

MAIZE GENETICS COOPERATION

NEWS LETTER

16

1942

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

MAIZE GENETICS COÖPERATION
DEPARTMENT OF PLANT BREEDING
CORNELL UNIVERSITY
ITHACA, NEW YORK

December 10, 1941

To Maize Geneticists:

Circumstances beyond the control of mortal man have again laid Maize Genetic Cooperation on my doorstep. It is, of course, too early to know what can be done next summer by any of us. But I feel that such fundamental and long-time undertakings as ours should not be lightly abandoned. I plan, therefore, to assemble material for a Maize Genetics News Letter to be mailed on or about the first of February next. Since I shall be away from my office during much of February and March, I must have your reports by January 15. Even if you cannot make a complete report by that time, please send me whatever you can get ready.

Sincerely,

R. A. Emerson

R. A. Emerson

RAE:P

[Feb 10, 1942]

Vol. 16

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I. PROFESSOR A. C. FRASER

Somewhat more than a year ago, when I expected to retire at the end of June, I persuaded Professor Fraser to take charge of Maize Genetics Coöperation. I did not retire, and now Professor Fraser has gone. He assembled the material for the 15th News Letter. It was done in his characteristically careful way. It has pleased me a lot to hear more than one of you say that last year's News Letter was the best one so far put out.

Without the knowledge of any of us, Professor Fraser had been treated by a specialist for over a year. He did not meet his class in advanced genetics after the spring vacation, but he did prepare seed for planting and staked glossy seedlings in the field. Dr. Murray and I made pollinations for him in the summer and Dr. Murray made the final records from his cultures. Some of these are reported in this News Letter.

Professor Fraser was primarily a teacher. He was unusually successful with both undergraduate and graduate students. Many of you, who had courses with him, have told me this and more. You who were thus associated with him for a few years will feel this loss. To those of us who had been his colleagues for many years, his death came as a profound shock. Our memory of many things about him is small consolation. His ability, his determination, his untiring energy and resourcefulness, his never failing cheerfulness - he "kept his chin up" to the end - his willing helpfulness, and withal his unassuming manner, all these memories of him force upon all of us an ever growing sense of our loss.

R. A. Emerson

II. REPORTS FROM COÖPERATORS

The presentation of data in these News Letters is not regarded as constituting publication. These data should not, therefore, be used in published papers without the consent of the authors.

R. A. Emerson

Columbia University, New York City

1. Location of Dt in the short arm of chromosome 9. - F₂ data presented in the 1941 News Letter indicate that Dt is situated close to the yg2 locus at the end of the short arm of chromosome 9. These data also suggested that Dt was about ten units beyond yg2. However, Creighton found only one percent recombination between yg2 and the terminal knob. Backcross tests recently completed prove that Dt does lie approximately seven units beyond yg2. The low recombination value of one percent for the yg2-knob region may be ascribed to the disturbing effect on crossing over of the large heterozygous knob present in Creighton's set-up. The backcross data are as follows:

		<u>Dt + + +</u>															
		<u>+ yg2 sh wx</u>															
		<u>0</u>		<u>1</u>		<u>2</u>		<u>3</u>		<u>1-2</u>		<u>2-3</u>		<u>1-3</u>		<u>Total</u>	
333	278	22	23	76	86	82	64	0	3	2	3	0	0				
611		45		162		146		3		5		0		972			
		<u>Dt-Yg2</u>		5.2%		<u>Yg-Sh</u>		17.4%		<u>Sh-Wx</u>		15.8%					

		<u>Dt + +</u>									
		<u>+ yg2 sh</u>									
		<u>0</u>		<u>1</u>		<u>2</u>		<u>1-2</u>		<u>Total</u>	
306	228	18	33	83	93	2	4				
534		51		176		6		767			
		<u>Dt-Yg2</u>		7.4%		<u>Yg2-Sh</u>		23.7%			

		<u>Dt+</u>		<u>Dt yg2</u>		<u>++</u>		<u>+Yg2</u>		<u>Total</u>	
<u>Dt +</u>		283		24		25		293		625	
<u>+ yg2</u>											
				<u>Dt-Yg2</u>		7.8%					

$$\frac{Dt \ + \ +}{+ \ sh \ wx}$$

<u>0</u>		<u>1</u>		<u>2</u>		<u>1-2</u>		<u>Total</u>
345	330	115	110	85	76	3	4	1068
675		225		161		7		
<u>Dt-Sh</u> 21.7%		<u>Sh-Wx</u> 15.7%						

	<u>Dt+</u>	<u>Dt sh</u>	<u>++</u>	<u>+sh</u>	<u>Total</u>
$\frac{Dt \ +}{+ \ sh}$	838	277	324	765	2204
	<u>Dt Sh</u> 27.3%				

2. In a culture with A B Pl and A b Pl plants the R^r and R^S? alleles were segregating. A b Pl R^S? plants had green anthers with colored glumes. There was no color at the base of the culm but an occasional small blotch of color was found along the culm. Possibly a new R allele.

3. Jenkins gave the writer a selfed ear of inbred Hy that was segregating for what appeared to be a green seedling character. This new recessive mutant is linked with either C or R. Inasmuch as A B pl plants homozygous for this gene have a deep bronze color instead of the usual red, this gene has been tentatively designated "bronze" (symbol bz). A b pl and A b Pl plants homozygous for bz are not green but have a bronze color at the base of the culm. Some strains of A b pl and A b Pl plants homozygous for bz have chocolate colored anthers while other strains have green anthers. Some interactions with the R alleles may be involved here. The effect of bz on the color of A B Pl plants or on pericarp color has not yet been determined. The effect of bz on aleurone color is also unknown since it arose in a line homozygous for recessive c and r and its being linked to one of these factors makes the aleurone effect difficult to determine. The bz gene has a rather remarkable pleiotropic effect. In addition to affecting the anthocyanin system it also causes considerable pollen abortion. The sterility effect of bz is variable from season to season. At Arlington, Virginia in the summer of 1940 the amount of aborted pollen was so great that the anthers were shriveled and many failed to dehisce while in the summer of 1941 at Cold Spring Harbor little or no pollen abortion was evident.

4. Location of dwarf-7. Singh reported that d7 belonged in the tenth linkage group approximately 27 units to the right of R. Singh's placement of d7 rested upon the linkage of d7 with aleurone color in F₂ populations segregating for both C and R, and upon an F₂ population of 109 individuals segregating for d7 and golden-1 where he found 35 percent recombination

between d7 and g. Singh's placing of d7 in chromosome 10 rests entirely upon the loose and dubious linkage of d7 with g. The writer has been unable to find linkage of d7 with genes in chromosome 10. F_2 data from cultures segregating for d7 and shrunken show 24 percent recombination. Apparently d7 belongs in chromosome 9 and since d3 shows 25 percent recombination with sh it is not unlikely that d7 and d3 are identical. At any rate it is clear that the d7 locus should be dropped from the map of the tenth linkage group.

5. Inasmuch as the writer was assigned chromosome 2 he has from time to time collected additional data on the location of certain genes placed in the map by two-point tests. The floury locus was placed between sk and ts by two-point data. This has been confirmed by three-point tests. Some of the data involving floury are presented below:

$$\frac{\underline{lg} \underline{gl} \underline{B} \underline{Fl} \underline{v4}}{\underline{Lg} \underline{Gl} \underline{b} \underline{fl} \underline{V4}} \quad x \quad \underline{lg} \underline{gl} \underline{b} \underline{V4} \underline{v4}$$

B.C. for lg gl B Fl F_2 for V4

Lg-Gl 16%; Gl-B 16%; B-Fl 16%; Fl-V4 14%; B-V4 23%

The order is lg gl B Fl V4

$$\frac{\underline{B} \underline{Fl} \underline{ts} \underline{v4}}{\underline{b} \underline{fl} \underline{Ts} \underline{V4}} \quad x \quad \underline{b} \frac{\underline{Ts-v4}}{\underline{ts-V4}}$$

B.C. for B Fl F_2 for ts and v4

B-Fl 19%; Fl-Ts 3%; B-Ts 21%; Fl-V4 18%; B-V4 32%

The order is B Fl ts v4

Summary of unpublished linkage data for chromosome 2

XY Genes	Phase						Total	Percent recombination
		<u>XY</u>	<u>Xy</u>	<u>xY</u>	<u>xy</u>			
B Fl	CB	549	135	129	663	1476	18	
B Ts	RS	254	101	413	27	795	21	
B V4	RS	480	204	716	76	1476	26	
Fl Ts	RS	376	243	768	7	1394	3	
Fl V4	RS	569	281	891	60	1801	18	
Gs2 Fl	RS	161	212	113	19	505	17	

M. M. Rhoades

6. The following experiment was undertaken to determine if the pollen tubes obtain nutriment from the silks as they grow downward or whether food materials stored in the pollen grains are the chief source of energy.

Pollinations were made one day after cutting back the silks, so that brushes of silks approximately $1\frac{1}{2}$ inches long were available. Following pollination that portion of the silk (with the attached pollen grains) extending beyond the husks was cut off at intervals of $\frac{1}{2}$, $\frac{3}{4}$, 1, $1\frac{1}{2}$, 2, $2\frac{1}{2}$, 3, $3\frac{1}{2}$, 4, and 6 hours after pollinating. Silks removed at different intervals of time were fixed in alcohol and later stained with carmine-chloral hydrate.

It was found that germination occurred within the first half-hour. Germinated grains on silks removed at the different time intervals were examined cytologically to determine whether or not the two sperm cells and the tube nucleus had passed into the silk. The data are given as follows:

Table 1. Percent of germinated grains with no (0), one (1), and two (2) sperm nuclei, and having (1) or lacking (0) a tube nucleus on silks removed at different time intervals after pollination.

Hours after pollination	:2 sperm:1 tube nucleus	:2 sperm:0 tube	:1 sperm:1 tube	:1 sperm:0 tube	:0 sperm:1 tube	:0 sperm:0 tube	:No. of grains examined
$\frac{1}{2}$: 92	: 0	: 0	: 0	: 6	: 2	: 50
$\frac{3}{4}$: 80	: 4	: 4	: 0	: 12	: 0	: 25
1	: 82	: 0	: 0	: 2	: 7	: 9	: 52
$1\frac{1}{2}$: 59	: 1	: 1	: 0	: 20	: 18	: 61
2	: 17	: 2	: 2	: 1	: 9	: 69	: 120
$2\frac{1}{2}$: 0	: 0	: 0	: 0	: 5	: 95	: 20

The average number of grains on each examined silk was approximately twenty but considerable variation was found. Every silk examined, however, had a number of established grains.

Most of the sperm and tube nuclei pass out of the pollen grains between one and two hours after pollination. The sperm cells usually precede the tube nucleus in passing into the pollen tube. Four hours after pollination the pollen grains are nearly empty. The pollen grains retained a considerable portion of their contents two hours after pollination, even though the sperm nuclei and the tube nucleus had entered the silk. Pollen grains cut off before all of the food reserves had passed into the pollen tubes might not achieve fertilization for lack of sufficient nutriment if the growing tubes obtain little or no nourishment from the stylar tissue. The pollen tubes would contain the sperm and tube nuclei, but only part of the total food material stored in the pollen. If the pollen tubes obtained nutriment from the silk, they would continue to grow and all the ovaries would be fertilized.

If, however, the pollen tube could not obtain sufficient

nutriment from the silk, it would grow only until the available food material in the pollen tube was exhausted. Many of the ovaries at the bottom of the ear would not be fertilized, because the pollen tubes lacked the energy to grow a longer distance.

Seed set was determined at maturity.

Table 2. Number of ears, total number of seeds, and the percent of seeds found in the upper half of all the ears of corn for each time interval.

Series A	Hours after pollination						
	: 1	: 2	: 2½	: 3	: 3½	: 4	: 6
Number of ears	: 3	: 6	: 5	: 6	: 9	: 10	: 4
Total no. of seeds	: 1	: 193	: 862	: 337	: 1233	: 2607	: 1380
Percent seeds in upper half	: -	: 64	: 71	: 75	: 72	: 58	: 52
	: :	: :	: :	: :	: :	: :	: :

Series B	Hours after pollination				
	: 1	: 2	: 3	: 4	: ∞
Number of ears	: 8	: 8	: 8	: 7	: 11
Total no. of seeds	: 5	: 26	: 81	: 408	: 3182
Percent seeds in upper half	: -	: 78	: 69	: 68	: 52
	: :	: :	: :	: :	: :

(Note: ∞ = silks were not removed)

The number of seeds in the upper half of the ear was consistently greater than in the lower half at the time intervals when food material still remained in the pollen grain at the time of removal. Inasmuch as nearly all of the contents of the pollen grain had been discharged into the pollen tube by four hours after pollination but there were an appreciable number of unfertilized ovules at the base of the ear it seems that practically all of the stored reserves are needed for the long journey to the basal ovules. It is doubtful if the stylar tissue offers any nourishment to the growing pollen tube.

Sidney Wiesner

Connecticut Agricultural Experiment Station
New Haven, Connecticut

1. Paired red and dark purple mosaic areas in light purple seeds, heterozygous for Pr pr, rarely show growth changes. In some of these cases the red area grows out beyond the normal cells, sometimes the dark area. In the few cases that have been examined so far no growth changes accompany the exchange of both Pr and Bt. Since Bt is close to the centromere, presumably, paired changes that include Pr and Bt involve an exchange of almost the entire right arm of chromosome 5. If the alteration in growth were due to a loss or accumulation of specific growth regulating genes or to a general chromosome

unbalance it would be expected that all of the paired changes involving both Bt and Pr would be altered. Since they are not, this is a strong indication that growth changes result from breaks and reattachments at critical places in the chromosomes.

2. Paired pericarp mosaics, especially those that may occur in plants heterozygous for p^{RW} and p^{WR} , would make possible a distinction between reciprocal translocation and somatic crossing over. In plants of this composition red-seeded, red-cobbed ears would show colorless seeds underlaid with red cob adjacent to colored seeds over white cob. Any mosaics of this type should be examined cytologically and put on record. The writer would appreciate having any of these mosaics, especially where the areas involved cover several seeds.

D. F. Jones

3. Effect of environment on aleurone color - Marcross sweet corn with the aleurone constitution A C r Pr was changed to a purple aleurone (phenotype A C R Pr) by growing in the greenhouse in the winter time with no additional light. The corn was planted on January 21, 1941 in soil fertility plots where different types of phosphorous fertilizers were being tested. The fertility in all plots was sufficient to produce a normal crop of corn. In some cases ears were produced in the tassels as is characteristic of corn grown in this latitude with no extra light. Many fully purple kernels were found on the main ears as well as those produced in the tassel. One tassel ear had all the kernels fully colored similar to any A C R Pr stock. Examination showed this color to be in the aleurone layer. Seeds from the fully colored tassel-ear were planted in the field in the summer of 1941. Three selfed ears showed no aleurone color. The kernels were all Y su. Ears crossed by A C R Pr were entirely purple, also those crossed by a C R pr and A c R. Ears crossed by ACr were colorless showing the aleurone constitution to be A C r Pr. No explanation is readily available for the apparent changing of r or R when grown in the greenhouse. The experiment is being repeated in the greenhouse in 1942.

