}-\frac{2(h+l)(1-2p)}{1-2p+2p^2}-\frac{(e+f+g+h+i)2p}{2+p^2}=0$$

This is also the same as given in the paper.

For coupling the entire formula is multiplied by (-1).

If linkage data from these three sources are available, these formulae are combined by addition into one maximum likelihood formula, the observed values substituted and the value of p which best satisfies this equation is determined.

The standard error to be applied to this value is calculated from the total amount of information furnished by the available data, since S.E.p $\sqrt{\frac{1}{Ip}}$ where Ip is the total amount of information. Ip can be calculated easily by the method in Mather "Measurement of Linkage in Heredity", page 68.

A supplementary note to the paper in Genetics had been proposed by Immer.

H. H. Kramer and C. R. Burnham

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Variations in Kernel Shape and Texture in Corn-Belt Maize.-- Typical kernels were selected from 140 different inbred lines of dent corn. These included as many of the standard inbreds such as 38-11, WF-9, etc. as could be obtained, together with some of the newer inbreds and various "second-cycle improvements" on older inbreds. Care was taken to obtain healthy and well-grown ears in spite of the weakness of some of the inbreds. As representative a kernel as possible was selected from each ear and the variation of the entire collection was repeatedly examined and compared with collections of open-pollinated varieties from various parts of the New World.

Much of the variation in this material, more than at first seemed possible, is accounted for by differences in the texture (hard dent, soft dent, etc.) and in the position at which the kernel shows its maximum width. The latter character varies from wedge-shaped kernels like WF-9 to broad-based, pointed ones like K 43. If a small percentage of "buckshot" and poorly developed kernels are excluded as too difficult to classify, the remainder show a clear set of transitional stages between these two extremes. At the one end is the flat, wedge-shaped kernel fairly similar to many of the older open-pollinated varieties. It is widest at its apex, and allowing for the shrinkage when it dents, it is also thicker at that point. Consequently it not only tapers to the base, it also slopes to the base (i.e. the narrowing is in two dimensions). The kernels at the other extreme are both wide and high at the base, bulging out broadly below and tapering conewise toward the apex.

Between these two extremes it is possible to select a whole series of intermediates. Those about in the middle are flattish kernels, widest in the middle and also slightly thicker there. It is they and the ones even less pointed which are of most interest in this classification. It does not seem probable that one would have recognized what is apparently a slight degree of pointing, until he had seen all the intermediate types laid out in this way. These different kernel shapes seem to result from various intermediates between two fundamentally different growth patterns, similar to some of those which have been analyzed in Cucurbits by Sinnott.

The kernels were then classified for texture. At the one extreme (grade 1) were a few inbreds which showed no capping of soft starch. In the next class were those which were capped but not perceptibly dented. Next (grade 3) were both capped and dented but without a wrinkled pericarp due to the collapse of the soft starch area. Finally there was a class whose kernels were capped, dented, and with the pericarp distinctly wrinkled at the apex.

When these grades of denting and pointing had been determined, the entire collection was sorted out simultaneously for both characters. A few of the small kernels remained difficult to classify and there may well be other factors such as long kernels *vs.* wide kernels which need to be considered. However this simple two-way scheme worked surprisingly well and brought similar types together. The distribution was as follows:

DENTING OF KERNEL →	POINTING OF KERNEL →		
	Widest at apex	Widest at middle	Widest at base
GRADE 4	20	0	0
GRADE 3	26	26	12
GRADE 2	14	21	0
GRADE 1	7	11	3

Figures show No. of kernels in each class.

It will be seen that there is a fairly strong negative correlation between denting and pointing. The heavily dented kernels are all widest at the apex and the less the degree of denting the higher is the proportion of pointed kernels.

After the kernels had been laid out in this way it was apparent that certain other characters were correlated with pointing or with denting. The association of red pericarp with pointed kernels was particularly conspicuous. Of those widest at the apex only 7 percent were so affected whereas 10 percent of the medium pointed, and 53 percent of those widest at the base. This may be related to the fact that in Mexico, the supposed ancestral home of our dent corns, pointing of the kernels is very closely associated with red pericarp. Red pericarp was found to have no obvious connection with denting but blistering of the pericarp was strongly associated with denting, as well as negatively with pointing. Another feature which (though it varies greatly in its expression) is characteristic of certain inbreds, is a silvery appearance of the pericarp, apparently due to air. This showed no association with denting but was strongly correlated with pointing.

