Longley

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MAIZE GENETICS COÖPERATION

NEWS LETTER

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

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I. NEWS LETTER FUND

It costs about $250.00 to issue and distribute the Maize Genetics Cooperation News Letter each year. Since support from the Rockefeller Foundation ended in 1953 it was necessary to obtain new funds. In view of the interest shown, hybrid corn companies were solicited for contributions to help finance the News Letter. The response to our request was immediate, generous, and most encouraging. A total of $560.00 has been received to date, so that two volumes of the News Letter can be issued on available funds with money to spare for a third. We wish to express our thanks and appreciation to the following who contributed:

AMERICAN MAIZE-PRODUCTS CO., Roby, Indiana

ASSOCIATED SEED GROWERS, INC., New Haven, Conn.

BEAR HYBRID CORN CO., INC., Decatur, Illinois

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DE KALB AGRICULTURAL ASSOC., INC., DeKalb, Illinois

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UNITED-HAGIE HYBRIDS, INC., Des Moines, Iowa

II. REPORT ON MAIZE COOPERATIVE

During the past summer the initial plantings of genetic stocks at the North Central Maize Genetics Research Center were grown. In addition to an extensive collection of maize stocks obtained from Cornell University, genetic stocks were solicited and received from about two dozen other sources in this country. A total of about sixteen thousand plants, comprising more than eleven hundred cultures, were grown.

In this first season, major emphasis was placed on preserving established genetic stocks, increasing the supply of material for distribution, and beginning a program of conversion of all stocks to three inbred lines. Whenever possible, specific genetic stocks were increased both by sib pollinations and by intercrossing stocks of different backgrounds in order to increase their vigor. In addition, all stocks were crossed routinely to the inbred lines M14, W23, and Oh51a with the object of extending the range of their adaptability.

Certain other types of crosses were made as labor considerations permitted. However, during this first season, they were necessarily on a rather small scale. In some instances, stocks were intercrossed to test their genetic identity or allelism. In the case of genes which have been assigned to specific chromosomes but whose positions in the linkage groups have not been established, some crosses were made to appropriate genetic testers with a view to eventually determining their map positions. Many of the genes which are not yet assigned to individual chromosomes were crossed to a selected series of chromosome rearrangements which are mostly marked by closely-linked endosperm or seedling genes. It is planned that these F_1's will be selfed or test crossed next season to check linkages. A considerable number of the unplaced gene stocks were also pollinated by A-B translocations. Some intercrosses of chromosome linkage tester stocks were made with a view to extracting more favorable gene combinations. Likewise, several of the multiple gene stocks were intercrossed in order to derive various new combinations.

The presently available Cooperation stocks are indicated below. Genes listed under specific chromosomes include some whose placements should be considered only tentative pending further verification. On the other hand, some of the genes designated as unplaced may have been assigned to particular chromosomes on the basis of more recent information. The listing which follows is intended primarily as a catalogue of stocks rather than as an indication of chromosome placement.

MAIZE COOPERATIVE STOCKS

Chromosome 1 stocks

as
bm_2 (may seg. zb_4, ts_2, br_1)
bm_2 v_{19}
Hm
Kn
lw_1
ms_{17} (may seg. zb_4, P)
ms_{17} (may seg zl)
prr
por
prr ad_1 bm_2
prr br_1 an_1 gs_1 bm_2
prr br_1 f_1 an_1 gs_1 bm_2
sr bm_2 (may seg. an_1)
Ts_6
Vg
vp_5
zb_4 ts_2

Chromosome 2 stocks

ba_2
lg_1 al
lg_1 gl_2 b (heterozygous ws_3, fl_1, v_4)
lg_1 gl_2 b fl_1 v_4
lg_1 gl_2 B sk v_4
lg_1 gl_2 b sk v_4
lg_1 gl_2 b v_4
seg lg_1 gl_2 ts_1 v_4
seg lg_1, gl_2, b, gs_2, v_4, Ch
ws_3 lg_1 gl_2

Chromosome 3 stocks

A^d-31
$\frac{a_{x-1}\ Et}{a\quad et}$
$\frac{a_{x-3}}{a}$
a_1 et
a_1 sh_2 (seg. Dt)
aP et Dt
A ga_7
ba_1
cr_1 ts_4 na_1
d_1
d_1 Rg
d_1 ts_4 lg_2
d_2
g_2
gl_6

Chromosome 3 stocks (Cont.)

gl_6 lg_2 a_1 et
gl_6 v_{17}
lg_2 $\frac{A^b}{a}$ et C R Pr (Carries Dt)
Lg_3
ms_3
pg_2
pm
ra_2
may seg. ra_2 lg_2 a_1
may seg. ra_2, pm, lg_2, a_1
Rg (may carry ra_2)
Rg Lg_3
rt
vp_1

Chromosome 4 stocks

may carry bt_2
bm_3
de(1?)