W. R. Singleton

4. In a field corn test in 1938, 311 different hybrids and inbreds were grown. A total of 14,916 ears were picked and of this number 26 (from 22 different lines) were classified as semi-sterile. This is not a good determination of the frequency of changes giving semi-sterility, but is an indication of the types of changes that occur. Progeny of 24 of the 26 ears have been grown for one to three generations to test the transmissibility of these sterilities. Twelve were definitely transmitted, three had questionable transmission and nine were not transmitted and were probably due to environmental or physiological causes. Nine of the twelve have been examined cytologically, and in these the following changes were found:

asynapsis, a 1-6 translocation, a 6-8 translocation, a pollen lethal character with no apparent chromosomal change or deficiency, and a long inversion in chromosome 1 including the centromere. It is of particular interest that the inversion in chromosome 1 was found in three different hybrids having as one parent, the inbred U.S. 4-8. It would be desirable to know if 4-8 has been found to have this inversion in the heterozygous condition and whether any unusual number of semi-sterile ears have been found in hybrids with 4-8. The 4-8 inbred used in the hybrids grown in Connecticut was not homozygous for the inversion since all the ears were not semi-sterile. It could have been obtained by contamination, but it seems unlikely that three hybrids with one parent in common would have been so affected. The inversions are apparently the same cytologically although crosses between them have not been made as yet to detect any differences.

Twelve semi-sterile ears, obtained from other field corn tests and sweet corn trials, have been tested for transmissibility. Five were not transmitted, one possibly is transmitted and six were transmitted. From the last six a lethal ovule character was found, a 2-5 translocation and a 6-9 translocation. Three have not been examined cytologically.

5. An unusual example of a somatic change was found in a plant heterozygous for the translocation T5-9a. The ear on this plant had approximately half the silks green and half red. Other plants from the same cross had green silks, with the exception of two plants having a few red silks and all others green. Although the ear which was about half red and half green was open pollinated, tests are being made to determine if the change was only in maternal tissue.

F. J. Clark

Cornell University, Ithaca, N. Y.

1. White-capped red pericarp - E. G. Anderson reported (Genetics 9:442-453. 1924) an allelic series of maize pericarp and cob colors with their genes at the locus of P. These included self red pericarp with red cob R-R (Anderson's symbols are used here, the first letter representing pericarp and the second cob color), colorless pericarp with red cob W-R, colorless pericarp with white cob W-W, variegated pericarp and cob V-V, mosaic pericarp and cob M-M, white-capped red pericarp with red cob C-R, and white-capped red pericarp with white cob C-W. That these combinations of pericarp and cob colors constitute an allelic series has not been questioned heretofore, so far as I am aware, and is not now questioned except for C-R and C-W. In fact, all the data with which I am familiar tend to substantiate Anderson's conclusions except for white-capped red pericarp. Heretofore I have regarded C-R and C-W as belonging to the P series of alleles and long ago (Nebr. Agr. Exp. Sta. Rpt. 24: 57-90. 1911) published records for C-W -

involving exceedingly few individuals - in support of this idea. Anderson's records involved adequate numbers. For the backcross (C-W x W-R) x W-W, the two parental types only were obtained, 1684 C-W and 1751 W-R. But he reported that: "This cross is not wholly satisfactory, since heterozygous C-W is light colored, making immature ears difficult to separate from white." He found no red-cobbed ears with white-capped red pericarp, while the white-cobbed ones all exhibited this pericarp color. But, in his description of W-R, he said: "Pericarp white (colorless) in some varieties, pale orange in others."

If these statements seem to imply that both Anderson and I were wrong in our early interpretations respecting C-W, I must admit that I have no evidence to support such an implication. But for C-R I shall here present evidence which indicates that the white-capped red pericarp of Bloody Butcher is conditioned by multiple genes. The C-W combination studied earlier by Anderson and by me is that seen in Northwestern Dent. The color patterns of the pericarp of these two varieties are identical in appearance and the intensity of pigment of both is reduced noticeably when made heterozygous by crossing with colorless pericarp types. In this respect both differ from self-red, variegated red, and mosaic red. It seems strange, therefore, that white-capped red of Northwestern Dent, C-W, should differ in inheritance from the apparently identical pericarp color of Bloody Butcher, C-R. Both Anderson (1924) and I (1911) reported crosses of C-W x W-R and of most of the other possible combinations of pericarp and cob color patterns, but neither one of us reported results of C-R x W-W.

All the crosses to be reported here involve a single one of Dr. Wiggans' inbred strains of Bloody Butcher (C-R), his inbred #4. This was crossed with three others of his inbreds; namely, Cornell 11 inbred #3 (W-R), Luce's Favorite inbred #1 (W-W) and Onondaga White inbred #2 (W-W). Generations F₂ and F₃ and repeated backcrosses to W-W have been studied. Since in one of the crosses, C-R x W-R, white cob color is not involved, both parents having red cobs, I shall present first the evidence involving pericarp color alone from all the crosses. In the presentation to follow the intensity of pericarp color is indicated in six grades. Grade 0 indicates pericarp in which no tinge of color can be seen, grade 6 the color intensity of the Bloody Butcher parent, grade 5 that of most F₁ ears, grade 1 a barely discernible tinge of color and 2, 3, 4 intermediate grades, in ascending order of color intensity. The mean grade of color intensity is presented both for all ears and for ears with some color in the pericarp. In table 1 are given the records of nine different F₂ cultures of the three crosses and of nine backcrosses of F₁ to colorless pericarp.

Table 1

Gen- era- tion:	Parent: grades:	Progeny grades							Total:	Mean grade	
		0	1	2	3	4	5	6		All ears:	Colored ears
F ₂	5	103	9	76	114	117	159	18	596	3.1	3.8
bc	5 x 0	273	13	74	113	114	54	0	643	1.9	3.3

The ratio of plants with colored to those with colorless pericarp is 4.8 : 1 for F₂ and 1.4 : 1 for backcrosses instead of 3 : 1 and 1 : 1, respectively. The frequency distributions of individuals of grades 1 to 6 are those typical of multiple-gene inheritance. The mode and the mean grade are somewhat lower in the backcross than in F₂, just as F₁ is of lower grade than the colored parent.

Progenies of selfed F₂ and of selfed backcross plants with diverse grades of pericarp color are recorded in table 2.

Table 2

Number of cultures:	Parent: grade:	Progeny grades							Total:	Mean grades	
		0	1	2	3	4	5	6		All ears:	Colored ears
4	0	104	-	-	-	-	-	-	104	0	
2	0?	35	12	-	-	-	-	-	47	0.3	1.0
14	1	171	227	38	-	-	-	-	446	0.7	1.1
5	2	29	58	43	20	8	4	-	162	1.5	1.9
7	3	46	28	46	65	38	9	-	232	2.2	2.7
3	4	19	8	10	17	28	16	-	98	2.8	3.4
3	5	-	1	2	9	26	48	23	109	4.7	4.7
2	6	-	-	1	1	9	35	32	78	5.2	5.2

Individuals of various pericarp-color grades of the first backcross generation were backcrossed a second or third time. The progenies of these backcrosses are reported in table 3.

Table 3

Number of cultures:	Parent: grades:	Progeny grades							Total:	Mean grades	
		0	1	2	3	4	5	6		All ears:	Colored ears
5	0 x 0	206	-	-	-	-	-	-	206	0	
1	0? x 0	74	4	-	-	-	-	-	78	0.05	1.0
4	1 x 0	65	63	-	-	-	-	-	128	0.5	1.0
4	2 x 0	59	20	64	9	-	-	-	152	1.2	1.9
1	3 x 0	35	-	13	13	-	-	-	61	1.1	2.3
6	4 x 0	46	34	35	42	19	2	1	179	1.8	2.4
1	5 x 0	38	-	-	5	40	7	-	90	2.3	4.0

Tables 2 and 3 not only exhibit frequency distributions characteristic of multiple-gene inheritance, but also demon-

strate that selection is effective in isolating diverse types, as in most instances of quantitative inheritance.

In many of the crosses reported above, cob color, as well as pericarp color, was involved. In table 4 the data for F_2 and the first backcross generations are presented for red-cob and white-cob ears separately.

Table 4

Gen- eration: Parent: Cob color: grades:	:	:	Progenies						:Mean grades					
			0	1	Grades			5	6	:Total:	All :Colored			
tion:	grades:	color:	0	1	2	3	4	5	6	:	ears:	ears		
F_2	:	:	{	R	32	4	45	58	72	113	17	341	3.6	4.0
				W	49	4	24	25	13	3	-	118	1.6	2.8
bc	:	:	{	R	48	6	38	41	40	37	2	212	2.7	3.4
				W	119	2	7	41	28	5	-	202	1.4	3.3

The segregation of cob colors was sharp without appreciable intergrades between red and white. The ratios of red-cob to white-cob ears, 341 : 118 and 212 : 202 in the F_2 and backcross generations, respectively, are approximately the 3 : 1 and 1 : 1 ratios expected where a single gene pair is concerned. The mean grades for pericarp color were somewhat higher in the red-cob than in the white-cob lots. This is the more pronounced when mean grade is calculated from all ears, because a higher percentage of the white-cob ears have colorless pericarp than is true of red-cob ears.

From the cross C-R x W-W, there have been obtained the four combinations; namely, C-R, W-R, C-W, W-W, expected on the basis of independent inheritance of pericarp and cob colors. The numerical relations, however, do not fit those of independent inheritance - 9-3-3-1 and 1-1-1-1 - as indicated in table 5.

Table 5

		C-R	W-R	C-W	W-W	Total
F_2	Observed	309	32	69	49	459
	Calculated	258	86	86	29	459
bc	Observed	164	48	83	119	414
	Calculated	103.5	103.5	103.5	103.5	414

If we were dealing with dihybrid inheritance, these data would indicate linkage of pericarp and cob colors with 26% or 31% of crossing over for F_2 or backcross progenies, respectively. It is conceivable that there is one primary gene for white-capped red pericarp which is modified in its expression by other genes.

Records of F_3 , and of F_2 after one or more backcrosses, are summarized in table 6.

Table 6

Number of cultures	Parent grade	Cob color	Progeny Grades							Mean grades		
			0	1	2	3	4	5	6	Total	All ears	Colored ears
1	0	(R	22	-	-	-	-	-	-	22	0	
		(W	14	-	-	-	-	-	-	14	0	
5	1	(R	27	94	35	-	-	-	-	156	1.1	1.3
		(W	31	3	-	-	-	-	-	34	0.1	1.0
2	2	(R	7	40	13	2	-	-	-	62	1.2	1.3
		(W	12	3	-	-	-	-	-	15	0.2	1.0
3	3	(R	16	12	16	25	17	3	-	89	2.3	2.8
		(W	7	2	4	4	4	-	-	21	1.8	2.7
1	3	(R	3	10	7	11	1	-	-	32	1.9	2.1
		(W	11	-	-	-	-	-	-	11	0	
5	4	(R	16	12	7	17	44	24	-	120	3.1	3.6
		(W	9	2	3	12	10	4	-	40	2.6	3.4

Individuals of various pericarp-color grades among backcross and F_2 progenies were backcrossed to W-W, with the results shown in table 7.

Table 7

Number of cultures	Parent grades	Cob color	Progenies Pericarp grade							Mean grades		
			0	1	2	3	4	5	6	Total	All ears	Colored ears
2	0 x 0	(R	79	-	-	-	-	-	-	79	0	
		(W	74	-	-	-	-	-	-	74	0	
3	1 x 0	(R	2	91	-	-	-	-	-	93	1.0	1.0
		(W	80	-	-	-	-	-	-	80	0	
1	1 x 0	(R	7	8	-	-	-	-	-	15	0.5	1.0
		(W	17	8	-	-	-	-	-	25	0.3	1.0
1	2 x 0	(R	8	7	7	1	-	-	-	23	1.0	1.6
		(W	20	-	-	-	-	-	-	20	0	
6	4 x 0	(R	38	38	9	17	20	17	-	139	2.0	2.7
		(W	39	8	19	13	11	15	-	105	1.9	3.1

Tables 6 and 7 show at least that low grade pericarp color is closely linked with red cob color. That even this very low grade pericarp color cannot be allelic to cob color is shown by the occurrence of cultures in which the red-cob ears, as well as

the white-cob ones, exhibit no discernible trace of pericarp color.

In addition to the cultures that segregated for cob color, there occurred, in F_3 and backcross generations of the cross C-R x W-W, progenies that bred true for red or for white cob color, as shown in table 8.

Table 8

Number of cultures	Parent: grades	Cob: color	Progenies							:Mean grades		
			Pericarp grade							Total: ears	All: ears	Colored: ears
			0	1	2	3	4	5	6			
1	: 1	: R	15	23	-	-	-	-	-	: 38	: 0.6	: 1.0
2	: 1	: W	18	15	-	-	-	-	-	: 33	: 0.5	: 1.0
3	: 2	: W	10	15	30	18	8	4	-	: 85	: 2.1	: 2.4
3	: 3	: W	9	4	19	25	16	6	-	: 79	: 2.7	: 3.0
1	: 5	: R	-	1	2	5	7	11	11	: 37	: 4.3	: 4.3
1	: 5	: W	-	-	-	3	12	11	1	: 27	: 4.4	: 4.4
2	: 6	: R	-	-	1	1	9	35	32	: 78	: 5.2	: 5.2
6	: 0 x 0	: W	197	-	-	-	-	-	-	: 197	: 0	: 0
7	: 1 x 0	: W	66	73	2	-	-	-	-	: 141	: 0.5	: 1.0
1	: 2 x 0	: W	5	4	16	6	-	-	-	: 31	: 1.7	: 2.1
3	: 3 x 0	: W	86	2	27	28	17	1	-	: 161	: 1.3	: 2.8
3	: 4 x 0	: W	24	12	15	28	7	-	-	: 86	: 1.8	: 2.5

It will be noted from table 8 that six cultures produced nothing but W-W ears like one parent of the original cross; that three cultures produced only C-R ears like the other parent but with considerable variation in intensity of pericarp color; that one culture had only C-W ears like Northwestern Dent but with some variation in pericarp color intensity; that, while no true breeding W-R lots have been obtained, two cultures (table 7) contained only W-R and W-W ears, from which homozygous W-R stocks can presumably be obtained.

From all this it seems obvious that white-capped red pericarp of Bloody Butcher is not a member of the P allelic series but is conditioned by multiple genes one or more of which are linked with red cob and therefore with P. So far as the P allelic series is concerned, Bloody Butcher is apparently W-R to which has been added other genes for pericarp color not of that series.

Since white-capped red pericarp of Northwestern Dent is identical with that of Bloody Butcher in appearance and in having its intensity reduced in the heterozygous condition, it will be interesting to discover whether Anderson and I were wrong in our earlier interpretation and, if then right, what relation exists between C-W of Northwestern Dent and the C-W that has come from the cross of C-R x W-W. The study is underway.

2. Linkage data involving an and Ts₃ or Ts₆ - Striking differences between complementary crossover classes were reported by Emerson 1941 News Letter (p. 13-15). These records may not have been wholly accurate for the following reason. Some of the Ts plants failed to develop ears since the tassels were not removed at the time of emergence. Classification of an from the tassel when combined with Ts is difficult. Therefore, similar progenies were repeated this summer and the classification of an based on the ear.

+ Ts ₃ /an +	+ Ts ₃	++	an Ts ₃	an +
1941, tassels removed	174	109	5	288
1940, tassels not removed	183	80	8	238
+ Ts ₆ /an +	+ Ts ₆	++	an Ts ₆	an +
1941, tassels removed	75	36	17	67
1940, tassels not removed	213	159	50	151

The results of both plantings are essentially alike. One may conclude that the unequal nature of the complementary crossover classes is not primarily due to inaccuracies of classification but rather to some other cause.

Using the totals of both seasons, the following ratios occur:

Ts₃ cultures

370 Ts₃ : 715 + D/PE = .9 for 1:2 ratio

546 + : 539 an D/PE = .4 for 1:1 ratio

Ts₆ cultures

355 Ts₆ : 413 + D/PE = 3.1 for 1:1 ratio

483 + : 285 an D/PE = 3.3 for 2:1 ratio

In the Ts₃ data, Ts₃ is deficient while an is normal; whereas, in the Ts₆ data, Ts₆ is only slightly deficient and an greatly so. If these effects are due to an interaction between an and either Ts₃ or Ts₆ as Emerson 1941 News Letter (p. 15) suggests, the interaction is presumably different for the two tassel-seed genes.