After the above analysis had been made it was interesting to examine various inbred, single-cross, and open-pollinated varieties. The interaction of various factors in producing different types of dent corn is much clearer after such an examination. The production of a smooth, dimpled dent (such as characterizes OS 420 among the inbreds) is very evidently the combination of a high degree of denting with a fairly high degree of pointing. It is the pointing which shapes up the kernel and gives the ear its neat appearance.

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In the early summer of 1944 Professor S. Horovitz, of the Phytotechnical Institute of Santa Catalina, of Argentina, sent me some seeds of his new sugary (su$_x$). He and coworkers reported this new sugary in the Anales del Instituto Fitotecnico de Santa Catalina (1941) 3:37-44. He says there that it is on chromosome 6, and that it interacts with su$_1$ to make su$_1$ dominant.

The su$_x$ was crossed with su$_1$ (the inbred, P51) as soon as possible; the F$_1$ seeds were starchy. Last summer I grew the F$_1$ and selfed four plants. Five classes of seeds appeared: starchy; su$_x$, which is waxy looking but stains black with I$_2$KI; a smooth-sugary seed which is dented and translucent, but not wrinkled; ordinary sugary; and super-sugary (Horovitz's name), which is more wrinkled than ordinary sugary. Not only was there an extra class, but two of the four ears fit an extraordinary ratio, as shown below:

	87 (14) (x) 87B (2) (x)				87 (3) (x) 87B (5) (x)	
	Obs.	Ratio	Calc.	Obs.	Ratio	Calc.
Starchy	224	8	230.0	312	9	299.5
Sugary - x	61	2	57.5	56	2	66.6
Smooth sugary	35	1	28.8	35	1	33.3
Sugary - 1	83	3	86.3	93	3	100.0
Supersugary	57	2	57.5	37	1	33.3
	x^2 = 1.84				x^2 = 3.20	

If the four ears are assumed to be the same and are lumped together, the total counts do not fit either ratio, but are nearer to 8-1/2: 2:1:3:1-1/2. The classification of the various kinds of kernels is clear except between sugary and supersugary.

John Shafer, Jr.

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The determination of chromosome knob numbers in the more important inbred lines of Corn Belt maize was started in the summer of 1945, of which a preliminary account may be made at this time. To date, approximately thirty inbred lines of dent corn, twelve open pollinated or inbred strains of popcorn, and five North American flints have been examined. Although these numbers are relatively small when compared with the total amount of material available, the results obtained reveal some rather interesting facts. Among the thirty dent corn inbreds studied, knob numbers are found to range from two to nine with a frequency distribution as indicated in figure (1). Knob numbers appear to be correlated with certain morphological characters of the ear. For example, those lines possessing high knob numbers have, in general, a more compressed base, more tapered ears, and higher numbers of rows of kernels than those with low numbers. There is also some evidence indicating that irregular rowing is associated with high knob number. Among the popcorn strains examined, all were found to possess median knob numbers (4-6). The most interesting observation encountered occurred in the 8-10 rowed North American flints which were found to be knobless or nearly so. Of the five lines examined, four were knobless and one contained a single knob. These data, it will be noted, are not entirely in agreement with what one would expect on the basis of the tripsacum hypothesis.

William L. Brown

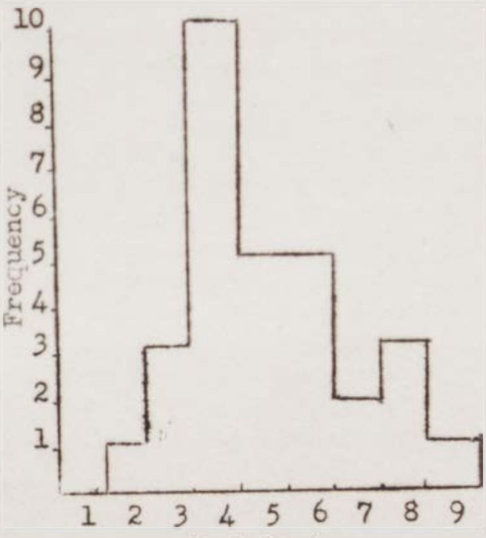

Fig. 1

University of S. Paulo,
"Luz de Queiroz" School of Agriculture, S. Paulo, Brazil

1. The al gene is very closely linked to lg_1 according to the following data obtained in F_2 (repulsion):

Pedigree NO.	+ +	+ lg_1	al +	al lg_1
754- 1	108	67	46	0
- 4	151	58	85	1
- 5	103	42	45	0
- 6	131	62	54	1
- 7	196	88	106	0
- 8	114	57	39	0
- 9	180	80	87	0
-11	118	46	56	1
-18	132	63	47	1
TOTAL	1233	563	565	4

Crosses involving al, lg_1 and gl_2 were made this summer (1945-October) in order to get the position of al in relation to lg_1 and gl_2 in chromosome 2.