$\frac{Ga_1\ Su}{ga_1\ su}$
may seg. lo
lw_4 (with lw_3)
S_1 (with S_2 S_3 s_4)
sp_1 su_1 (may seg. lo)
seg sp_1, su_1, la, gl(3?)
st
(st) A_1 A_2 B^W Pl
su_1 bm_3
su_1 gl_3 (may seg. j_2)
su_1 gl_4
su_1 la gl_3
su_1 Tu
su_1 zb_6
su_1 zb_6 Tu
Ts_5
v_8

Chromosome 5 stocks

a_2 bm_1 bt_1 bv pr
a_2 bm_1 bv pr
a_2 bm_1 pr v_2
a_2 bt_1 pr ye_1
bm_1 yg_1
seg bm_1 pr ys_1 v_2
gl_5

Chromosome 5 stocks (Cont.)

gl_8
gl_{17}
lw_2
lw_3 (with lw_4)
ms_{18}
pr A_1 A_2 A_3 C R
pr v_3 (aleurone genes may not be homozygous)
seg sh_3, bm_1, pr, ys_1, intensifier (apparently linked to sh_3)
tn
v_3
v_{12}
vp_2 gl_8
vp_2 A_1 A_2 A_3 C R pr
vp_7 (may seg. gl_8)

Chromosome 6 stocks

at si
l (Eyster's lutens on chromosome 6); may = l_{10}
pg_{11} (with pg_{12})
Pl Bh (with A_1 A_2 A_3 B c sh_1 wx R^g)
Pl sm py (with A_1 A_2 b)
po
(si?)
v_7
w_1
w_1 (may seg. py)
y l_{10}
y; seg $l_{(10?)}$,$^{w}{}_{(1?)}$
y $ms_{(1)}$
Y A_1 A_2 b pl
Y Pl sm (may seg. py); A_1 A_2 b
y su_2
y su_2 (may seg. si)
y su_2 v_7
y w_1

Chromosome 7 stocks

(Bn)
gl_1
gl_1 sl (Bn)
Hs
Hs o_2 v_5 ra_1 gl_1
in (with A_1 A_2 A_3 C R pr)
o_2 v_5 ra_1 gl_1
ra_1 gl_1
ra_1 gl_1 ij
Tp_1 (may seg. v_5, ra_1, gl_1)
va_1
vp_9 gl_1
(Wh) gl_1

Chromosome 8 stocks

v_{16} ms_8 j_1

Chromosome 9 stocks

au_1 au_2
carries bk_2, ms_{20}
C sh_1 au_1 au_2 (with A_1 A_2 A_3 R Pr)
c sh_1 pc_1 Pc_2 Pc_3 pc_4
c sh_1 wx gl_4 (may seg. yg_2, l_6); probably A_1 A_2 A_3 R
c sh_1 wx gl_H; A_1 A_2 A_3 R
c sh_1 wx (may seg. v_1, l_7); R may not be homozygous
gl_{10}
gm(1?)
I wx (with A_1 A_2 A_3 R)
I wx (with A_1 A_2 A_3 R B pl y)
l_7
ms_2
ms_{20}
ms_{20} (may seg. bk_2)
o_1
Pc_1 (with Pc_2 Pc_3 pc_4)
pg_{12} (with pg_{11})
sh_1
sh_1 (may seg. l_6)
sh_1 bp wx
sh_1 d_3
seg sh_1, d_3, l_6
sh_1 l_7
sh_1 ms_2
sh_1 wx d_3
sh_1 wx d_3; may carry l_6
(Wc?)
wx^a
wx; seg l_6
wx g_4
wx v_1
seg wx, sa, ar, da, ms_2

Chromosome 10 stocks

a_3 g_1
du_1 (with su_1)
g_1
g_1; may seg. l_2
gl_9; may carry g_1
l_1; with ms_8, j_1, v_{16}
li
li g_1 R
li r abnormal 10; carries g_1
Mt
na_2
nl_1 g_1 R
nl_1 g_1 r
Og
Og a_2; carries g_1

Chromosome 10 stocks (Cont.)