M. J. Murray

3. Chromosome 7 linkage data - Professor A. C. Fraser made the following field plantings last spring and marked the seed-

lings. I assume all responsibility for the records on the mature plants and the following summary of the results (table 1).

Table 1. + + +/in v5 gl

<u>0</u>		<u>1</u>		<u>2</u>		<u>1-2</u>		<u>Total</u>
552	438	1	11	18	20	2	12	
990		12		38		14		1054

Recombination percentages: in-v5 2.4, v5-gl 4.8

Ratios: 573+ : 481 in, 593+ : 461 v5, 585+ : 469 gl

Percent non-germination of In seeds 20.6, of in seeds 28.4.

Fraser in News Letter 1938 (p. 11) reported in-V5 = 4.3% V5-gl = 12.2% where n = 1017 and in News Letter 1940 (p. 14) in-V5 = 6.% V5-gl = 14% where n = 10,563. The present records are obviously different from the previous ones in that crossing over in the V5-gl region is markedly reduced. While all the recessives were somewhat deficient, this in itself probably does not account for the reduced crossing over. Fraser (News Letter 1940) indicated that he was investigating the reason for marked differences in the complementary crossover classes in the in-V5 region. A study of the lineage of all these cultures may perhaps clarify the present results.

Table 2. + + +/v5 ra gl

<u>0</u>		<u>1</u>		<u>2</u>		<u>1-2</u>		<u>Total</u>
832	478	40	39	8	314	29	0	
1310		79		322		29		1740

Recombination percentages: v5-ra 6.2, ra-gl 20.2

Ratios: 909+ : 831 v5, 879+ : 861 ra, 1214+ : 526 gl

Fraser (News Letter 1941 p. 19) reported crossover percentages as follows: v5-ra 7, ra-gl 6, gl-ij 18. The present records agree for the first region but not for the second. However, the ratio of glossies to non-glossies is roughly 1:2.

Table 3. + + +/ra gl ij

<u>0</u>		<u>1</u>		<u>2</u>		<u>1-2</u>		<u>Total</u>
340	184	16	47	101	63	3	94	
524		63		164		97		848

Recombination percentages: ra-gl 18.9, gl-ij 30.8,

Ratios: 460+ : 388 ra, 582+ : 266 gl, 453+ : 395 ij.

The region ra-gl was also studied in another culture where 20.2 percent of crossing over was obtained. These two sets of data agree in fixing the length of this region at about 18-20 units. However, this is in contrast to the result of 6 units obtained by Fraser (News Letter 1941). The region gl-ij is longer (30.8) than in the previously reported data 18 (Fraser News Letter p. 19)

No final interpretation of these data will be attempted until I have had an opportunity to study the origin of all cultures. Even then, further work will probably be necessary.

M. J. Murray

4. Trisomics - Seed weight. In order to get a relatively high frequency of trisomic plants the smaller seeds are often selected from a trisomic ear. A study was made to find how close a correlation exists between weight of seed and chromosome number and whether this correlation varies in different trisomic stocks.

Random samples of from 50 to 150 seeds were taken from trisomic ears. In some cases, however, only relatively small numbers of seeds were available. Each seed was weighed to the nearest .01 gram and placed in its weight class. In most cases the weights when plotted against number formed a unimodal curve. In some, however, bimodal curves resulted (see III x lg2). The seeds were germinated in trays and roots taken before transplanting to the field. The results are expressed in table 1.

Table 1

Relative length of extra chromosome	Trisomic Stock	Weight of seed in mg.	% tri-somics	No. of individuals	% tri-somics in random sample	No. of individuals
85	II x L.F. Inbred	140-210	82	38	50	139
		220-230	53	59		
		240-260	19	42		
	II x Inbred II	160-220	14	7	37	43
		230-240	56	16		
		250-280	30	20		
	II x C. II Inbred	130-200	87	30	52	93
		210-230	49	35		
		230-260	18	28		
	II x lg	130-180	80	5	39	52
		190-200	61	18		
		210-240	17	29		
79	III x L.F. Inbred	150-240	69	16	35	34
		250-300	6	18		
	III x Inbred II	100-150	50	12	33	52
		160-180	40	20		
		190-230	15	20		
	III x lg 2	140-160	100	31	45	91
		170-180	50	16		
		190-240	5	44		
	78	V x Inbred II	120-160	65	52	52
170-230			32	37		
60	VI x su2	140-200	77	30	30	103
		210-220	12	42		
		230-260	10	31		
60	VII x L.F. Inbred	70-110	73	11	45	22
		120-150	18	11		
	VII x Inbred II	70-120	63	16	40	58
		130-140	39	23		
		150-200	21	19		

Relative length of extra chromosome	Trisomic Stock	Weight of seed in mg.	% trisomics	No. of individuals	% trisomics in random sample	No. of individuals
60	VIII x L.F. Inbred	110-170	63	38	32	146
		170-180	44	43		
		190-220	6	65		
	VIII x j	200-230	33	18	27	45
		240-260	33	18		
		270-320	0	9		
52	IX x v wx	120-160	46	13	22	113
		170-180	71	24		
		190-220	3	76		
45	X x L.F. Inbred	220-250	48	54	26	149
		260-270	12	52		
		280-310	12	43		
	X x <u>v</u> 18	200-230	58	12	37	49
		240-250	35	20		
		260-270	24	17		

Table 2

Relative length of extra chromosome	Trisomic stock	Percent : 2n + 1 plants in progeny	No. of individuals	Percent : microspores with n + 1 chromosomes	No. of individuals
85	II. x L.F.	50	139	50	212
79	III. x lg2	45	91	41	167
45	X x L.F.	26	149	34	190
	X x <u>v</u> 18	37	49	33	109

Relative length of extra chromosome	Trisomic stock	Percent : microsporocytes with univalents in Met. I	No. of individuals
85	II. x L.F.	30	247
79	III. x lg2	-	-
45	X x L.F.	49	372
	X x <u>v</u> 18	37	300

5. Frequency of transmission of the extra chromosome in trisomes. Different trisomic stocks derived as maternal 21 chromosome plants from tetraploids show decided differences in percentage of trisomic plants in the progenies. Marked differences have also been observed in univalent frequencies, frequency of lagging in anaphase I and II and in other details of meiosis. A stock in which 40% of the progeny was found to be trisomic had one of the longer chromosomes in triplicate. Another stock producing 24% trisomic progeny had one of the shorter chromosomes in triplicate.

In order to test whether length of the extra chromosome can be correlated with frequency of transmission, known stocks have been studied. The data presented are incomplete but may be of some interest.

As the table indicates, the frequency of transmission of the extra chromosome through the egg varies from 22% to 52%. Different stocks of the same trisome show considerable variability in frequency of $2n + 1$ progeny. However, there is a strong positive correlation between length of the extra chromosome and the frequency with which it is transmitted through the egg. Several of the cases which are out of line may be due to the small number of seeds available.

Such explanations as abortion of ovules or differential seed viability would not seem to account for the observed differences in frequency of transmission since a close correspondence is found between the percentage of progeny which is $2n+1$ and the percentage of microspores with the $n+1$ number (see table 2).

Sporocyte studies, which have not yet been completed, indicate a greater frequency of univalents in the shorter chromosome stocks with more lagging in Met. I. and the formation of a greater number of micronuclei.

John Einset

Harvard University, Cambridge, Massachusetts

The readers of this News Letter may be interested in some of my observations on maize in Mexico. I spent the months of July and August in that country, travelled approximately 8,000 miles in fifteen states and visited a number of the experiment stations.

Maize is the universal crop in Mexico. It is grown from sea level to altitudes of approximately 10,000 feet. One sees it everywhere, planted between peach and apple trees in temperate regions; between bananas and pineapples in the tropics. It is frequently encountered as an ornamental plant in front yards and parks. Volunteer maize plants appearing in a garden or field devoted to other crops are usually allowed to remain.

The average Mexican apparently has the same feeling toward the maize plant which the Southern negroe exhibits toward a water-melon vine. It distresses him to see it destroyed.

The diversity of maize in Mexico is enormous. Near El Seco we saw many fields in which the plants were tasseling out at a height of about two feet. Near Monterey we saw fields irrigated with sewage water with stalks fifteen feet in height. We did not see the famous giant corn of the Jala Valley except in experimental plantings at the station near Leon.

Much of the diversity, however, is environmental. In many respects Mexican maize is quite uniform. Practically all of the maize plants of the great central plateau of Mexico are highly pubescent and uniformly pigmented, either sun red or purple. Practically all of the maize in all parts of Mexico shows strong external indications of contamination with *Tripsacum*.

It is a common opinion in Mexico that maize reverts easily to teosinte. A very intelligent Canadian manager of a large estate assured us that teosinte-like segregates appear in the maize fields even when there is no teosinte in the vicinity to cause contamination. He is of the opinion that the potentialities for producing teosinte by recombination exist in many Mexican varieties.

A well-planned program of maize-breeding under the direction of Ing. Edmundo Taboado, Dirección de Agricultura, Mexico, D.F., is in progress at several stations. Ing. Eduardo Limon in charge of the Campo Experimental at Leon, Guanajuato, is one of the most enthusiastic of maize breeders.

Because of the Mexican trip, I missed for the first time in twenty years, the usual summer pollinating season. However the work carried on by J. W. Cameron during my absence has resulted in several interesting developments. The most important of these is a study of knob numbers on the chromosomes of Guatemalan varieties. Two hundred varieties were grown and knob numbers determined for 162 of these. The number varies from 1 to 16, and involves every previously encountered knob position in maize as well as two unusual positions on No. 10. Knob number is correlated with several other factors. Pubescent varieties had an average of 6.2 knobs as compared to 11.6 for non-pubescent types. Varieties with low knob numbers usually have tender brittle stalks which lodge easily; those with high numbers usually possess strong tough stalks. There is a relation between the altitude at which the corn was collected and knob number. Tentative averages based on the altitude data so far available are as follows:

500 meters	12.6 knobs
1000 "	10.7 "
1500 "	10.8 "
2000 "	7.5 "
2500 "	5.5 "

Finally, types described on the basis of the general appearance of the ear as "Andean" proved to have a low number of knobs, 4.7, as compared to the population as a whole, 7.9. The results are in general agreement with the hypothesis (Mangelsdorf and Reeves) that corn with knobless chromosomes was introduced from South America into Central America where it hybridized with *Tripsacum* to produce teosinte and new *Tripsacum*-contaminated varieties of maize with knobby chromosomes. The South American types apparently still persist in a relative state of purity at the higher altitudes in Guatemala.

P. C. Mangelsdorf

University of Illinois, Urbana, Illinois

1. The gene rt appears to be close to d (chromosome 3). In a progeny of eight plants (backcross repulsion phase), all the normal plants were rt and dwarf plants Rt.

2. The dwarf types reported in the 1941 News Letter may be located in chromosome 3, at about 24 (assuming the chromosome reversed with cr at 0).

3. A leaf spotting has been discovered in one of our inbred lines. It is a simple recessive to the normal.

C. M. Woodworth

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

1. A new sugary, located by Horovitz in chromosome 6, was sent to me. A test with su2 indicates these two genes are probably alleles, although the test was not very clearcut.

2. Glossies - The third-leaf glossy, gl4 according to tests at that time, reported by Hayes as being linked with waxy (8% recombination, Coöp Letter April 1939), is the same as the Coöp, glossy 10, Coöp number C37-110 (1) (x). This glossy 10 is different from Sprague's glossy 10.

3. A group of unlinked genes is being tested for linkage in chromosome 6.

C. R. Burnham

4. Further studies have been made with chromosomal interchanges and the Minn. #13 smut resistant inbred line first reported by Saboe and Hayes, Jour. Amer. Soc. Agron. 33: 463-470. The long arms of #3, #7, and #8 and the short arm of #6 seem definitely to carry factors for smut reaction.

Lewis C. Saboe

Missouri Botanical Garden, St. Louis, Missouri

1. *Tripsacum*. With Dr. Hugh Cutler a preliminary survey of the genus *Tripsacum* has been published (separates available on request). The most important new fact turned up is a *Tripsacum* indigenous to South America from the Amazon Basin to Colombia. The numerous specimens from that region have at least one unique character and cannot therefore be recent introductions as had previously been supposed. The genus is so complex that it will take a decade to work out a complete and detailed monograph. In the meantime we shall be grateful for viable seeds or for chromosome counts of any species of *Tripsacum* from known localities.

2. Races of Maize. Cutler's collections of Mexican and Guatemalan maize have made it possible to begin another long-time project, the determination and description of the races of maize. While Sturtevant's classification (dents, flints, pops, etc.) is adequate as a cataloguing device there is also need for at least a rough grouping indicating general relationships in somewhat the same way that anthropologists analyze human variation. For such a grouping it is necessary to know as much as possible about the entire plant; tassel and leaf as well as ear and grain. We have therefore built up an herbarium of as many corn varieties as possible, including with the ear, herbarium specimens of seedlings, leaves, and tassels and notes on the number of nodes above the ear, the height of the plant, etc. For a considerable number of our collections duplicate specimens have been prepared in St. Louis, Texas, and Cuba. In addition to Cutler's collections we grew George Carter's extensive collection of Indian varieties from the southwest and a few unusual varieties such as Louisiana Gourdseed.

From an examination of the herbarium material the following characters were chosen as most indicative of general relationship: row number; kernel width, length, and thickness; mid cob width; number of tassel branches; length of glume (tassel); percentage of condensed internodes in tassel; pedicel length of pedicillate spikelet; percentage of sub-sessile pedicillate spikelets; length of sterile zone at base of tassel branches; pubescence of sheath.

By the use of these criteria our Mexican and Guatemalan collections can be divided into at least three main races, Big Grains, Mexican Pyramidals, and small-seeded Tropical Flints. The Big Grains are big cobbed and bigkerneled with more or less enlarged butts. While they may be flour or flint they are characteristically more or less dented. The small-seeded Tropical Flints are not only exceedingly straight-rowed but the kernels are very uniform in diameter so that a row of them looks like a stack of pearl buttons seen from the side. They are all flints, have small cylindrical ears, and are prevalently bright-colored. The Mexican Pyramidals are the common race in Mexico City and adjacent portions of the plateau. Important to U.S. corn breeding because most of their distinguish-

ing features, in a more or less diluted form, are found in cornbelt dents. They have a short pyramidal ear with long (often pointed) kernels. They are nearly all dents or semi-dents and the majority of them are white. They have few tassel branches and large glumes so that they are strikingly different from most other races and have been commented upon by Bonafous and Bukasov. The Indian corns of the southwest go into two races, the Pima-Papago and the Pueblo, the latter being closely allied to the Big Grains. Median values for representatives of these five races (and subraces) in our collections are as follows:

	Guatemala Big Grain	Tropical Flints	Pueblo	Pima- Papago	Mexican Pyra- midal
Mid-cob width	30	22	26	22	20
Kernel width	10	7	9	8	8
Kernel thickness	5	3	5	5	4
Kernel length	10	9	10	8	14
No. of tassel branches	20	21	18	10	4
Length of sterile zone	3	7	8	5	3
Percent condensed internodes	0	0	10	0	40
Percent sub-sessile spikelets	0	0	0	10	50

It will be seen that on the whole the Big Grains are at one extreme and the Mexican Pyramidals are at the other. It is also to be noted that the Pima-Papago race while similar to the Tropical Flints in cob-size and grain-size is far removed from them in all other characters. Collins (in Guernsey and Kidder 1921) was therefore in error in identifying the prehistoric Basketmaker corn (which is practically identical with the modern Pima-Papago) with the Tropical Flints.