2. One ear segregating for y_3 showed female elimination for this condition. The cross made was $Y_1y_1Y_3y_3Y_5Y_5$ x $y_1y_1y_3y_3Y_5Y_5$ and the expected ratio 1 orange ($Y_1y_1Y_3y_3$) : 3 white ($Y_1y_1y_3y_3$, $y_1y_1Y_3y_3$, $y_1y_1y_3y_3$) was changed to 1 orange : 1 white (81 orange seeds : 66 white seeds). The orange seeds sowed were selfed and gave in all cases ears segregating for 9 orange : 7 white. The white seeds gave normal plants which when selfed produced ears segregating for albescent seedlings.

3. Material received from Dr. A. M. Brunson was sowed and is now being crossed with several Y-testers. The white seeds always gave albino plants and the dual effect of this mutation (provisionally called y_x) seems to me in favor of the hypothesis y_3 that is identical with al.

4. Seeds received from Dr. Merle T. Jenkins were sowed and only the "dark yellow" germinated. The "lemon yellow" is very similar to some Y_1 stocks I have and in my opinion must be called only "yellow" in order not to confuse it with the "lemon yellow" due to the yellow aleurone color. Dr. Jenkins' ratio 3 dark yellow (orange) : 1 yellow is identical with that I obtained in Brazilian strains (Maize News Letter 17:1943 and Amer. Nat. 79:187-192, 1945) and the gene producing the difference orange : yellow I called provisionally Y_D. Several crosses are now being made in order to try the location of Y_D and to see its interrelations with Dr. Jenkins' gene in chromosome 7.

5. My working hypothesis on the yellow-orange endosperm is now as follows:

(a) Several $\underline{Y}$-genes with complementary effect, similar to the $\underline{A_1A_2A_3C}$ $\underline{R}$ series for aleurone color. Of the $\underline{Y}$-series, the known genes are $\underline{Y_1}$ in chromosome 6, $\underline{Y_3}$ in chromosome 2 and probably $\underline{Y_x}$ of Dr. Brunson, chromosome unknown. The $\underline{y_x}$ condition is lethal and the $\underline{y_3}$ produces albescent seedlings ($\underline{al}$ gene).

(b) The $\underline{Y_5}$ gene, isolated from Brazilian strains is complementary to $\underline{Y_1}$ in producing yellow endosperm but is independent of $\underline{Y_3}$ and so, also, of the other $\underline{Y}$-genes of the series.

(c) The $\underline{Y_D}$ gene (D=determiner) producing the difference orange : yellow, found in Brazilian material and extremely influenced by modifiers. Similar gene found recently by Dr. Jenkins in chromosome 7.

(d) The $\underline{Bn}$ gene in chromosome 7, producing yellow pigment only in the aleurone layer. These "lemon yellow" seeds are detectable in stocks lacking one of the complementary $\underline{Y}$-genes for endosperm color.

6. The ratio 15 orange : 1 white was secured in one ear resulting from a cross of Brazilian strains orange x white. The plants obtained from the orange seeds were selfed and in 46 ears the following results obtained:

Ears pure for orange	23
Ears segregating 3 orange : 1 white	14
Ears segregating 15 orange : 1 white	9

As the mutation from the recessive to the dominant condition is not probable and the ratio of ears obtained not in favor of two independent genes, some of the plants obtained from the ears segregating 15 : 1 were fixed and will be checked cytologically.

7. The location of the $\underline{Y_5}$ gene is being tried and the cross involving a tester of Dr. Randolph's covering most of the chromosomes gave the following results in two ears obtained from the same plant:

Ratio	36		9		19	
Pedigree NO.	Orange (Y_1- Y_3-)		Yellow (Y_1- $y_3y_3Y_5$-)		White + Lemon yellow	
	+	su_1	+	su_1	+	su_1
179A-1	231	78	69	15	109	48
179A-2	112	28	34	13	37	16
TOTAL	343	106	103	28	146	64

The segregation for $\underline{su_1}$ is normal. The yellow seeds not $\underline{su_1}$, where the classification was good, were sowed giving most of them *al* plants. Few plants not *al* came from *Bn* seeds since this gene was present in Dr. Randolph's stock. Segregation for $\underline{bm_2}$ and $\underline{cr_1}$ was normal and only one plant seemed to be $\underline{g_1}$ and none R^g. Proper tests for chromosome 10 are being prepared but we don't know if plant character markers combined with *al* will be easy to classify.