Pc_2 (with Pc_1 Pc_3 pc_4)
pc_2 (with Pc_1 Pc_3 pc_4) r; condition of A and C unknown.
R^{mb} (with A_1 A_2 A_3 C Pr)
R^{nj}
R^{st}
v_{18}; may carry l_4
v_{20}
w_2
may carry w_3

Stocks of unplaced genes
(In some cases, allelism tests with other genes are not complete.)

an_2
at
bk_1
bk_2
bm_4
"bt_4" Singleton
cl
de_{17}
may carry dv
dy
fl_2
gl_{11}
gl_{12}
gl_{13}
gl_{14}
gl_{15}
gl_{16}
gl_g
h
mg
mn
ms_5
ms_6
ms_7
ms_9
ms_{10}
ms_{11}
ms_{12}
ms_{13}
ms_{14}
nl_2
New starchy gene
pb_4
Pc_3
pc_4
"ra_3" Perry
Rs_1
rs_2
S_2 S_3 s_4 (with S_1)

Stocks of unplaced genes (Cont.)

sb
"sh_4" Singleton
"sh_5" Singleton
sy
Ts_3
tw_1
tw_2
may carry tw_3
v13
v17
v19
may carry va_2
vp6
wa
ws_1 ws_2
may carry yg_3
zb_1
zb_2
zb_3
zb_5

Multiple gene stocks

A_1 A_2 A_3 C R Pr
(")Pr wx
(")Pr wx y
(")pr
(")pr wx
(")pr wx y
(")pr su
(")pr lg_1 gl_2
A_1 A_2 A_3 B Pl (C)(Rg) Pr lg_1 y (C and R may segregate)
(") C Rg Pr
(") c Rg sh_1 wx Bh
A_1 A_2 A_3 c R Pr su_1
(") y wx
(") y sh_1 wx
A_1 A_2 A_3 C r Pr su_1
(") su_1 y gl
(") y wx
(") y sh_1 wx
y lg_1 gl_2 b v_4
wx lg_1 gl_2 b v_4
y su_1 ra_1 gl_1
y wx gl_1
lg_1 su_1 bm_1 y gl_1 j_1
lg_1 su_1 bm_1 y gl_1 j_1 g_1
su_1 y wx a_1 A_2 A_3 C Rg pr

Combinations of endosperm genes (from Dr. Kramer)

du_1
du_2
fl_1
h
o_1
o_2
sh_2
su_1
su_1^{am}
su_2
wx
du_1 du_2
du_1 sh_2
du_1 wx
su_1 du_1
su_1 h
su_1 su_2
su_1 wx
su_1^{am} du_1
su_1^{am} su_2
su_2 du_1
su_2 sh_2
su_2 wx
su_1 du_1 wx
su_1^{am} du_1 du_2
su_1^{am} su_2 du_2

Stocks used in studies of Gn factors (from Dr. Nelson)

Hulless
South American
Ohio Yellow
Black Beauty
Red
Amber Pearl
Supergold
White Rice

Exotics and varieties

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

Stocks of A-B chromosome translocations

B-1a	1L	.2	Proximal to Hm
B-1b	1S	.05	
B-3a	3L	.1	
B-4a	4S	.25	Proximal to su_1
B-7b	7L	.3	Proximal to ra_1
B-9b	9S	.4	Between wx and C; close to wx
B-10a	10L	.35	Proximal to g_1

Stocks of primary trisomics

Stocks possibly segregating for each of the ten primary trisomics of maize were planted last summer. Root tip samples were taken from all plants in order to obtain a cytological check on chromosome number. All plants were pollinated by the inbred W23 in an effort to maintain trisomic stocks with favorable characteristics for cytological work. Chromosome counts have not yet been made in this material. However, they will be made shortly and the information will be available in time for requests prior to spring planting.

Chromosome rearrangements marked with closely-linked genes for endosperm or seedling traits

A collection of chromosome rearrangements is being maintained for use in locating unplaced genes. A series giving rather complete chromosome coverage is available marked with wx. Supplementary, and to some extent overlapping, series are available which are closely linked with su_1, y, or gl_2. Stocks of some of these are being increased in a greenhouse generation and it is hoped that an improved series will be available for spring planting.

The excellent cooperation of many maize workers in contributing genetic stocks to this collection is gratefully acknowledged. If any recipients of the Newsletter have additional useful stocks that they feel should be added to the collection, we would be most happy to receive them. Likewise, any suggestions for useful new gene combinations or any corrections of the listing above will be welcomed.