3. Southwestern races of maize. In the southwestern United States our collection of varieties is complete enough and the situation is so comparatively simple that we can generalize more completely than in Central America. Southwestern maize goes in two races plus a few obvious recent admixtures and an extensive series of intermediates between the two extremes. One race (the Pima-Papago) has been in the country a much longer time and is not now commonly grown by the Pueblo-dwelling Indians.

The Pueblo race is the big-shanked, long-eared, usually bright colored maize which is commonly sold to tourists. While it may be either flour or flint it has a strong tendency to be at least slightly dented. Characteristically it has short internodes immediately above the node of the upper ear and its tillers are morphologically unlike stalk in height, tassel, and ear. It is grown by all the Pueblo-dwelling Indians as well as

by the Navahos and Apaches.

The Pima-Papago corn, though extensively grown, is from districts so remote that it is seldom seen in collections. It is small-grained and small-cobbed and either white or bright light yellow. It is small-shanked and ears often taper as much to the butt as to the tip. While the kernels are in rows, the sulci between them are scarcely apparent and the kernels have somewhat the appearance of tiles in a mosaic. Characteristically the internodes of the main stem do not shorten above the ear and the tillers, in height, ear, and tassel are similar to the main stalk. It is grown by the Pima and the closely allied Papago and to a lesser extent by neighboring tribes. It is of peculiar interest because its ears are almost identical with those of the prehistoric Basketmaker Corn which according to dendrochronological reckoning appeared in the southwest about A.D. 300.

Since everyone to whom we have shown the collection has asked whether our work gives evidence for or against Mangelsdorf and Reeve's theory, it may be well to add that while in general it supports them, we have as yet no conclusive evidence for or against. It is already abundantly clear, however, that maize has had a complicated career in Central America.

We will be grateful for viable seed of old or unusual varieties.

Edgar Anderson

University of Missouri, Columbia, Missouri

1. Comparison of Xray and Ultra-violet Mutations of A. The origin of the Xray and UV mutants compared in this study, and observation on their phenotypic effects, viability and reaction to Dt, were given in the last News Letter. All three Xray mutants showed more or less reduction in gametophytic viability and were zygotically lethal; all four UV mutants were fully viable, regularly transmitted through male and female germ cells, and readily established as homozygous recessives.

This suggests that the Xray mutants are probably deficiencies too small for cytological identification and too slight in effect to be lethal in haplophase, but it leaves open the possibility that they are alleles of a with lowered viability.

With losses too small for cytological detection, the only proof of deficiency is genetic evidence of the loss of associated loci. McClintock's study of Bm ring-chromosomes showed the possibility of identifying loci in a deficiency through their effects upon tissue within a sector made homozygous deficient by loss or modification of the covering ring.

We were fortunately able to obtain a ring including the A

locus. The origin of this ring is an interesting story in itself, but it will not be included here. The ring carries the gene \underline{A}^b , and its behavior is similar to that described by McClintock. It is maintained in a stock otherwise homozygous for \underline{a} . Crossed on standard \underline{a} stocks it gives sectors of \underline{a} tissue in both the aleurone and the plant.

Ring bearing plants otherwise homozygous for the Xray mutant \underline{a}^{X4} were obtained for comparison by crossing and backcrossing as follows:

- (1) $\underline{a}^X \underline{a}^D \times \underline{a} \underline{a} \underline{A}^b$ -ring
- (2) $\underline{a}^X \underline{a}^D \times \underline{a}^X \underline{a} \underline{A}^b$ -ring
- (3) $\underline{a}^X \underline{a}^D \times \underline{a}^X \underline{a}^X \underline{A}^b$ -ring

Cross (1) gives mostly pale and colorless seeds, but also a considerable number of colored seeds, all of which are mosaic for pale or colorless. These are the ring-bearing individuals. Cross (2) yields mosaic colored seeds similarly, but among them there is included a new class in which the mosaic regions are of shriveled, degenerate tissue. These are the $\underline{a}^X \underline{a}^X \underline{A}^b$ -ring individuals. In cross (3) this class comprises nearly half of the mosaic seeds. The remainder (without degenerate tissue) are all phenotypically \underline{a}^D in the mosaic regions, and represent the $\underline{a}^X \underline{a}^D \underline{A}^b$ -ring class.

The sectors produced in plants grown from these two types of seed are very different. In the plants with \underline{a}^D the sectors are of wholly normal tissue, lacking only the anthocyanin characteristic of \underline{A}^b . They include both large and small sectors. In the plants homozygous for \underline{a}^X the sectors are small, and many show reduced growth leading to distorted development of the plant. Their most conspicuous feature is lack of chlorophyll. These sectors, whenever they occur in regions in which anthocyanin develops, show normal anthocyanin. In other words, they do not show the loss of \underline{A}^b . Very rarely a sector is found with loss of anthocyanin and with no loss of chlorophyll. In four cases we have found narrow sectors showing loss of both anthocyanin and chlorophyll, and each of these occurred as a secondary sector within a larger sector showing loss of chlorophyll without loss of anthocyanin.

We interpret this to mean that the mutant \underline{a}^{X4} represents the loss of not only the \underline{A} factor but also of a separable factor essential to chlorophyll development, and possibly of another essential to tissue survival. If the sectors showing loss of chlorophyll without loss of anthocyanin have the genetic constitution indicated by their phenotype, the separable viability factor must be assumed. The absence of primary sectors showing loss of both chlorophyll and anthocyanin would indicate that simultaneous loss of the two factors is lethal, while the occurrence of sectors deficient for both as a result

of consecutive losses would show that the lethal effect is not due merely to deficiency of these two factors. It would therefore have to be ascribed to a separable portion of the ring which is regularly eliminated when A and the chlorophyll factors are lost simultaneously. It is possible however that the sectors are in fact deficient for A^b. Their anthocyanin pigmentation is normal, but since the sectors are small it is possible that this may be a result of diffusion from the neighboring non-deficient tissue. If this is true, the assumption of a viability factor separable from A and the chlorophyll factor is not required.

The description given above for a^{X4} a^{X4}-Ring plants applies also to the compounds a^{X4} a^{X1}-Ring and a^{X4} a^{X6}-Ring. This shows that a^{X1} and a^{X6} also lack the associated factor or factors. We have not yet succeeded in producing a plant which could be proven to be homozygous a^{X1} a^{X1} A^b-ring or a^{X6} a^{X6} A^b-ring. It is possible that both a^{X1} and a^{X6} involve more loss than a^{X4}. a^{X6} is distinctly lower in male transmission than a^{X4}, while a^{X1} is distinct from both in having visibly defective pollen and no male transmission. The most extreme mutant, a^{X1}, reduces crossing-over between A and Et, though there is no visible indication of deficiency in the pachytene chromosome.

The results indicate that the apparent mutations of A induced by Xray treatment are in fact minute deficiencies. The original series of Xray-induced A-losses from which the mutants were selected included, in addition to obvious extreme deficiencies, several less defective plants with segregating pollen not wholly aborted but distinctly sub-normal in development. a^{X1} was a representative of this class. The A-losses with normally developed and partially functional pollen, a^{X4} and a^{X6}, apparently represent simply the extreme of the continuous series of intercalary deficiencies of varying length induced by Xray treatment.

On the contrary, the UV mutants, a^{U3}, a^{U15}, and a^{U18}, similarly tested with the ring-chromosome, behave precisely as do the standard alleles, a^P and a, and their sectors are phenotypically identical with those of standard a.

The UV mutants, unlike the X-ray mutants, appear in the F₁ from treated pollen as a class distinct from the deficiencies produced by the treatment. The series of UV-induced A-losses included, in addition to the three mutant a's and the intermediate allele A^{lt}, a large number of extreme deficiencies with distinctly defective growth and aborted pollen, but none of the intermediate type with subnormal pollen. This may be due to the rarity of intercalary deficiencies induced by this agent. Although it is reasonable to assume that intercalary deficiencies may sometimes be induced by UV (since translocations are), it is clear that the UV mutations are much too frequent to be accounted for in the way suggested above for the Xray mutations.

If the UV mutants are deficiencies they are deficiencies of a different order. They show no difference from standard a except in their failure to mutate under the influence of Dt. As previously stated (News Letter 1941: 45), this is not convincing evidence against intragenic mutation.

L. J. Stadler and Herschel Roman

2. Translocations involving B chromosomes. Eight translocations between A and B chromosomes have been obtained from B-bearing pollen treated with Xrays. The A chromosome of six of these has been identified and the approximate position of breakage points determined, as follows:

Translocation	Cytological Position	
	A chromosome	B chromosome
T1-B	S .1	heterochromatin
T2-B	S .2-.3	junction*
T4-B	S .2	junction
T6-B	S (dividing nucleolar organizing body)	heterochromatin?
T7a-B	L .9-1.0	junction
T7b-B	L .35	euchromatin

*This is the junction of the euchromatic region and the large heterochromatic region.

All of these except T7a-B were tested for male and female transmission. The female transmission was quite normal but the male transmission was distinctly low. For example, a plant heterozygous for T2-B in which the translocation was marked by V4 and the normal chromosome by v4, when used as the male parent on homozygous v4, gave 80 V4 : 164 v4 F₁ seedlings. There is considerable crossing over between V4 and the point of breakage so that the frequency with which the translocation is transmitted is less than the ratio indicates. Similar crosses with T4-B, in which the translocation was marked by Su and the normal chromosome 4 by su, when crossed on su gave 253 Su : 797 su. Since very little, if any, crossing over occurs between Su and the point of breakage the ratio of Su : su probably represents a close approximation of the frequency with which T4-B is transmitted.

Evidence that a heterozygous A-B translocation when used as the male parent produces hypo- and hyperploid F₁ plants suggested that the low male transmission was a result of non-disjunction in the second microspore division. Hyperploid plants from T1-B, T2-B, T4-B, T7a-B, and T7b-B were identified cytologically and were found to contain the heterozygous translocation plus an extra translocation chromosome. Thus the extra chromosome must have resulted from non-disjunction either at meiosis or elsewhere. In every case the extra chromosome

was the translocation chromosome which possessed the B chromosome centromere.

The production of hypoploids was demonstrated when plants heterozygous for an A-B translocation and carrying only dominant factors were crossed on plants carrying appropriate recessives. The data from this type of cross are given in the following table.

<u>Crosses</u>	<u>Frequency of recessives appearing in F₁</u>	<u>Per Cent</u>
<u>Su su</u> x T4-B/normal, <u>Su Su</u>	52 <u>su</u> /423	25*
<u>su</u> x T4-B/normal, <u>Su Su</u>	31 <u>su</u> /92	34
<u>O2 gl</u> x T7b-B/normal, <u>O2 O2 Gl Gl</u>	0 <u>o2</u> /63	0
	21 <u>gl</u> /63	33
<u>Ij ij Gl gl</u> x T7b-B/normal, <u>Ij Ij Gl Gl</u>	6 <u>ij gl</u> /42	28*

*These values have been corrected for the fact that the female parent was heterozygous rather than homozygous recessive.

The appearance of the recessive character in the F₁ is due to the loss of the translocation chromosome bearing the factor for the corresponding dominant. Since Gl is nearer the end of the long arm of chromosome 7 than O2, the loss of Gl without the loss of O2 must mean that the absent chromosome is the one possessing the B chromosome centromere.

Proof that non-disjunction occurs at the second microspore division was obtained from a cross using a hyperploid plant from T2-B as the male parent. Twenty-three F₁ plants were examined cytologically. Of the twenty-three, twelve were hyperloid like the male parent; seven were euploid, heterozygous for the translocation; and four were euploid, homozygous normal. The occurrence of twelve hyperploid plants, which could have resulted only from non-disjunction, and the absence of other classes that would be expected with the same frequency from non-disjunction elsewhere show that non-disjunction occurs only at the second microspore division.

The frequency with which non-disjunction occurs may be roughly estimated from the data in the table demonstrating hypoploidy. The maximum frequency with which the recessive may appear is 25% (corresponding to 100% non-disjunction) if the hypoploid plants are viable (as they certainly are in the case of T7b-B and probably also in T4-B). The fact that the observed frequencies equal and exceed this value cannot be taken too seriously since these data were obtained from a limited series of crosses and may be effected by the presence of associated transmission factors. It is known from cytological

evidence that the frequency of non-disjunction is not 100%. But the data do suggest a very high frequency and further experiments to determine this with accuracy in each of the A-B translocations are in progress.

Will non-disjunction account for the anomalous male transmission of the intact B chromosome? The combined data of Longley and Randolph, from a cross of a 1B male on a 0B female, gave 108 plants with no B chromosomes, 35 with 1, 20 with 2, and 2 with 3 B chromosomes. We should expect, from 50% non-disjunction, 103 plants with no B's, 41 with 1, 21 with 2, and none with 3 B chromosomes. The observed 3 B chromosome plants may be accounted for in other ways. The close fit indicates that the mechanism for the aberrant male transmission of A-B translocations is identical with that of the intact B chromosome.

Can we localize the cause of non-disjunction within the B chromosome? The heterochromatic region may be excluded as a factor in non-disjunction for in T7b-B the chromosome undergoing non-disjunction does not contain this region. Furthermore, non-disjunction is not related merely to the shortness of the chromosome for in the case of T1-B the translocation chromosome undergoing non-disjunction is longer than the normally behaving short A chromosomes. Consequently, the cause of non-disjunction is related to the position or the special nature of the B chromosome centromere or to some factor in the proximal portion of the euchromatic region of the chromosome.

3. Some uses of A-B translocations. The B chromosome provides a centromere to which specific segments of A chromatin may be translocated. The exceptional behavior of the resultant chromosome in the second microspore division provides a mechanism for the accumulation of this chromosome for various cytogenetic problems in which duplications are useful. One application of this, now in progress, is a study of the effect of accumulation on the phenotype of recessive and intermediate alleles, using T2-B for a comparison of B, B^W, and b in various doses.

The fact that A-B translocations produce functional gametes deficient for as much as a whole arm of an A chromosome provides a tool for the location of recessive genes in the physical chromosome in a single generation. One would simply cross known A-B translocations on the recessive in question. If the locus of this gene is in the translocation chromosome with the B centromere, the recessive phenotype will appear in the F₁. For example, if the recessive is located in the distal four-fifths of the short arm of chromosome 4, it will appear in the F₁ of a cross by T⁴-B. The results summarized in the table place Su in this region. Likewise G1 and Ij are in the distal two-thirds of the long arm of chromosome 7, whereas O2 is not in this segment. An extensive planting for new A-B translocations involving different segments of the A chromosomes is planned for this summer.

Herschel Roman

4. The Anthocyanin Pigments of Corn. According to Sando et al, the plant pigment of purple corn (A B Pl R^r) is chrysanthememin. The anthocyanin pigments present in other types have not previously been reported.

The anthocyanins which occur most commonly as flower color pigments (glycosides of pelargonidin, cyanidin, delphinidin, peonidin, malvidin and petunidin) may be identified by simple qualitative tests outlined by Robinson and Robinson. The reactions of many less commonly occurring anthocyanins and of some synthetic anthocyanins not known to occur naturally have been summarized by Karrer.

Robinson's qualitative tests have been applied to the pigments extracted from numerous genetic types of corn. Although some of the pigments were identifiable with the qualitative tests, there were several which proved to be distinctly different in their reactions from the common flower pigments listed above.

An F_2 of the hybrid a pr b pl R^G x A Pr B Pl R^r was closely examined for color variations. In addition to the familiar plant color types expected from this cross, there were various minor modifications which have not previously been analyzed genetically. Plant material was taken from many of these plants for analysis, and all of the plants were self-fertilized.