8. Markers in all chromosomes and in back-ground favorable for the State of S. Paulo (Brazil) and probably for South America conditions are now available. Trisomic stocks for chromosomes 2 to 10 segregating recessive genes in the respective chromosomes are now available and the trisomic segregation will be checked again this summer. The transference of deficiencies in chromosomes 3,4,5,6, and 9 (material from Dr. Stadler) to Brazilian strains is being continued.

9. Treatment of seedlings by artificial light during 15 days and four hours every day, in one very early and other very late stocks did not show significant difference in flowering when compared with plants that did not receive treatment. Also, plants with daylight reduced to 10 hours every day, during 15 days, flowered normally when compared with the control.

E. A. Graner

United States Department of Agriculture
and
Cornell University, Ithaca, N. Y.

1. In the preceding News Letter it was reported that tetraploid hybrids of Tripsacum and maize had been produced from experimental autotetraploids of maize pollinated by a natural autotetraploid Tripsacum from the Eastern United States. Repeated attempts to obtain seed from these hybrids by backcrossing to the parents failed. Since they produced only aborted pollen, with the possible exception of a very few grains partly filled with reserve food material, extensive attempts to self or sib cross these hybrids were not made. But very recently it was noted that a few partly developed seeds had formed on two of the 13 hybrid plants being wintered over in the greenhouse. These seeds apparently resulted from sib-crossing. By culturing the embryos of these seeds four seedlings have been obtained from which it may be possible to procure additional progenies.

During 1945 an initial attempt was made to repeat the cross of diploid corn and diploid Tripsacum made by Mangelsdorf and Reeves in 1930. A diploid Tripsacum from Kansas was used rather than the Texas form used by Mangelsdorf and Reeves. Very little difficulty was experienced in making the cross; 35 hybrids each with 28 somatic chromosomes were produced by pollinating 56 ear shoots of corn. The comparable frequency obtained by Mangelsdorf and Reeves was 29 hybrids from 382 ears.

Sporocyte examination of these hybrids is now in progress. The observations to date indicate that there is an appreciable amount of loose pairing at pachytene. Associations of 2, and not infrequently 3 chromosomes are prevalent at diakinesis. However, very few chiasmata apparently are formed as configurations suggesting chiasmata are rare at diakinesis and very few bivalent or trivalent associations persist to the metaphase stage. About one third of the figures have no bivalents on the metaphase plate and most of the other cells have not more than one or two bivalents at this stage.

The meiotic behavior of the chromosomes in these diploid Tripsacum-maize hybrids indicates that there has been very little if any exchange of parts of chromosomes during the meiotic prophase. The functioning of any mechanism for the transfer of Tripsacum chromatin to corn is conspicuous by its absence. It is quite possible that an occasional exchange of parts between the Tripsacum and corn chromosomes may take place as a result of something approaching typical crossing over, or fortuitous translocations; but it would be extremely difficult, on the basis of the observed cytological behavior of the chromosome in these hybrids, to account for a transfer of complete sets of knobs from Tripsacum to corn, as postulated by Mangelsdorf and Reeves.

However, the inference to be drawn from the observed meiotic behavior of the chromosomes in the F_1 Tripsacum-corn hybrids, namely, that there has been little or no exchange of parts between the corn and Tripsacum chromosomes is in full agreement with the observation of Mangelsdorf and Reeves that the plants with no Tripsacum chromosomes in the progeny of triploid Zea-Tripsacum hybrids backcrossed to corn, "were for the most part, normal corn plants differing in no way from ordinary corn plants--------most of the Zea chromosomes segregated out intact and completely uncontaminated by their association with those of Tripsacum". (M. and R., 1939, pp. 142-143).

2. From a comparison of pachytene figures in different inbred lines it is apparent that consistently "good" figures may be obtained from some lines and consistently "bad" figures from others. Hybrids of good and bad lines have bad figures and plants with good figures are recovered in backcrosses to lines with good figures with a frequency suggesting that a single major recessive gene for good pachytene figures is involved.

Lines having consistently good pachytenes include Luces Favorite (parent of 29-3 hybrid), 4-8d, L 289, CC5, OS426. Lines with badly clumped pachytenes of poor quality include B 164, OS 420, WF 9, 38-11 and O40B.