Earl B. Patterson

III. REPORTS FROM COOPERATORS

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

1. Dotted r

It now seems most likely that an r stock produces dotted kernels similar to the dotted a condition. This strain arose as a segregate of a BNL3 X BNL1 cross. The aleurone constitution of these stocks was A C r pr X A C R Pr. The BNL1 which was also BP1 was grown in the radiation field and received 2.9 r/d of γ radiation. This amount of radiation produces no detectable effect on endosperm mutations. However, it may have induced the dotted condition. It is being tested further. Seed stocks are available to anyone interested.

2. Spontaneous Mutation for Intense Seedling Anthocyanin

A stock of BNL 145 (A B P1 C R Pr) in 1952 produced one plant (out of a total of several hundred grown) that had intense anthocyanin in the seedling. The plant also had wine colored silk, and a deep red pericarp similar to that produced by the r^{ch} allele. In some crosses the intense color appears dominant while in others the color in the plant is much reduced with no pericarp color. Apparently this character is subject to considerable modification. Tests under way should determine the genetics of this character.

3. Mutable Anthocyanin Color

In segregating progenies of the character described above it was noted that some of the green seedlings had pronounced streaks of red. In the later seedling stage these streaks are accentuated. Genetics and cytological tests will be conducted to determine the nature of this mutable condition.

4. bv_2

The character we have been calling reduced rd (reduced internode length) has a growth characteristic of brevis bv (Emerson, Fraser and Beadle, 1935). Consequently, we think our terminology should be changed to bv_2 instead of rd. The original bv would then become bv_1. From the F_2 of a cross of bv_1 X bv_2 some extremely short plants segregated, undoubtedly the double recessive bv_1 bv_1 bv_2 bv_2. Pollen of these when placed on silks of bv_2 bv_2 produced plants indistinguishable from bv_2. Apparently either bv_1 or bv_2 will shorten the plant to a height of about 4 feet.

W. R. Singleton

5. Pre-meiotic mutation.

Preliminary experiments were made in an attempt to induce recessive mutation by y-irradiation in pre-meiotic cells for the A_1, A_2 Bt_1, Pr, and R loci. Individual homozygous dominant plants were irradiated for various intervals and at various doses before meiosis and the resulting pollen used to pollinate appropriate recessive testers. It is a reasonable assumption that a cell in which pre-meiotic mutation occurred should by subsequent mitoses give rise to a sector of the tassel which would be heterozygous for the mutation. Thus, depending upon the size of the sector, a number of gametes carrying the mutation would be produced.

In a total of 61 plants tested in this manner two pre-meiotic mutations were found. One pre-meiotic mutation occurred at the A_1 locus and the other at the Bt_1 locus. The phenotype of the A_1 mutant is characterized by a mosaic

anthocyanin aleurone. Further tests indicate that this is a mutable in which Sh_2 mutates simultaneously with A_1. First tests indicate (not definitely established) that this is an autonomous type of mutable. Transmission tests indicate no sterility is involved, and no obserable chromosomal aberrations or pollen sterility have been detected. The phenotype of the Bt_2 mutant is characterized by complete mutation to bt_2. Tests of this mutant indicate no transmission sterility, pollen sterility or detectable chromosomal alteration.

In general, the data indicate that irradiation of pre-meiotic cells is an inefficient method for producing mutation. However, it seems a possibility that most mutations due to gross chromosomal alteration may be screened out by this method.

E. J. Dollinger

6. Treatment of corn with z.i.p. as a crow repellent.

In the spring of 1953 on the advice of Dr. D. F. Jones of the New Haven Exp. Station, we treated all our corn seed with z.i.p. as a crow repellent. This material provided a complete control of crows. In the 5 acres of treated corn planted less than 100 seeds were pulled. On corn not so treated 25% to 75% loss of stand was experienced. We observed no adverse effects to germination or plant vigor due to the use of z.i.p. even when corn was dusted with Arasan (DuPont) following the application of z.i.p.

The active material in z.i.p. is zinc dimethyl dithiocarbamate cyclohexylamine complex and polyethylene polysulfide. It is sold by the B. F. Goodrich Chemical Company, Cleveland, Ohio. The material was applied to the seed without dilution and no difficulty was experienced due to excess moisture. The concentrated z.i.p. dried on the seed very rapidly even when the seed was treated in 5 coin envelopes.

7. Seeding and plant type mutants produced in F_2 by chronic gamma radiation of maize pollen.

About 500 progenies of endosperm mutations produced in 1950 and 1951 were tested for seeding mutations in 1953. From these three viable mutants for plant type and two lethals were obtained.

The viables were one dwarf which closely resembles $dwarf_1$, a dwarf $2\frac{1}{2}$ feet tall which had a close phenotypic resemblance to normal corn having neither anther ear nor tillers, and a brevis type $3\frac{1}{2}$ to 4 feet tall with zig zag stalk. The brevis type and $dwarf_1$ type could be identified in the seedling stage. The seedings are much reduced in height, having a compact appearance with very broad leaves.