The "A" type plants (A B Pl) in this hybrid population fall into three fairly distinct groups: (1) deep bluish purple, (2) deep reddish purple (maroon) and (3) light, distinctly reddish purple (dilute). The anthocyanins extracted from these plants included typical pelargonidin as well as typical chrysanthememin, and also in several cases pigments giving a typical reaction. The pigment differences are not always evident from the external appearance of the plant. Both chrysanthememin and pelargonidin are found among the deep bluish purple plants and among the maroon plants, but chrysanthememin is not found in the "dilute" class.

In F_3 , pure breeding families of the above described types were established. One deep bluish-purple family contained typical chrysanthememin. One deep bluish purple, indistinguishable from the chrysanthememin family except by anther color, contained a pigment which differed only slightly in reactions from pelargonidin 3-monoside, and one family of reddish purple (maroon) had pigment apparently identical to that of the deep purple pelargonidin type. A pure breeding "dilute" family showed typical pelargonidin 3-monoside reactions.

The pigment of "B" type plants (A B pl) showed reactions not typical of any of the commonly occurring anthocyanin types. Although there was variation in intensity of pigmentation comparable to that among the "A" type plants, no differences in the pigment of the different "B" type plants have been established.

The variation in intensity of the "E" type (aBf1) plants is correlated, at least to a large extent, with that of "A" type plants. In families with "A" type plants mostly deep purple, the "E" types were mostly deep brown and in families of "dilute" pigmentation it was difficult to distinguish a B Pl from a B Pl plants until the plants were nearly mature.

The pure breeding pelargonidin families of this stock were recessive pr but in many plants of this hybrid the Pr separation was doubtful. Therefore tests were made on different hybrids with positive Pr separation to establish this relation. In the first planting, the Pr plants, (6 in number) all contained chrysanthem in and the pr plants (8 in number) pelargonidin 3-monoside. In tests on the Pr and pr plants from six ears of the progeny of this family (self-fertilized or back-crossed) the same results were obtained. The pigment was found to be the same in all parts of the plant, including roots, coleoptile, sheath, husks, cob and aleurone.

Analyses have been made of pigments characteristic of other A alleles, in plants with B and Pl. A^b gives chrysanthem in indistinguishable from that of A plants of the same culture. Standard a^p, several mutant a^p's (by spontaneous mutation from A^b), and A^{lt}, (an ultraviolet mutant of A), all give mixtures of anthocyanin and flavonol in varying proportions. The anthocyanin in these mixtures, however, is distinct from that produced by A and A^b, and resembles in some reactions the pigments of sun-red plants.

J. E. McClary

5. Experiments on Gene Action in Anthocyanin Synthesis. In those genotypes which normally produce anthocyanin in the root, excised roots cultured on media containing glucose and mineral nutrients produce anthocyanin abundantly. Anthocyanin therefore may be synthesized by the cell from externally supplied glucose, without the intercession of other substances derived from the overground parts of the plant. The genes essential for root color in the dark are A (or A^b), A₂, Pl, and a suitable R allele (R^{ch}, r^{ch}, and some but not all R^r's and r^r's). B is not essential and does not replace R^r.

It may be possible to learn something of the course of synthesis of anthocyanin, and of the role of various genes affecting it, by physiological experiments with excised tissues, testing the effects of postulated intermediates between glucose and anthocyanin, of specific enzyme inhibitors, of diffusible substances extracted from plants of contrasting genotype, etc.

Experiments with intermediates supplied in place of glucose cannot well be made with excised root-tip cultures, because the addition of some glucose or fructose is necessary to keep the roots growing. An intermediate would have to replace glucose in general metabolism as well as in anthocyanin

synthesis to give positive results. Minimal quantities of sugar will maintain slow growth with little or no anthocyanin production, and experiments may be made with intermediates added to increase the anthocyanin yield.

A more satisfactory technique is to use sections of mesocotyl or leaf blade from young seedlings, since cell division is not a factor and since differentiated cells capable of anthocyanin production are present from the start. These sections remain alive for several days in buffer solutions, dilute salt solutions, or pure water. In suitable genotypes, they fail to produce anthocyanin unless sugar is added, while with added glucose or fructose they produce anthocyanin abundantly. Although these sections may contain reserve carbohydrate which may be used in the synthesis of anthocyanin, they cannot complete the synthesis without something which they obtain from added glucose.

Leaf blades from mature plants also serve very well in r^{ch} stocks (with A b Pl), and quite well in R^{ch} . Anthocyanin is produced poorly in mature leaf tissues with the best of the R^r and r^r alleles tested, and not at all with some. Mature leaves are convenient material, especially for producing the quantities of pigment required for chemical analysis.

Several preliminary experiments of this type were performed this winter, and some of the results are summarized below.

Galactose, which does not support the growth of excised root tips, may be substituted for glucose in the production of anthocyanin in leaf or mesocotyl tissue. On the contrary, mannose, l-sorbose, and l-rhamnose give no anthocyanin.

The pentoses, xylose and lyxose, give a good yield of anthocyanin, while arabinose (both d- and l- forms) and ribose fail.

Some modifications of the C_1 and C_6 groups in the glucose molecule may be made without preventing the production of anthocyanin. Sorbitol and glucuronic acid yield anthocyanin; -methyl-glucoside and gluconic acid do not.

The trioses, glyceraldehyde and dihydroxyacetone, in phosphorylated form, are produced from glucose in the normal course of respiration. Either glyceraldehyde or dihydroxyacetone (unphosphorylated), supplied in place of glucose, will permit the production of some anthocyanin, more in the case of glyceraldehyde than of dihydroxyacetone.

Various specific enzyme inhibitors or poisons have been supplied over a range of concentration extending to the toxic limit, without producing a distinct reduction in the yield of anthocyanin from glucose. These include cyanide, azide, iodoacetate, fluoride, malonic acid, urethane and maleic acid. Certain other inhibitors show possible effects which are still

under study. The only substance which in catalytic concentrations shows inhibition of the production of anthocyanin from glucose, in the trials made so far, is 2-4-dinitrophenol. This is a well-known stimulant of respiration and glycolysis, and may reduce anthocyanin synthesis competitively by diverting glucose to other channels. At concentrations of the order of 10^{-5} molar it inhibits anthocyanin production, and at lower concentrations it reduces materially the quantity of anthocyanin produced.

A possible hypothesis is that anthocyanin is produced by condensation of two phenol derivatives, related to phloroglucinol and catechol, with a 3C unit derived from glyceraldehyde. The effect of A would be a reduction in the 3C unit, which might occur either before or after the condensation. If the reduced 3C substance in A stocks were glyceraldehyde itself, it might be possible to produce anthocyanin in tissue lacking the A gene by supplying this substance. This was tried, unsuccessfully, with a, a^D, A^{lt}, and a₂. Similar trials with dihydroxyacetone, glycerol, and hydroxypyruvic aldehyde (all of which produce some anthocyanin in A tissue) also failed. Experiments in this direction with various 3C substances are being continued, together with analogous experiments with catechol derivatives and 6C-3C compounds in relation to the Pr effect.

The experiments mentioned are of course merely exploratory trials, made chiefly to test the feasibility of the general approach and to determine which aspects, if any, have sufficient promise to justify more intensive study. Obviously, neither the positive nor the negative effects of specific substances upon anthocyanin production may be interpreted in terms of the place of these substances in biosynthesis, without careful study of their other physiological effects.

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Backcross data indicating the order of the genes gs2, B and lg are given below.

		<u>0</u>	<u>1</u>	<u>2</u>	<u>1-2</u>
<u>+</u>	<u>B</u>	107	104	11 0	46 38
<u>gs2</u>	<u>+</u>	211	11	84	3 1
	<u>+</u>				4 = 310

The linear order and map distances are: gs2 4.8 B 28.4 lg.

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University of Wisconsin, Madison, Wisconsin

Below are given the results of a backcross test with Golden 2 against translocation 3-7b. In the light of our earlier report (M.G.C. N.L., 3-23-37, p. 14) that g2 was possibly linked with d, the indication is that g2 is in chromosome 3. Chromosome 7, however, is not excluded.

	T+	Tg2	++	+g2	
<u>g2</u> T3-7b	139	19	19	160	= 337

Percent recombination = 11.3

R. A. Brink and D. C. Army

III. MAIZE PUBLICATIONS

There is presented here a list of papers on maize, probably an incomplete one. No long search of the literature has been made. Fraser did a better job last year.

R. A. Emerson

- Abbe, Ernst C., L. F. Randolph, and John Einset - The developmental relationship between shoot apex and growth pattern of leaf blade in diploid maize. *Amer. Jour. Bot.* 28: 778-784. 1941.
- _____ and B. O. Phinney - The action of the gene dwarf 1 in the outogeny of the stem of maize. *Abst. in Genetics* 27, p. 129. 1942.
- Anderson, E. G. - Translocations in maize involving the short arm of chromosome 1. *Genetics* 26: 452-459. 1941.
- Bair, R. A. and W. E. Loomis - The germination of maize pollen. *Science* 94: 168. 1941.
- Blanchard, Ralph A., John H. Bigger and Ralph O. Snelling - Resistance of corn strains to the corn ear worm. *Jour. Amer. Soc. Agron.* 33: 344-350. 1941.
- Burnham, C. R. - Cytogenetic studies of a case of pollen abortion in maize. *Genetics* 26: 460-468. 1941.
- Clark, Frances J. - Preliminary investigations in *Zea mays* of the germination capacity of pollen with aberrant nuclei. *Abst. in Genetics* 27, p. 137. 1942.
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- Cutler, Hugh C. and Edgar Anderson - A preliminary survey of the genus *Tripsacum*. *Ann. Mo. Bot. Gard.* 28: 249-269. 1941.
- Jenkins, M. T. - The segregation of genes affecting yield of grain in maize. *Abst. in Proc. Seventh Intern. Gen. Cong.*, p. 168. 1941 (1939)
- Jones, Donald F. - Somatic segregation. *Bot. Rev.* 7: 291-307. 1941.
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- _____ - Inheritance of seed longevity in maize inbreds and hybrids. Abst. in Genetics 27, p. 154. 1942.
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- Mangelsdorf, P. C. - The origin of maize. Abst. in Proc. Seventh Intern. Gen. Cong. p. 209. 1941 (1939).
- McClintock, Barbara - The association of mutants with homozygous deficiencies in Zea mays. Genetics 26: 542-571. 1941.
- Randolph, L. F. - An evaluation of induced polyploidy as a method of breeding crop plants. Amer. Nat. 75: 347-363. 1941. (Includes a discussion of polyploid maize and teosinte. Ed.)
- _____ - Genetic characteristics of the B chromosomes in maize. Genetics 26: 608-631. 1941.
- _____ - The influence of heterozygosis on fertility and vigor in autotetraploid maize. Abst. in Genetics 27, p. 163. 1942.
- Rhoades, M. M. - On the high mutation rate of the a allele in maize induced by the Dt gene. Proc. Seventh Internat. Gen. Cong. pp. 247, 248. 1941 (1939).
- _____ - Different rates of crossing over in male and female gametes of maize. Jour. Amer. Soc. Agron. 33: 603-615. 1941.
- Roberts, E. and Irwin R. Horner. Causes of preferences exhibited by animals for certain inbred strains of corn. Jour. Amer. Soc. Agron. 33: 448-453. 1941.
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- Roman, Herschel - Translocations involving "B" chromosomes in maize. Abst. in Genetics 27, p. 167. 1942.

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- Shafer, John, Jr. and R. G. Wiggans - Correlation of total dry matter with grain yield in maize. Jour. Amer. Soc. Agron. 33: 927-932. 1941.
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IV. Inventory of Seed Stocks Propagated in 1940 and 1941

A complete list of all Coop. stocks on hand at the close of the 1939 season appeared in the 1940 News Letter. The symbol (x) = selfed and # = sib crossed.

1940

- Co 40-1 and 2 (x) Inbred I (U.S. 204) P^{wr} Y A b pl, also pollinated with y Hadjinov's gl₅, may seg. v_x (98); may seg. pr yg_a (88); P^{wr} Y cr "white stripe", may seg. wx pg₂ lg_x (95); gl₄, may seg. y pr c sh wx ws (118); may seg. y wx B Pl f Hadjinov's gl₈ (101); seg. at, may seg. y I? si ts₂ br f bv (107); pr v₃, may seg. su (61); lg B/A/Pr/ y pl/C R^{gg}/bm_x S_x, may seg. v_x (69); P^{wr}, may seg. y pr R^{gg} R^{nj}? su B Pl lg_x g d₇ v_x (115); su^{am}? ba₂, may seg. y pr Pl v_x f? lg_x (112); Y rt, may seg. pr Pl d_x bl? (124); P^{wr} Y f_x pk? sk_x, may seg. ms_x d_x (74); Y A b Pl vb, may seg. P v_x (109); P a sh wx f lg_x, may seg. su (71); ws₂?, may seg. y pr l₁ g (119); sh pk, may seg. y lg_x v_x or l_x (64); may seg. pr su wx? pg_a (94); y a C r pr wx, may seg. ys_x (116); wx? may seg. y Bn? an_x v₆ d_x cr_x (81); P a br f, may seg. bm₂ nl₂ w_x (123); may seg. d_x^s d^D (114); A B pl Rg Lg₃ d^s, may seg. y Bn? an_x (129); 34 ears
- " 40-3 and 4 (x) Inbred II (West Branch) Y A b pl, also pollinated with P^{wr} Y cr "white stripe", may seg. wx pg₂ lg_x (95); lg B/A/Pr/y pl/C/R^{gg}/bm_x S_x, may seg. v_x (69); Y rt, may seg. pr Pl d_x bl? (124); may seg. pr su pg_a (94); Pr, may seg. P pg g (65); 14 ears.
- " 40-5 and 6 (x) Dutton's Flint Inbred Y, also pollinated with P^{wr}, may seg. y pr R^{gg} R^{nj}? su B Pl lg_x g d₇ v_x (115); Y rt also Rg, may seg. pr Pl d_x bl? (124); P^{wr} Y f_x pk? sk_x, may seg. ms_x d_x (74); Y cr_x, may seg. Bn? v₆ d_x (82); "Deep Y" lg gl₄, may seg. v_x bm_x (103); lg B/A/Pr/y pl/C/R^{gg}/bm_x S_x, may seg. v_x (69); seg. sk, may seg. P^{wr} y d_x bl_x v_x cr_x (84); sh pk, may seg. y lg_x v_x or l_x (64); f, may seg. y wx B Pl Hadjinov's gl₈ (101); Y wx?, may seg. pr su ar_a (93); 19 ears
- " 40-7 (x) F₂ involving P^{wr} Y Pr wx, may seg. yg_a; 3 ears
- " 40-8 (x) F₂ involving P sk, may seg. v_x lg_x; 4 ears
- " 40-9 (x) " " P^{wr} Y y Pr su sp?; 4 ears
- " 40-10 (x) F₂ " P^{wr} Y zb₄; 3 ears
- " 40-11 (x) " " P^{wr} Y R^{mb}, may seg. j; 1 ear
- " 40-12 (x) " " P^{wr} Y y Rst Pr; 1 ear
- " 40-13 (x) " " P^{wr} Y y A C R^{nj} Pr wx?; 5 ears
- " 40-14 (x) " " P^{wr} Y y R^{gg} Pr; 3 ears
- " 40-15 (x) " " P^{wr} P^{vv} Y y A C R^{gg} Pr su; 4 ears