The observations on the quality of the pachytene figures were made under a wide variety of climatic conditions in New York and southern California, involving appreciable differences in temperature, humidity, and time of day when fixations were made. The quality of the cytological preparations was remarkably uniform under a wide diversity of environmental conditions.

L. F. Randolph

II. MAIZE PUBLICATIONS — 1945

(Including certain 1944 publications not previously listed and some early 1946 publications.)

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III SEED STOCKS PROPAGATED

A complete inventory of material on hand was presented in News Letter 14 and additional lists were given in News Letter 16. Inasmuch as there appear to have been relatively few stocks added to the Coöp collection since 1941, it has seemed unnecessary to present additional lists. Most of the propagation of material during the past few years has merely involved the growing of cultures from old seed, so that genes would not be lost. However, Dr. Murray began in 1943 to outcross weak genetic stocks to inbreds, in order to make material available in more vigorous combinations. This has been continued and a number of such combinations are ready for use. Progress has also been made in the transfer of marker genes to trisomic stocks.

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Linkage and cytological data on translocations involving chromosomes 1, 2, and 3.

Translocation	Chromosome	Locus of break	Linkage	Chromosome	Locus of break	Linkage
1-2b	1	S.2	ts_2-P-3.8-T	2	S.6	B-sk-1.4-T
1-2c	1		T-1.4-sr-P	2		near v_4
1-3a	1	S.25	P-18.7-T-36.9-br	3	L.2	ts_4±2.8
1-3d	1		near br	3		d±0.6
1-4a	1		br-18.8-T——bm$_2$	4		su±3.0
1-5a	1		br±8.54	5		bm$_1$-T-1.3-pr
1-5b	1		P-24.2-T-30.9-br	5		close to bm$_1$
1-5c	1		P-23.0-T-25.3-br	5		bm$_1$±0.2
1-6c	1	S.3	ts_2-P-9.9-T	6	L.2+	very near Y
1-7a	1	L.4	near br	7	L.1+	close to ra
1-7b	1	L.6	br-3.4-T-48.6-bm$_2$	7	L.2	T-0.9-ra-gl$_1$
1-7c	1	L.3	br±3.9	7	L.1	ra±0.6
1-7d	1	L.8	br-32.4-T-20.4-bm$_2$	7	S.4	T-2.9-ra-gl$_1$
1-9a	1	S.	P-21.2-T-35.6-br	9	L.	c-wx-11.2-T
1-9b	1	L.6	br±8.9	9	L.5	c-wx-37.8-T
1-9c	1	S.6	ts_2-P-0.8-T	9	L.2+	c-wx-12.1-T
1-10a	1	L.4	br±2.7	10	L.3	T-15.3-g-R
2-3b	2		B-v_4-4.0-T	3		ts_4±1.1
2-3c	2	S.6	B-0.5-T-4.9-sk	3	S.8	d±0.2

(Continued)

Translocation	Chromo-some	Locus of break	Linkage	Chromo-some	Locus of break	Linkage
3-5a	3		ts$_4$±2.1	5		bm$_1$-28.4-pr-6.4-T
3-5b	3	L.	na-4.8-T-19.1-a	5	L	bm$_1$-pr-4.1-T
3-5c	3	L.	na-11.7-T-12.8-a	5	L	T-1.7-pr-bm$_1$
3-6a	3		ts$_4$±1.8	6		Y-6.6-T-2.8-Pl
3-6b	3	S.8	d±0.5	6	Sat	T-15.6-Y
3-7a	3	S.2	ts$_4$±5.0	7	L.25	ra±1.1
3-7b	3	S.8	d±0.4	7	L.1	near ra
3-7c	3	L.6	close to na	7	L.5	near ra
3-8a	3	L.6	ts$_4$±2.5	8	L.8	T-13.6-ms$_8$-j
3-8b	3	L.1	close to ts$_4$	8	L.2	T-32.9-ms$_8$-j
3-9a	3		ts$_4$±2.9	9	L.1+	c-wx-3.6-T
3-9b	3		lg$_2$-7.9-T-19.3-a$_1$	9		c-wx-6.8-T
3-9c	2	L.1	ts$_4$±2.4	9	L.2	c-wx-7.6-T
3-10a	3	L.1+	ts$_4$±10.4	10	L.1	T-15.7-g-R
3-10b	3		ts$_4$±1.3	10		T-18.8-g-R
3-10c	3		ts$_4$±0.7	10		T-6.5-g-R

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