The lethals obtained were a white seedling and a glossy type in which the plumule and leaves were tightly rolled. These were unrolled and appeared to be normal. The new growth was also tightly rolled. It was noted that this seedling had an extremely large primary root system.

8. Ratio of + to mutant seedling types in F_2 of endosperm mutations produced by radiation of maize pollen.

In 1952 a large number of maize endosperm mutations were produced at Brookhaven National Laboratory. The mutagenic agents were chronic gamma radiation of corn tassels, and radiation of mature pollen with thermal neutrons and ultraviolet.

The endosperm mutants were grown in 1953 and selfed. The F_2 were grown this winter in the greenhouse and observed for seeding mutation. The ratio of + to mutant for the three mutagenic agents were as follows:

Mutagen	Progenies	Number of Mutants	3:1	Deficiency of Mutant	Excess of Mutant
Chronic gamma	496	45	38%	58%	4%
Thermal neutrons	136	14	36%	64%	
Ultraviolet	196	20	60%	40%	

Alan Caspar

CALIFORNIA INSTITUTE OF TECHNOLOGY
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1. Patterns of recombination suppression in heterozygous translocations involving chromosomes 4, 6, and 10.

A list of pre-Bikini and Eniwetok translocations with their cytological positions was given in the 1952 newsletter. Summaries of linkage studies have recently been completed on those involving chromosomes 4, 6, and 10. Table 1 presents the summary for chromosome 4 with the translocations listed in approximate order of their position from left to right. Recombinations in adjacent regions are included to indicate the pattern of suppression due to the translocation. The number on which each recombination value is based is in parentheses.

The centromere on chromosome 4 is between su and Tu. Translocations in the short arm, proximal to su apparently do not reduce either Ts5-su or su-Tu recombinations but those in the long arm proximal to Tu reduce the su-Tu values. There must be an appreciable region to the left of the centromere in which little crossing-over normally occurs and interchanges in this region appear to have little effect on the normal values.

Table 2 presents similar data for chromosome 6. In this chromosome, although the map distance is 31 units between Y and Pl, any translocation occurring in an area extending from the centromere region to the Pl locus greatly reduces the Y-Pl recombination.

In chromosome 10, (table 3), T-g and T-R recombinations exhibit an approximately linear relationship with the cytological position in the long arm ($r = -.85$, 11 DF, for T-R). In addition, g-R recombinations are homogeneous ($.3 < P < .5$) for all translocations in the long arm to the left of g which show more than 2% recombination with g.

E. G. Anderson, H. H. Kramer
and A. E. Longley

Table 1. Translocations involving chromosome 4.

Trans-location	Linkage relationships									Position
T4-6b	Ts_5	1.6(320)	T	8.6(580)	su	29.6(260)	Tu			4S.71
T1-4a	Ts_5	0.0(424)	T	3.5(832)	su	32.4(265)	Tu	1.5(67)	gl_3	4S.66
T2-4i	Ts_5		T	4.4(294)	su	33.5(182)	Tu			4S.37
T4-8a	Ts_5	4.0(630)	T	1.6(1770)	su	22.6(190)	Tu			4S.54
T2-4g	Ts_5	7.1(255)	T	2.7(997)	su	28.3(99)	Tu			4S.26
T4-7a	Ts_5	10.6(255)	T	0.6(519)	su	33.3(42)	Tu			4S.27
T4-10c	Ts_5	13.1(175)	su	1.1(3420)	T	24.8(951)	Tu			4S.70
T4-5c	Ts_5	10.3(642)	su	1.1(1667)	T	26.4(413)	Tu			4S.45
T4-9g	Ts_5	11.6(103)	su	3.3(1348)	T	22.1(516)	Tu			4S.35
T4-5d	Ts_5	13.9(208)	su	3.4(385)	T	21.5(177)	Tu	17.5(103)	gl_3	4S.21
T4-8b	Ts5	18.0(679)	su	5.7(859)	T					4S.54
T4-6c			su	8.6(839)	T	31.2(455)	Tu			4S.13
T2-4c	Ts_5	19.3(710)	su	9.2(1561)	T	30.8(130)	Tu	8.5(130)	gl_3	4S.09
T2-4a			su	3.3(361)	T	14.0(361)	Tu	16.0(187)	gl_3	4L.16
T4-9d	Ts_5	22.6(1043)	su	3.8(1326)	T	21.2(283)	Tu			4L.14
T4-10b	Ts_5	15.0(361)	su	4.0(500)	T					4L.18
T2-4f			su	6.1(900)	T	19.3(378)	Tu			4L.13
T4-6a	Ts_5	14.9(429)	su	4.9(1390)	T	14.6(219)	Tu			4L.33
T4-9a	Ts_5	13.6(516)	su	9.8(1615)	T	14.1(468)	Tu	28.3(99)	gl_3	4L.18
T2-4d			su	28.4(496)	Tu	0.2(496)	T	5.4(496)	gl_3	4L.25
T4-5b			su	42.4(165)	Tu	3.6(165)	gl_3	3.0(165)	T	4L.66
T2-4b			su	40.5(215)	Tu	5.0(99)	gl_3	15.2(99)	T	4L.54
T4-9b	Ts_5	10.0(170)	su	34.2(556)	Tu	8.8(556)	gl_3	21.9(556)	T	4L.84