Co 40-16	(x)	F ₂	involving	pwr Y v7-striped; 3 ears
" 40-17	(x)	"	"	pwr Y o B v _x ; 5 ears
" 40-18	(x)	"	"	P Y a ^p B Pl, seg. b pl; 5 ears
" 40-19	(x)	"	"	pwr Y y wx? v18; 4 ears
" 40-20	(x)	"	"	pwr Y fs; 5 ears
" 40-21	(x)	"	"	pwr Y y zb4 br f bm2 wx?; 3 ears
" 40-22	(x)	"	"	pwr Y A b lg gl2 ts v4, seg. Pl; 4 ears
" 40-23	(x)	"	"	pwr Y y A b pl ws3 lg gl2; 4 ears
" 40-24	(x)	"	"	pwr Y y A b pl lg gl2 fl v4; 5 ears
" 40-25	(x)	"	"	pwr Y y d lg2, seg. an _x , may seg. pm; 5 ears
" 40-26	(x)	"	"	pwr Y y d a lg2, may seg. ts4; 5 ears
" 40-27	(x)	"	"	pwr Y y sh wx gl4 v _x ; 3 ears
" 40-28	(x)	"	"	pwr Y yg2 sh wx gl4 lg; 5 ears
" 40-29	(x)	"	"	pwr Y y wx gl4 v _x ; 4 ears
" 40-30	(x)	"	"	pwr Y y zb5, may seg. g n1; 3 ears
" 40-31	(x)	"	"	pwr Y y Pl "brown stripe", may seg. msll ar-like stripe; 2 ears
" 40-32	(x)	"	"	Y Pr wx, may seg. yg _a ; 4 ears
" 40-33	(x)	"	"	P Y y sk, may seg. v _x lg _x ; 4 ears
" 40-34	(x)	"	"	Y y Rst? Pr su sp?; 3 ears
" 40-35	(x)	"	"	Y zb4; 5 ears
" 40-36	(x)	"	"	Y Rmb, may seg. j; 4 ears
" 40-37	(x)	"	"	Y y Rst Pr; 4 ears
" 40-38	(x)	"	"	Y y R 88 Pr; 4 ears
" 40-39	(x)	"	"	Pv ^v Y A C R ⁸⁸ Pr pr wx?; 5 ears
" 40-40	(x)	"	"	Y y Wh? su r ^{rr} ; 3 ears
" 40-41	(x)	"	"	pwr Y v7-striped; 4 ears
" 40-42	(x)	"	"	Y o v _x ; 3 ears
" 40-43	(x)	"	"	P Y y a ^p B Pl, seg. b pl p; 4 ears
" 40-44	(x)	"	"	Y fs; 2 ears
" 40-45	(x)	"	"	Y y zb4 br f bm2 wx?; 4 ears
" 40-46	(x)	"	"	Y y y _x ? ws3 lg gl2; 5 ears
" 40-47	(x)	"	"	Y y lg gl2 fl v4; 4 ears
" 40-48	(x)	"	"	Pw ^r Y d lg2, may seg. pm; few seeds
" 40-49	(x)	"	"	Y yg2 sh wx gl4 lg; 4 ears
" 40-50	(x)	"	"	Y y wx gl4 v _x ; 5 ears
" 40-51	(x)	"	"	Y y "brown stripe", seg. B Pl P, may seg. msll ar-like stripe; 4 ears
" 40-52	(x)	F ₃	"	Inbred I and pwr Y wx g4; also crossed with Y wx g4 (59); 11 ears
" 40-53	(x)	"	"	Inbred I and pwr Y y ra sl, also crossed with Y y ra sl (56); 14 ears
" 40-54	(x)	"	"	Inbred I and pwr Y bm3, also cross- ed with Y bm3 (57); 15 ears
" 40-55	(x)	"	"	Inbred I and pwr Y wx g4, also crossed with Y wx g4 (58) and Y wx g4 (59); 14 ears
" 40-56	(x)	and #F ₃	"	Inbred II and Y y ra sl; 13 ears
" 40-57	(x)	" #F ₃	"	Inbred II and pwr Y bm3, also crossed with Y bm3 (54); 20 ears

- Co 40-58 (x) and #F₃ involving Inbred II and Y wx g⁴, also
crossed with Y wx g⁴ (52)
and Y wx g⁴ (55); 13 ears
- " 40-59 (x) F₃ involving Inbred II and Y wx g⁴, also crossed
with Y wx g⁴ (52); 12 ears
- " 40-60 (x) y, may seg. g³ l_x, (freezing injury, poor germ-
ination); 1 ear
- " 40-61 (x) pr v³, seg. su, also pollinated with Inbred I
(1) and Inbred II (3) and recip-
rocally with Inbred I (1); 6 ears
- " 40-62 (x) P^{WR} y, seg. ms¹⁸ bm lg_x, may seg. pg_x or l_x,
also pollinated with Inbred I
(1 and 2); 3 ears
- " 40-63 (x) and # g¹, seg. Wh sl_x, also pollinated with In-
bred II (3); 4 ears
- " 40-64 (x) and # sh pk, seg. y lg_x, may seg. v_x or l_x, also
crossed onto Inbred I (1) and
Dutton's Flint Inbred (5); 3 ears
- " 40-65 (x) and # Pr g, seg. P pg, also pollinated with In-
bred II (3) and reciprocally with
Inbred II (4); 6 ears
- " 40-66 (x) y r g, may seg. pr su l², also pollinated with
Inbred I (1); 3 ears
- " 40-67 (x) Seg. Pr pr ms_x, may seg. pg? pb? zb? and usually
completely sterile plants with
necrotic leaves, also pollinated
with Inbred I (1), Inbred II (3)
and y +/po (121); 7 ears
- " 40-68 (x) Seg. y Rst Pr, may seg. l_x ms_x, also pollinated
with Inbred I (1 and 2) and Inbred
II (3); 10 ears
- " 40-69 (x) and # lg B/A/Pr/y pl/C/RGG/bm_x S_x, may seg. v_x,
also pollinated with Inbred I
(2) and reciprocally with Inbred
I (1), Inbred II (3) and Dutton's
Flint Inbred (5); 9 ears
- " 40-70 (x) and # y a C R pr in j lg, also pollinated with
Inbred I (1); 8 ears
- " 40-71 (x) and # P a sh wx f, seg. su lg_x, also pollinated
with Inbred I (1) and Inbred II
(3) and reciprocally with Inbred
I (1 and 2); 10 ears
- " 40-72 (x) P a sh wx su lg f (freezing injury, poor germina-
tion); 4 ears
- " 40-73 (x) and # a B Pl lg v⁴, seg. y ts; 7 ears
- " 40-74 (x) P^{WR} Y pk?, seg. sk_x, ms_x, may seg. d_x f_x, also
pollinated with Inbred I (2) and
reciprocally with Inbred I (1)
and Dutton's Flint Inbred (5);
3 ears
- " 40-75 (x) su, seg. y sh, may seg. v¹⁴ d³ w_x; 2 ears
- " 40-76 (x) and # P A B pl sh, seg. cr_x wx?, may seg. l⁶;
3 ears

- Co 40-77 (x) and # Pr, seg. sh Ts_x, may seg. v⁸ d_x, also pollinated with Inbred I (1 and 2), (freezing injury, poor germination); 10 ears
- " 40-78 (x) and # Y, seg. su fl_x v_x cr_x, may seg. d_x v⁸, also pollinated with Inbred I (1) and Inbred II (3); 12 ears
- " 40-79 (x) y su, seg. f_x, may seg. d_x v⁸, also pollinated with Inbred I (2), (freezing injury, poor germination); 2 ears
- " 40-80 (x) Y, seg. su fl_x v_x, may seg. v⁸ d_x, also pollinated with Inbred I (2) and Inbred II (3); 8 ears
- " 40-81 (x) wx?, seg. PWR y Bn? d_x an_x, may seg. v⁶ cr_x, also pollinated with Inbred I (2) and reciprocally with Inbred I (2); 10 ears
- " 40-82 (x) and # Y cr_x, seg. Bn?, may seg. d_x v⁶, also crossed onto Dutton's Flint Inbred (5 and 6), (freezing injury, poor germination); 3 ears
- " 40-83 (x) and # PWR Y gs?, seg. fl?, may seg. v⁶, also pollinated with Inbred I (1 and 2); 6 ears
- " 40-84 # PWR cr_x, seg. y sk, may seg. d_x bl_x v_x, also pollinated with Inbred I (1) and reciprocally with Dutton's Flint Inbred (5 and 6); 2 ears
- " 40-88 (x) Seg. Pr pr, may seg. yg_a, also pollinated with Inbred II (3) and Dutton's Flint Inbred (5) and reciprocally with Inbred I (1); 6 ears
- " 40-89 (x) Y, seg. pr wx, may seg. d_a, also pollinated with Inbred I (1); 7 ears
- " 40-91 (x) and # lg_x, seg. y, may seg. pg_x; 3 ears
- " 40-92 (x) Y wx?, seg. su, may seg. ar_a, also pollinated with Inbred II (3); 4 ears
- " 40-93 (x) Y wx?, seg. Pr pr su, may seg. ar_a, also crossed onto Dutton's Flint Inbred (6); 4 ears
- " 40-94 (x) Seg. Pr pr su wx?, may seg. pg_a, also pollinated with Inbred II (3), and reciprocally with Inbred I (2) and Inbred II (3 and 4); 7 ears
- " 40-95 (x) and # PWR Y cr, seg. wx pg² "white stripe", may seg. lg_x, also pollinated with Inbred I (1 and 2) and reciprocally with Inbred I (1) and Inbred II (3); 7 ears
- " 40-96 (x) A Pl, seg. y Pr pr lg gl² B v⁴, may seg. ts_x; 3 ears
- " 40-98 (x) y Hadjinov's gl⁵, seg. v_x, also pollinated with Inbred II (3) and reciprocally with Inbred I (1); few seeds

- Co 40-99 (x) y Hadjinov's gl6; few seeds
- " 40-100 (x) y, may seg. Hadjinov's gl7; 3 ears
- " 40-101 (x) Seg. y B Pl f, may seg. wx Hadjinov's gl8, also
pollinated with Inbred I (2) and
reciprocally with Inbred I (1)
and Dutton's Flint Inbred (6);
3 ears
- " 40-102 (x) P Y Hadjinov's gl10, also pollinated with Inbred
I (1 and 2) and Inbred II (3);
4 ears
- " 40-103 (x) and # "Deep Y" lg gl4, may seg. v_x bm_x, also
pollinated with Inbred I (1 and 2),
and reciprocally with Dutton's
Flint Inbred (5 and 6); 9 ears
- " 40-105 (x) and # Y, seg. rs2 gl_x; 5 ears
- " 40-107 (x) and # Seg. y Pr I? Hadjinov's at si ts2 br? bv?,
may seg. f, also pollinated with
Inbred I (1 and 2) and reciprocal-
ly with Inbred I (1); 6 ears
- " 40-108 (x) P^{WR} Y, may seg. Hadjinov's bs v_x; 1 ear
- " 40-109 (x) and # Y A b Pl, seg. P vb, may seg. v_x, also
pollinated with Inbred I (1) and
reciprocally with Inbred I (1);
6 ears
- " 40-110 (x) and # y A Pl (zg3) lg_x, seg. B d_x, also pol-
linated with Inbred I (1); 7 ears
- " 40-111 # A, seg. y Pr R^{GG} su B Pl ba, may seg. v_x, also
pollinated with Inbred I (2);
11 ears
- " 40-112 (x) and # A su^{am}?, seg. y Pr pr Pl ba2 v_x f? lg_x,
also pollinated with Inbred II
(3) and reciprocally with Inbred
I (1); 6 ears
- " 40-113 (x) and # y a lg_x, seg. ts⁴ g_x cr_x, may seg. v_x,
also pollinated with Inbred I (1);
8 ears
- " 40-114 Crossed onto Inbred I (2), may seg. d_x^s d^D
- " 40-115 (x) P^{WR}, seg. y Pr pr R^{GG} R^{nj}? su B Pl lg_x^x, may seg.
g d7 v_x, also crossed onto Inbred
I (1) and Dutton's Flint Inbred
(5); 15 ears
- " 40-116 (x) and # y a C r pr wx, may seg. ys_x, also pollin-
ated with Inbred I (1) and Inbred
II (3) and reciprocally with In-
bred I (2); 6 ears
- " 40-117 (x) and # Seg. y Bn v5 gl, may seg. ws2; 5 ears
- " 40-118 (x) and # Seg. P^{WR} y Pr pr c sh wx ws gl4, also
crossed onto Inbred I (1); 6 ears
- " 40-119 (x) and # Seg. y Pr pr g?, may seg. li ws2, also
crossed onto Inbred I (1); 4 ears
- " 40-120 (x) a B Pl wx?, seg. y as lg_x "white stripe", may
seg. gs, also pollinated with In-
bred I (1); 5 ears
- " 40-121 (x) and # Seg. Pr pr po; 10 ears

- Co 40-122 (x) Y, may seg. st v_x; 2 ears
 " 40-123 (x) P a, may seg. br f bm2 nl2 w_x, also crossed onto Inbred I (2); 2 ears
 " 40-124 (x) and # Y, seg. Pr pr Pl Rg rt bl?, may seg. d_x, also crossed onto Inbred I (1 and 2), Inbred II (3) and Dutton's Flint Inbred (5 and 6); 5 ears
 " 40-125 (x) and # PVV - bm2/lg-b/y?-pl/ c-wx/g - RGG/j/pr pk?; few seeds
 " 40-126 (x) and # PVV and p-bm2/lg-b/A-Cr cr + cr/Su and su/y? - pl/c-wx/g - RGG/pr/j; few seeds
 " 40-127 (x) Seg. PWR y Pr vp5, also pollinated with Inbred I (2); 8 ears
 " 40-128 (x) PWR y o2 v5 ra gl; 1 ear
 " 40-129 (x) PWR A B pl d^s? an_x, seg. y Bn? Lg3?, also crossed onto Inbred I (2); 2 ears
 " 40-130 (x) Rg d^s? an_x, seg. y; few seeds
 " 40-131 (x) Y, seg. su? bt?, also open pollinated ear somewhat like Tp; few seeds
 " 40-133 (x) y pr, seg. Rst? wx? g, may seg. mr; 3 ears
 " 40-134 (x) and # P A br f bm2, may seg. ts2; 3 ears
 " 40-135 (x) Seg. y4 y_x It Pr pr; 5 ears
 " 40-136 (x) Hadjinov's gl6, seg. y Wh?; 3 ears

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- Co 41-1 Inbred I (U.S. 204) PWR Y A b pl, pollinated with Y A b pl nl, seg. R, may seg. d_x g zb5 (113); y gl10, may seg. w_x (69); Y a lg2 ra2 ? (21); Y cr na a v5 gl, may seg. lg_x (54); Y A b pl su vl4, may seg. sh d3 (166); P Y A b pl, may seg. d5 v5 (57); Y A b pl, seg. hf, may seg. wx v_x Rg? (78); Y A b pl rs2, may seg. gl_x v_x (12); A b Pl Kn (86); Y A b pl gs_x, seg. ms11, may seg. lg_x "ar-like" stripe (103); y A b pl vl8, may seg. 14 (91); y A b pl pg2, seg. d (128); may seg. vp v? (171); pr A b Pl bm ys, may seg. v2 (180); "small anthers", may seg. pr su (170); nl2, may seg. br f bm2 gl_x (116); Y A b pl Rs, may seg. gl_x (13); Y A b pl cr_x, may seg. vp4 (174); Y A b pl bl_x (47); bv?, may seg. g pg (126); pr A b pl v3?, may seg. su (156); Y A B pl lg pk?, may seg. pg_x bm_x "white stripe" (132); Y a na yt, may seg. ts4 (182); Y A b pl d^s, seg. an_x (14); 28 ears
 " 41-2 (x) Inbred II (West Branch) Y A b pl, also pollinated with Y A b pl nl, seg. R, may seg. d_x g zb5 (113); Y A B pl lg bm_x pk?, may seg. pg_x "white stripe" (132); pr A b Pl bm v2, may seg. ys (180); 4 ears
 " 41-3 (x) y A b pl, may seg. g3 l_x; 1 ear
 " 41-7 (x) P sh A B pl, may seg. 16; 1 ear
 " 41-9 (x) y su A b pl "yellow flecked leaves", may seg. v8 d_x; 1 ear
 " 41-10 # Bn? A b pl cr?, may seg. v6 d_x; 1 ear