Table 2. Translocations involving chromosome 6.

Trans - location	Linkage relationships							Position
T3-6b	T	15.6(231)	Y					6S.75
T4-6c	T	8.4(479)	Y	23.0(152)	Pl	6.9(390)	sm	6S.86
T5-6c	T			9.7(207)	Pl			6S.11
T2-6a	T			9.6(188)	Pl			6S.09
T4-6b	T	5.6(1098)	Y	9.3(290)	Pl	10.3(290)	sm	6L.25
T1-6h	T	3.5(258)	Y					6L.15
T6-10b	T			8.2(417)	Pl	3.6(138)	sm	6L.17
T2-6e	T	4.7(170)	Y	5.2(345)	Pl	4.2(189)	sm	6L.22
T6-9e	Y	0.0(269)	T					6L.17
T6-9b	Y	1.4(515)	T	5.5(2218)	Pl	4.3(507)	sm	6L.13
T2-6c			T	5.0(281)	Pl	6.0(281)	sm	6L.20
T6-9c	Y	0.4(542)	T	4.5(286)	Pl	4.2(189)	sm	6L.22
T1-6c	Y	1.0(605)	T	5.7(1043)	Pl	1.8(439)	sm	6L.39
T4-6a	Y	1.3(389)	T	5.3(1025)	Pl	5.5(325)	sm	6L.44
T3-6a	Y	6.7(345)	T	3.1(1007)	Pl	5.5(219)	sm	6L.19
T6-8a	Y	11.3(789)	T	4.9(427)	Pl	2.6(189)	sm	6L.50
T2-6d			T	5.2(309)	Pl	6.9(101)	sm	6L.57
T5-6a			Pl	0.0(113)	T			6L.45
T1-6a	Y	39.8(98)	Pl	8.2(98)			T	6L.57
T2-6b			Pl	7.7(753)	sm	3.7(753)	T	6L.49
T1-6g			Pl	23.4(154)			T	6L.88
T6-10a	Pl	9.5(493)	sm	17.0(100)	py	3.0(134)	T	6L.68

Table 3. Translocations involving chromosome 10.

Trans-location	Results of 3-point tests T-g	T-R	g-R	No.	Position
T5-10b	27.4	35.3*	17.7	186	10S.24
T8-10c	22.8	33.1	14.4	535	10S.51
T9-10b	16.3	23.7	8.9	135	10S.28
T3-10b	18.9	22.1*	12.2	196	10S.25
T1-10a	15.3	34.3	20.4	137	10L.21
T3-10a	15.7*	27.7	12.6	372	10L.12
T6-10a	9.6*	23.7	14.2	274	10L.19
T8-10b	9.5	23.2	14.5	461	10L.14
T4-10e	-	22.8*	-	386*	10L.01
T4-10c	8.3	19.8*	13.5	828	10L.11
T3-10c	6.5*	22.8	15.9	346	10L.31
T6-10b	2.5*	18.6	15.8	291	10L.14
T1-10e	2.9	17.3	14.4	139	10L.30
T2-10a	1.8	9.6	8.1	542	10L.53
T4-10b	1.6*	8.6	8.3	324	10L.57
T1-10f	0.0	4.4	4.4	113	10L.65
T1-10c	-	0.0*	-	65*	10L.67

*Includes additional two point data.