- Co 41-11 (x) and # y A b pl Hadjinov's gl₆; 3 ears
- " 41-12 # Y A b pl, seg. rs₂, may seg. gl_x v_x, also crossed onto Inbred I(1); 3 ears
- " 41-13 (x) and # A b pl Rs, seg. y, may seg. gl_x, also crossed onto Inbred I(1); 2 ears
- " 41-14 # Y A b pl d^s an_x, also crossed onto Inbred I(1); 3 ears
- " 41-15 (x) and # A b pl gl₄, seg. y Pr pr wx? ws; 7 ears
- " 41-16 # P^{VV} - bm₂/lg-b/y-pl/c-wx/g-R^{GG}/j/pr pk?, also pollinated with 17, same genotype; 5 ears
- " 41-17 (x) and # P^{VV} - bm₂/lg-b/y-pl/c-wx/g-R^{GG}/j/pr pk?; 5 ears
- " 41-19 (x) and # Y A b pl, seg. Pr pr su_x h?; 3 ears
- " 41-20 (x) and # Y a C R pr in wx; 6 ears
- " 41-21 # Y a lg₂ ra₂?, also pollinated with Y a C R pr in wx (20), and with Inbred I (1), and reciprocally with Inbred I (1); 4 ears
- " 41-22 Y a C R Pr B Pl pollinated with Y a lg₂ ra₂? (21); 1 ear
- " 41-23 (x) and # y su a Dt, may seg. lg₂; 4 ears
- " 41-24 (x) and # y a₂ A C R v₂, seg. P^{WR}, may seg. bm; 4 ears
- " 41-25 # y a₂ A C R pr bt bv; 5 ears
- " 41-26 (x) and # y a₃ (A B pl?) Og; 8 ears may
- " 41-28 (x) and # Seg. P^{WR} y su Ts₆ al? ij?/seg. gl_x; 6 ears
- " 41-29 (x) and # P^{WR} Y A b pl, may seg. an₂ v_x gl_x d_x; 6 ears
- " 41-30 (x) and # Y wx, seg. ar; 9 ears
- " 41-31 # Y wx da A b pl ar sa, seg. Pr pr; 3 ears
- " 41-32 (x) and # y, seg. P^{VV} B z₁ as, may seg. ms₁₇; 6 ears
- " 41-33 (x) and # y Pr, seg. B R^{GG} ms₁₇ as, may seg. z₁; 9 ears
- " 41-34 # Seg. y at si bl_x ts_x f fl?, may seg. bv br zb_x v_x gl_x; 3 ears
- " 41-35 Y sh A b pl au₂ cr_x, pollinated with Inbred I (1), may seg. vp?; 3 ears (includes 2 very small ears)
- " 41-36 (x) and # Pr S_x A B pl R^{GG} lg_x bm_x; 2 ears
- " 41-37 (x) and # y Pr A B pl C R^{GG} S_x lg bm₂, seg. g? v? may seg. j d cr ts₂; 10 ears
- " 41-38 # Y a B Pl C R Pr, may seg. v_x; 4 ears
- " 41-39 # P^{CV} A b pl, may seg. ba_x; 1 ear
- " 41-40 (x) P A pl, seg. y su B ba, may seg. ba_x v_x; 16 ears
- " 41-41 (x) P Y A Pl, seg. Pr su B ba₂, may seg. ba_x v_x; 18 ears
- " 41-42 # Y gl₁ ij, seg. P bd; 2 ears
- " 41-43 (x) and # A b, seg. y Pl ra gl₁ ij bd; 10 ears
- " 41-44 (x) and # Y A b pl bk gl_x; 3 ears
- " 41-45 (x) and # Y bk₂; 5 ears
- " 41-46 # P Y A b pl, seg. sk lg_x, may seg. d_x v_x bl? cr?; 1 ear
- " 41-47 Y A b pl bl_x, crossed onto Inbred I (1)
- " 41-48 # A B Pl lg_x, seg. y Pr sk_x, may seg. R^{GG} bm; 1 ear
- " 41-49 (x) and # y a₂ A C R b pl v₂, seg. P^{WR}; 15 ears
- " 41-51 (x) and # Y, seg. P^{WR} sh wx v_x, may seg. bp zb?; 17 ears

- Co 41-52 # PWR Y A b pl bt2, may seg. gl_x "white stripe", 1 ear
- " 41-53 (x) and # y c, seg. su, may seg. v9; 3 ears
- " 41-54 Y cr na a v5 gl, crossed onto Inbred I (1), may seg. lg
- " 41-55 Y A b pl, pollinated with Inbred I (1), seg. PWR Tu d_H "white stripe", may seg. su; 3 ears
- " 41-56 (x) and # P Y sh wx c, may seg. d3; 4 ears
- " 41-57 P Y A b pl, crossed onto Inbred I (1), may seg. d5 v5
- " 41-58 (x) and # Y wx?, seg. nl?, may seg. d_b ms?; 2 ears
- " 41-60 Y de A b pl, pollinated with Inbred I (1), seg. mi?; 2 poor seeds
- " 41-61 (x) and # y a Dt lg, seg. ts4 na su, may seg. g; 6 ears
- " 41-62 # PWR Y fl2 gl_x; 2 ears
- " 41-63 (x) and # gl ij, seg. y, may seg. ra fr fr2; 11 ears
- " 41-65 (x) and # y A b pl Og li g; 2 ears
- " 41-67 (x) and # Y, seg. su, may seg. Ga; 6 ears
- " 41-68 (x) PWR Y wx gl₃ cr_x, seg. su, may seg. wl, also pollinated with Inbred I (1); 3 ears
- " 41-69 # y gl10, may seg. wx, also crossed onto Inbred I (1); 2 ears
- " 41-72 (x) and # y A b pl gl6, seg. P?; 3 ears
- " 41-74 (x) and # y A b pl, seg. gl7 vl7 Hadjinov's gl7, may seg. "white stripe"; 4 ears
- " 41-75 (x) PWR Y A b pl, seg. gl9; 1 ear
- " 41-76 (x) and # Seg. PWR y lg v4 gs2, may seg. gl2; 15 ears
- " 41-77 PWR Y A b pl h, pollinated with Inbred I (1); few seeds
- " 41-78 (x) and # PWR Y A b pl, seg. wx hf vx, may seg. Rg?, also crossed onto Inbred I (1); 3 ears
- " 41-79 # y A b pl Hs; 2 ears
- " 41-80 # y A c RGG pr in su, seg. PVV sh wx, may seg. vx; 3 ears
- " 41-82 (x) and # Seg. y4 and or y_x It Pr, may seg. sr_x; 6 ears
- " 41-83 y4 It It a c r pr i pollinated with Inbred I (1); 1 ear
- " 41-84 (x) and # A b pl, seg. y sh Wc? ms8 j gl_x, may seg. vl6; 4 ears
- " 41-85 (x) and # Y A b pl gl3, seg. su, may seg. j2; 5 ears
- " 41-86 # A, seg. y B Pl Kn, also crossed onto Inbred I (1); 3 ears
- " 41-87 (x) P A B pl lg_x bk?, may seg. l w; 1 ear
- " 41-88 (x) and # r, seg. y su Pl "white stripe", may seg. g 12; 8 ears
- " 41-89 # PWR Y "white stripe", may seg. l3; few seeds
- " 41-90 (x) and # PWR Y "white stripe" li?, seg. Pr, may seg. l3; 4 ears
- " 41-91 y A b pl vl8, may seg. 14, pollinated with Inbred I (1) and reciprocally with Inbred I (1); few seeds
- " 41-92 PWR Y A b pl, may seg. sh 17 ms2, pollinated with Inbred I (1); 2 ears

- Co 41-93 (x) Y su A B pl Ts5?, may seg. la; 1 ear; also su A B pl la pollinated with (94) su A B pl Ts5 la lg_x, may seg. gl_x; few seeds
- " 41-95 (x) P^{wr} Wc? A b pl gl_x, seg. y, may seg. ms_x; 2 ears
- " 41-97 (x) and # A b Pl, seg. P^{wr} Pr pr Rst r fl? may seg. g mr "white stripe"; 2 ears
- " 41-98 Y A b pl, seg. P^{wr} ms2, may seg. 17 br_x, pollinated with Inbred I (1); 2 ears
- " 41-99 P A b pl, seg. ms5, may seg. lg_x, pollinated with Inbred I (1); 1 ear
- " 41-100 (x) and # P Y A B pl, seg. Pr pr ms6, may seg. g_x; 4 ears
- " 41-101 # A b pl, seg. y ms9; 2 ears
- " 41-102 # P^{wr}, seg. ms10 "white stripe", also pollinated with Inbred I (1); 3 ears
- " 41-103 # Y, seg. P ms11 gs_x, may seg. lg_x, "ar-like stripe", also crossed onto Inbred I (1); 2 ears
- " 41-104 (x) Y A b pl, may seg. ms12 bm_x "white stripe" v?; 1 ear
- " 41-105 # y, seg. ms13; 4 ears
- " 41-106 # Y, seg. wx sh ms14; 4 ears
- " 41-107 (x) and # P^{wr}, seg. Pr pr bm, may seg. ms18 l_x lg_x dx; 2 ears
- " 41-109 (x) and # P b Pl, seg. Ab? ms37; 5 ears
- " 41-111 P^{wr} y A b pl, may seg. vl9 ms_x, pollinated with Inbred I (1); 2 ears
- " 41-112 # Seg. P^{wr} y Pr pr su B Pl na2, may seg. "white stripe"; 2 ears
- " 41-113 # Y A b pl nl, seg. r Pr, may seg. g zb5 dx, also crossed onto Inbred I (1) and Inbred II (2); few seeds
- " 41-114 # P Pr A b pl g, may seg. nl zb5 gl_x, also pollinated with (113) Y A b pl nl; 2 ears
- " 41-115 (x) and # P^{wr} y A b pl r zb5, may seg. nl g; 7 ears
- " 41-116 (x) and # a, seg. P br f bm2, may seg. nl2 gl_x, also crossed onto Inbred I (1); 5 ears
- " 41-117 # Y o A B pl, seg. vx; 5 ears
- " 41-118 P^{wr} y o2 A b pl, pollinated with Inbred I (1); 1 ear
- " 41-119 # P A b Pl sm, seg. py; 1 ear
- " 41-120 (x) Seg. Pr pr zb? pg? pb?, may seg. ms_x and usually completely sterile plants with necrotic leaves; 1 ear
- " 41-122 (x) and # y A b pl pb4, seg. gl_x; 7 ears
- " 41-123 (x) Y wx, may seg. pb_x lg_x "white stripe"; 1 ear
- " 41-124 # P^{wr}, seg. y B pb_x, also pollinated with Inbred I (1); 2 ears
- " 41-126 # P^{wr} Pr bv?, may seg. g pg, also crossed onto Inbred I (1); few seeds
- " 41-128 # y A b pl, seg. pg2 d, also crossed onto Inbred I (1); 6 ears
- " 41-129 (x) Pr, seg. su, may seg. pga; 2 ears
- " 41-130 (x) and # y A b pl, seg. lg_x; 8 ears
- " 41-131 (x) and # y lg_x, seg. pg_x; 11 ears

- Co 41-132 (x) and # Y lg pk?, seg. B "white stripe", may seg. pg_x bm_x, also crossed onto Inbred I (1) and Inbred II (2); 4 ears
- " 41-133 # PWR y A b pl bm, may seg. pg_x msl8 lg_x "white stripe", also pollinated with Inbred I (1); 6 ears
- " 41-134 # PWR, seg. y pm lg₂; 9 ears
- " 41-135 # pr A b Pl; 4 ears
- " 41-136 (x) and # A b pl RGG Pr; 5 ears
- " 41-137 # P A b pl, seg. ra₂?; 2 ears
- " 41-138 (x) and # P, seg. Pr a lg₂ ra₂ ra_x; 9 ears
- " 41-139 (x) and # Seg. y lg_x gl_x dx "light green", may seg. wx v₄; 12 ears
- " 41-140 # y su₂ lg_x, seg. PWR sb ms?; 5 ears
- " 41-141 y A b pl sb pk?, may seg. sh, pollinated with Inbred I (1); 1 ear
- " 41-142 (x) and # Seg. pcr pcw y sb ms_x; 6 ears
- " 41-143 # Y bl_x, seg. Pr si at br f bv? ts₂?, may seg. vx gl_x, also pollinated with Inbred I (1); 7 ears
- " 41-145 (x) and # y A b pl sr bm₂, seg. PWR Pr an; 10 ears
- " 41-146 # PWR o₂ A b pl v₅ ra gl, seg. y; 6 ears
- " 41-147 # Y A b pl, may seg. st; 4 ears
- " 41-148 # su^{am} du A b pl, seg. y; 6 ears
- " 41-149 # sy A b Pl, seg. y, may seg. al; few seeds
- " 41-150 (x) and # A b pl, seg. Bn? tn vx dx; 5 small ears
- " 41-151 # y ra gl v₅, also pollinated with Inbred I (1); 2 ears
- " 41-152 # v₅ gl, seg. y Pr pr wx? ra Tp; 3 ears
- " 41-153 (x) and # A, seg. y su RGG Pr pr Bn? v₅ ra gl Tp B Pl; 6 ears
- " 41-154 # P br f bm₂, seg. a, may seg. ts₂; 2 ears
- " 41-155 (x) and # y, seg. Pr Mt? tw₃ g_x sr_x gl_x, may seg. bl_x; 7 ears
- " 41-156 # pr A b pl v₃?, may seg. su, also crossed onto Inbred I (1); 1 ear
- " 41-157 (x) and # A b pl, seg. y Pr pr v₃, may seg. vx; 4 ears
- " 41-158 # PWR Y A b pl v₇-striped; 2 ears
- " 41-159 (x) and # PWR Y A b pl, seg. v₇-striped; 4 ears
- " 41-160 # y v₁₂, seg. pr, may seg. lg_x, also pollinated with Inbred I (1); 4 ears
- " 41-161 (x) and # Seg. y Pr pr Pl v₁₃; 11 ears
- " 41-163 # Y su A b pl, may seg. sp l_x; 1 ear
- " 41-164 (x) and # Seg. P y su, may seg. sp; 7 ears
- " 41-166 (x) and # Y su A b pl v₁₄, seg. sh, may seg. d₃, also crossed onto Inbred I (1); 2 ears
- " 41-167 (x) and # wx? li, seg. y su Pl, may seg. wx; 10 ears
- " 41-168 (x) PWR Y v₂₀ lg_x, also pollinated with Inbred I (1); 4 ears
- " 41-169 (x) and # P y A b pl, seg. va₂, also pollinated with Inbred I (1); 6 ears
- " 41-170 "small anthers", may seg. pr su, crossed onto Inbred I (1)
- " 41-171 (x) y Pr A b pl, seg. r vp, may seg. vx, also crossed onto Inbred I (1); 1 ear
- " 41-172 (x) pr vx pk?, seg. vp₂?, may seg. bm_x; 4 ears

- Co 41-173 (x) pr pk?, seg. vp2?, may seg. v_x bm_x; 2 ears
 " 41-174 (x) and # PWR Y A b pl cr_x, seg. vp⁴?, also crossed onto Inbred I (1); 2 ears
 " 41-175 PWR Y A b pl cr_x, may seg. sh vp⁴, pollinated with Inbred I (1); 2 ears
 " 41-176 (x) and # PVV y A, seg. wa "white stripe" BW? P1; 3 ears
 " 41-177 # Y Wc A b pl, may seg. "white stripe"; 1 ear
 " 41-178 # A b pl, seg. y Pr pr Mt? g li ws²; 11 ears
 " 41-179 (x) and # Y Y A B pl, seg. Y_x, may seg. w_x al; 4 ears
 " 41-180 # pr bm, seg. y Mt? sh wx ys v² P1, also crossed onto Inbred I (1) and Inbred II (2); 3 ears
 " 41-181 (x) and # y a C r pr wx, may seg. ys_x; 3 ears
 " 41-182 # Y wx a yt, seg. na, may seg. ts⁴, also pollinated with Inbred I (1) and reciprocally with Inbred I (1); 3 ears
 " 41-183 # Y A b pl zb⁴; 2 ears
 " 41-184 (x) PWR Y A b pl, seg. zb⁴; 2 ears
 " 41-185 (x) and # Y A b pl, seg. zb⁴; 4 ears
 " 41-187 (x) and # Y T8-9 homozygous terminal number 9 knob, seg. B P1 also R^{EE} or r^{EE}; 6 ears
 " 41-191 (x) and # y T1-2; 2 ears
 " 41-192 (x) and # y A pl T1-2b, seg. PWR Pr pr B, may seg. v_x; 3 ears
 " 41-194 # a² bm bt pr A A C C R R; 133 seeds
 " 41-195 (x) a² bt pr, seg. y bm; 1 ear

J. E. Welch

Trisomic stocks

The program began by Randolph in 1940 of improving and building up reserve stocks of all the available trisomes was continued in the summer of 1941. Trisomes one and four are still missing.