2. Chromosomal placement of new genes.

Utilizing chiefly the endosperm marked translocation technique, the chromosome placement of new genes is being continued, with about the efficiency predicted. But this year the seedling tests have been delayed so that only one-third of the 1953 season's tests have been completed. Since the 1953 newsletter, the following placements have been made.

gene	source	chromosome
zebra	4301	5
white	5183	9
w (albino)	6474	1
dwarf	x-ray	9
twisted	8631	10
twisted	8637	1
white	8896	6
w (albino)	7752	5
zebra	5183	10
zebra	4485	1
opaque-1		4
white	7366	2
orobanche-3		1
blue fluorescent-1		9L

E. G. Anderson
E. E. Dale

3. Translocation B-9a

This B-type translocation, isolated by Dr. H. L. Roman, has been little studied because of the lack of a good marker gene in the long arm of chromosome 9. In the course of building an adapted stock of TB-9a, sporocyte material was collected from which the cytological position of the chromosome breaks could be determined. The break in chromosome 9 is very near the middle of the long arm (L. 47). In the B chromosome the break is near a constriction frequently observed in the long heterochromatic region (measured position L. 69). Thus a large part of the heterochromatic material remains with the B^9 chromosome and only a smaller distal part is transferred to the 9^B chromosome.

The gene for blue fluorescent-1 had shown linkage with translocation $5\text{-}9_{x\text{-}14\text{-}111}$ which has the break in chromosome 9 far out on the long arm (L .72).

Pollination of homozygous fluorescent plants with hyperploid TB9a ($99^B9^B9^9$) gave fluorescent seedlings as well as normals. This hemizygous test places the gene for blue fluorescent-1 in the long arm of chromosome 9 distal to the break in TB-9a. As this is an excellent marker gene it will make possible an efficient study of the genetic behavior of TB-9a.

Czeslawa Prywer (Escuela National de Agricultura, Chapingo, Mex. Mexico)
A. E. Longley
E. G. Anderson

4. Preferential Segregation Due to a Paracentric Inversion

A paracentric inversion, when paired with its normal homologue, will have cross-overs in the inversion region. These cross-overs give a bridge and an acentric fragment at 1st anaphase. The bridge retards the movement of the depleted chromatids and allows the chromatids without cross-overs to reach the poles of the spindle first. If the deleted chromatids retain their proximal position during the interphase, the 2nd meiotic division of the megaspore will exclude deleted chromatids from the basal cell of the tetrad. All eggs develop from these cells and each will have a normal chromosome complement except these cases in which there has been a four strand double cross-over in the inversion region. Thus a paracentric inversion causes a preferential segregation at megasporogenesis.

In 1952 a progeny, homozygous for recessive r, for an inversion in the long arm of chromosome 7 and for knobs on the inverted piece was crossed to a progeny without this inversion but homozygous for ab. 10 and the closely linked dominant R.

All F_1 seeds of the above cross were colored and a progeny from these seeds was grown this season and crossed reciprocally with a normal R-tester stock. The 26 ears on the F_1 plants showed a slight indication of sterile eggs due, unquestionably, to the small amount of four strand double cross-overs in the inversion region. The 4954 seeds were classified and gave 71.9% colored seeds, that is approximately 71.9% of the eggs received the ab. 10. This percent is very close to that of previous tests on the preferential segregation of ab. 10, and there is no suggestion that the presence of the inverted chromosome has affected the transmission of ab. 10.

The 28 ears from the R-tester progeny were well filled, indicating that all eggs were viable. These ears gave 6542 seeds, 42.1% of which were colored. This departure from the expected 50% suggests that the sterility caused by the presence of a deleted chromatid is approximately 20% and is linked or associated with the dominant R. If the deleted chromatid went with the normal form of chromosome 10 during microsporogenesis, as it presumably does during megasporogenesis, there should have been an excess of colored seeds. The most obvious explanation of the excess of white seeds in these 28 ears is to assume that the 1st meiotic division was similar to the 1st megaspore division and that between the 1st and 2nd divisions the paired chromatids were re-oriented so that the faster-moving chromatids, e.g. the ab. 10 with its secondary centromere and the deleted 7, were in a position to move to the same pole.

The foregoing preliminary test will be extended the coming season. Colored seeds from the above cross will provide material heterozygous for the inversion and for ab. 10, and material heterozygous for ab. 10, but normal for chromosome 7. The former group will duplicate this season's test while the latter will provide the essential control test.

A. E. Longley

COLLEGE OF AGRICULTURE
Potchefstroom, Union of South Africa

1. Male fertile 33-16 inbred.

It was shown by Josephson and Jenkins (Jour. Agron. 40:267-274, 1948) that poor seed set in certain white hybrids was due to a cytoplasmic contribution for sterility in 33-16, an old inbred line developed in Indiana and still in extensive use. At that time it was suggested that it should be possible, through backcrossing, to develop a strain of 33-16 that does not carry the cytoplasmic contribution to male sterility.