Root tip counts were made on over 1500 plants to determine the trisomic plants. Over 300 ears were harvested.

In making crosses several inbred stocks were used as well as different genetic tester stocks. These were all checked to make sure that no B chromosomes were present.

Selected ears have been turned over to the Coöp. and are here listed under Coöp. numbers.

- Co 41-196 No. 2 trisome x Luce's Favorite Inbred
 1. (x) - 2 ears
 2. x L. F. Inbred - 5 ears
 3. x lg - 2 ears

- Co 41-197 No. 2 trisome x Cornell 11 Inbred
 1. (x) - 4 ears
 2. x L.F. Inbred - 1 ear
 3. # - 3 ears
- " 41-198 No. 2 trisome x Inbred II (West Branch)
 1. (x) - 1 ear
 2. x L.F. - 3 ears
 3. # - 1 ear
- " 41-199 No. 2 trisome x lg
 1. x L.F. - 4 ears
 2. # - 2 ears
- " 41-200 No. 3 trisome x lg²
 1. (x) - 6 ears
 2. x L.F. - 2 ears
 3. # - 3 ears
- " 41-201 No. 3 trisome x L.F. Inbred
 1. x L.F. - 2 ears
- " 41-202 No. 3 trisome x Inbred II
 1. x L.F. - 3 ears
- " 41-203 No. 5 trisome x Inbred II
 1. (x) - 1 ear
 2. x L.F. - 5 ears
 3. x bt - 2 ears
- " 41-204 No. 6 trisome x su²
 1. (x) - 3 ears
 2. x L.F. - 5 ears
 3. # - 2 ears
- " 41-205 No. 7 trisome x L.F. Inbred
 1. x L.F. 2 ears (all ears of trisome 7
 poor)
- " 41-206 No. 7 trisome x Inbred II
 1. x L.F. - 2 ears
 2. x gl - 1 ear
 3. open - 1 ear
- " 41-207 No. 8 trisome x L.F. Inbred
 1. (x) - 2 ears
 2. x L.F. - 5 ears
 3. # - 2 ears
- " 41-208 No. 8 trisome x j
 1. (x) - 2 ears
 2. # - 2 ears
- " 41-209 No. 9 trisome x wx (No. 9 also wx)
 1. (x) - 2 ears
 2. x L.F. - 4 ears
 3. # 1 ear
- " 41-210 No. 10 trisome x L.F. Inbred
 1. (x) - 1 ear
 2. x L.F. - 4 ears
 3. x v18 - 2 ears
- " 41-211 No. 10 trisome x v18
 1. (x) - 2 ears
 2. x L.F. - 2 ears

V. Index of Seed Stocks Propagated in 1940 and 1941

A complete index of all Coop stocks on hand at the close of the 1939 season appeared in the 1940 News Letter. The culture number of an inbred is followed by the number in parenthesis of the male parent carrying the gene in question. m.s. = may segregate.

a	Co	40-1 (71), 40-2 (71), 40-2 (116), 40-2 (123), 40-26, 40-70, 40-71, 40-72, 40-73, 40-113, 40-116, 40-120, 40-123, 41-1 (21), 41-1 (54), 41-1 (182), 41-20, 41-21, 41-22, 41-23, 41-38, 41-61, 41-83, 41-116, 41-138, 41-154, 41-181, 41-182
a ^p	"	40-18, 40-43
Ab?	"	41-109
a ₂	"	41-24, 41-25, 41-49, 41-194, 41-195
a ₃	"	41-26
a ₁	"	41-149 (m.s.), 41-179 (m.s.)
a ₁ ?	"	41-28
an	"	41-145
an ₂	"	41-29 (m.s.)
anx	"	40-2 (81, m.s.), 40-2 (129, m.s.), 40-25, 40-81, 40-129, 40-130, 41-1 (14), 41-14
"anthers small"	Co	41-1 (170)
ar	Co	41-30, 41-31
ara	"	40-6 (93, m.s.), 40-92 (m.s.), 40-93 (m.s.)
as	"	40-120, 41-32, 41-33
at	"	40-1 (107), 40-107, 41-34, 41-143
au	"	41-35
au ₂	"	41-35
B	"	40-1 (101, m.s.), 40-1 (69), 40-1 (115, m.s.), 40-2 (129), 40-3 (69), 40-5 (115, m.s.), 40-5 (69), 40-6 (101, m.s.), 40-17, 40-18, 40-43, 40-51, 40-69, 40-73, 40-76, 40-96, 40-101, 40-110, 40-111, 40-115, 40-120, 40-129, 41-7, 41-22, 41-32, 41-33, 41-36, 41-37, 41-38, 41-40, 41-41, 41-48, 41-86, 41-87, 41-93, 41-100, 41-112, 41-117, 41-124, 41-132, 41-153, 41-179, 41-187, 41-192
B ^w ?	"	41-176
ba	"	40-111, 41-40
ba ₂	"	40-1 (112), 40-112, 41-41
ba _x	"	41-39 (m.s.), 41-40 (m.s.), 41-41 (m.s.)
bd	"	41-42, 41-43
bk	"	41-44
bk ₂	"	41-45
bk?	"	41-87
bl _x	"	40-5 (84, m.s.), 40-6 (84, m.s.), 40-84 (m.s.), 41-1 (47), 41-34, 41-143, 41-155 (m.s.)
bl?	"	40-1 (124, m.s.), 40-2 (124, m.s.), 40-3 (124, m.s.), 40-5 (124, m.s.), 40-6 (124, m.s.), 40-124, 41-46 (m.s.)
bm	"	40-62, 41-1 (180), 41-2 (180), 41-24 (m.s.), 41-48 (m.s.), 41-107, 41-133, 41-180, 41-194, 41-195

bm2 Co 40-2 (123, m.s.), 40-21, 40-45, 40-123 (m.s.),
 40-125, 40-126, 40-134, 41-1 (116, m.s.), 41-16,
 41-17, 41-37, 41-116, 41-145, 41-154
 bm3 " 40-54, 40-57
 bmx " 40-1 (69), 40-3 (69), 40-5 (103, m.s.), 40-6 (103,
 m.s.), 40-5 (69), 40-69, 40-103 (m.s.), 41-1 (132,
 m.s.), 41-2 (132), 41-36, 41-104 (m.s.), 41-132
 (m.s.), 41-172 (m.s.), 41-173 (m.s.)
 Bn " 40-117
 Bn? " 40-2 (81, m.s.), 40-2 (129, m.s.), 40-5 (82, m.s.),
 40-6 (82, m.s.), 40-81, 40-82, 40-129, 41-10,
 41-150, 41-153
 bp " 41-51 (m.s.)
 br " 40-1 (107, m.s.), 40-2 (123), 40-21, 40-45, 40-123
 (m.s.), 40-134, 41-1 (116, m.s.), 41-34 (m.s.),
 41-116, 41-143, 41-154
 brx " 41-98 (m.s.)
 br? " 40-107
 bs Hadjinov Co 40-108 (m.s.)
 bs? Co 40-67 (m.s.), 41-120 (m.s.)
 bt " 41-25, 41-194, 41-195
 bt2 " 41-52
 bt? " 40-131
 bv " 40-1 (107, m.s.), 41-25, 41-34 (m.s.)
 bv? " 40-107 41-1 (126), 41-126, 41-143
 c " 40-1 (118, m.s.), 40-118, 40-125, 40-126, 41-16,
 41-17, 41-53, 41-56, 41-80, 41-83
 cr " 40-1 (95), 40-3 (95), 40-95, 40-126, 41-1 (54),
 41-37 (m.s.)
 crx " 40-2 (81, m.s.), 40-5 (82), 40-6 (82), 40-5 (84,
 m.s.), 40-6 (84, m.s.), 40-76, 40-78, 40-81 (m.s.),
 40-82, 40-84, 40-113, 41-1 (174), 41-35, 41-68,
 41-174, 41-175
 cr? " 41-10, 41-46 (m.s.)
 d " 40-2 (114, m.s.), 40-2 (129), 40-25, 40-26, 40-48,
 40-129 (?), 40-130 (?), 41-1 (128), 41-1 (14),
 41-14, 41-37 (m.s.), 41-128
 d3 " 40-75 (m.s.), 41-1 (166, m.s.), 41-56 (m.s.),
 41-166 (m.s.)
 d5 " 41-1 (57, m.s.)
 d7 " 40-1 (115, m.s.), 40-5 (115, m.s.), 40-115 (m.s.)
 da " 40-89 (m.s.)
 db " 41-58 (m.s.)
 dH " 41-55
 dx " 40-1 (124, m.s.), 40-2 (124, m.s.), 40-1 (74, m.s.),
 40-2 (81, m.s.), 40-2 (114, m.s.), 40-3 (124, m.s.),
 40-5 (124, m.s.), 40-6 (124, m.s.), 40-5 (74, m.s.),
 40-5 (82, m.s.), 40-6 (82, m.s.), 40-5 (84, m.s.),
 40-6 (84, m.s.), 40-74 (m.s.), 40-77 (m.s.), 40-78
 (m.s.), 40-79 (m.s.), 40-80 (m.s.), 40-81, 40-82
 (m.s.), 40-84 (m.s.), 40-110, 40-124 (m.s.), 41-1
 (113, m.s.), 41-2 (113, m.s.), 41-9 (m.s.), 41-10
 (m.s.), 41-29 (m.s.), 41-46 (m.s.), 41-107 (m.s.),
 41-113 (m.s.), 41-139, 41-150
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de Co 41-60
 Dt " 41-23, 41-61
 du " 41-143
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 f? " 40-1 (112, m.s.), 40-112
 fl " 40-24, 40-47
 fl2 " 41-62
 flx " 40-78, 40-80
 fl? " 40-83, 41-34, 41-97
 fr " 41-63 (m.s.)
 fr2 " 41-63 (m.s.)
 fs " 40-20, 40-44
 g " 40-1 (115, m.s.), 40-1 (119, m.s.), 40-4 (65, m.s.), 40-5 (115, m.s.), 40-30 (m.s.), 40-65, 40-66, 40-115 (m.s.), 40-125, 40-126, 40-133, 41-1 (113, m.s.), 41-1 (126, m.s.), 41-2 (113, m.s.), 41-16, 41-17, 41-61 (m.s.), 41-65, 41-88 (m.s.), 41-97 (m.s.), 41-113 (m.s.), 41-114, 41-115 (m.s.), 41-126 (m.s.), 41-178
 g3 " 40-60 (m.s.), 41-3 (m.s.)
 g4 " 40-52, 40-55, 40-58, 40-59
 gx " 40-113, 41-100 (m.s.), 41-155
 g? " 40-119, 41-37
 Ga " 41-67 (m.s.)
 gl " 40-63, 40-117, 40-128, 41-1 (54), 41-42, 41-43, 41-63, 41-146, 41-151, 41-152, 41-153
 gl2 " 40-22, 40-23, 40-24, 40-46, 40-47, 40-96, 41-76 (m.s.)
 gl3 " 41-68, 41-85
 gl4 " 40-1 (118), 40-5 (103), 40-6 (103), 40-27, 40-28, 40-29, 40-49, 40-50, 40-103, 40-118, 41-15
 gl6 " 41-72
 gl7 " 41-74
 gl9 " 41-75
 gl10 " 41-1 (69), 41-69
 gl5 Hadjinov Co 40-1 (98), 40-98
 gl6 Hadjinov " 40-99, 40-136, 41-11
 gl7 Hadjinov " 40-100 (m.s.), 41-74
 gl8 Hadjinov " 40-1 (101, m.s.), 40-6 (101, m.s.), 40-101 (m.s.)
 gl10 Hadjonov " 40-102
 glx Co 40-105, 41-1 (12, m.s.), 41-1 (116, m.s.), 41-1 (13, m.s.), 41-12 (m.s.), 41-13 (m.s.), 41-28 (m.s.), 41-29 (m.s.), 41-34 (m.s.), 41-44, 41-52 (m.s.), 41-62, 41-84, 41-93 (m.s.), 41-95, 41-114 (m.s.), 41-116 (m.s.), 41-122, 41-139, 41-143 (m.s.), 41-155
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 Knob " 41-187
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 l2 " 40-66 (m.s.), 41-88 (m.s.)
 l3 " 41-89 (m.s.), 41-90 (m.s.)
 l4 " 41-1 (91, m.s.), 41-91 (m.s.)
 l6 " 40-76 (m.s.), 41-7 (m.s.)
 l7 " 41-92 (m.s.), 41-98 (m.s.)
 lx " 40-1 (64, m.s.), 40-5 (64, m.s.), 40-60 (m.s.),
 40-62 (m.s.), 40-64 (m.s.), 40-68 (m.s.), 41-3
 (m.s.), 41-107 (m.s.), 41-163 (m.s.)
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 (m.s.), 41-134, 41-138
 Lg3 " 40-2 (129)
 Lg3? " 40-129
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 m.s.), 40-5 (115, m.s.), 40-5 (64, m.s.), 40-8
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 mi? " 41-60
 mr " 40-133 (m.s.), 41-97 (m.s.)
 ms2 " 41-92 (m.s.), 41-98
 ms5 " 41-99
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 ms8 " 41-84
 ms9 " 41-101
 ms10 " 41-102
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 ms12 " 41-104 (m.s.)
 ms13 " 41-105

ms14 Co 41-106
 ms17 " 41-32 (m.s.), 41-33
 ms18 " 40-62, 41-107 (m.s.), 41-133 (m.s.)
 ms37 " 41-109
 msx " 40-1 (74, m.s.), 40-5 (74, m.s.), 40-67, 40-68
 (m.s.), 40-74, 41-95 (m.s.), 41-111 (m.s.), 41-120
 (m.s.), 41-142
 ms? " 41-58 (m.s.), 41-140
 Mt? " 41-155, 41-178, 41-180
 na " 41-1 (54), 41-1 (182), 41-61, 41-182
 na2 " 41-112
 n1 " 40-30 (m.s.), 41-1 (113), 41-2 (113), 41-113, 41-
 114, 41-115 (m.s.)
 n12 " 40-2 (123, m.s.), 40-123 (m.s.), 41-1 (116), 41-116
 (m.s.)
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 Og " 41-26, 41-65
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