Eight backcrosses have now been made following the initial crosses to K64 and CI. 43 as female parents. The recoveries are identical in all respects to original 33-16, except that the line recovered through CI. 43 is slightly later in flowering in certain crosses. Test crosses have shown that the male sterile cytoplasm has been completely eliminated and that the combining ability of the recovered lines is identical with that of original 33-16. The recoveries, however, do not possess the restoring factor(s) when crossed with TX 61M ms or 33-16. KY27 ms.

Seed of recovered fertile 33-16 can be obtained from the Kentucky Agricultural Experiment Station or the College of Agriculture, Potchefstroom, Union of South Africa.

2. Fertility restoring inbreds.

Amongst the numerous inbreds tested in crosses with Tx61M ms and 33-16 .KY27 ms the following have been found to restore fertility: K55, KY122, KY21, R6, R7 and K6 and four South African inbreds A14, E184, A447 and C474 while K64 and A415 partially restore fertility. Insofar as tests have been conducted the inbreds K55, KY21, KY122 and R6 in combination as male parents restore fertility completely in double crosses.

L. M. Josephson

THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION
New Haven 4, Connecticut

1. Mutations in the expression of cytoplasmic pollen sterility.

Pollen producing plants occur rarely in sterile inbreds that are unaltered in type in other characters and are not outcrosses. Such plants have been crossed on other sterile lines of the same inbred. All of these crosses in replicated tests have remained completely pollen sterile. The change to partially fertile plants is therefore not a mutation to a dominant pollen restoring gene. It could be due to a mutation to a recessive gene or to a change in the cytoplasm. Evidence for these possibilities is being sought.

2. Relation of gene and cytoplasm to pollen sterility.

When genically controlled pollen abortion, due to a homozygous recessive gene ms_1 linked with y endosperm color, is incorporated in the same plant with cytoplasmically controlled abortion, as previously reported, the two conditions are independent of each other in transmission and have no effect upon each other in expression. Further evidence for this independence in transmission has been obtained by crossing gene sterile ms_1 ms_1 plants by normal plants with cytoplasmic pollen restorer genes combined with cytoplasmic pollen abortion. In all crosses of this type the cytoplasmic condition is never transmitted through the pollen, but the pollen restoring gene is transmitted. In F_2 selfed progenies and in backcrosses on to homozygous recessive gene steriles, segregation for gene controlled pollen abortion is clear-cut and uninfluenced by any cytoplasmic condition or the dominant restorer gene. In two lots of backcrossed plants, one grown in the greenhouse, the other in the field, 98 fertile and 99 sterile plants were observed. In several F_2 progenies grown in the greenhouse and in the field there were 196 fertile and 62 steriles where 194 and 64 were expected. Thus the restorer for cytoplasmic abortion has no effect whatever on the gene controlled condition. The reciprocal cross of normal fertile, having the cytoplasmic sterile condition restored by a dominant gene, crossed by normal plants, without the restorer but with homozygous Ms Ms, gave all fertile plants in F_1 and clear segregation in backcrosses of F_1 by normal fertile and F_1 selfed progenies. Three progenies of each have been grown with the following results: F_2 selfed--106 fertile : 23 sterile (96 and 32 expected), backcross-69 fertile : 49 sterile (59 of each expected). While both ratios deviate significantly from a single factor expectancy clear-cut genic segregation is shown. The dominant gene Ms present in all normal plants has no effect whatever on the expression of cytoplasmic pollen abortion. In this case the pollen sterile plants remain sterile as long as they are pollinated by Ms plants without cytoplasmic gene restorers, and thus differ widely in behavior from the gene sterile plants.

In this way cytoplasmic sterility can simulate genic sterility and has undoubtedly gone undiscovered in many experiments with maize and other plants.

D. F. Jones

CORNELL UNIVERSITY
Ithaca, New York

1. Cytoplasmic pollen sterility studies.

A. Studies on the cytoplasmic pollen sterility phenomenon are being continued. A cytological study of the meiotic behavior of the male-sterile lines confirms Rhoades' previous finding (1931, 1933) that the meiotic process is normal. Ten bivalents are formed at metaphase of division one and the following disjunction appears normal. Quartets are formed at the end of division two. The process following quartet formation is apparently one of starvation. The contents of the newly formed microspores diminish gradually until the spores are devoid of inclusion material except for the two nuclei that stain with carmine. An examination of the pollen sacs reveals the interesting fact that the tapetal layers of the male-sterile lines appear to have grown out of proportion. Moreover, the out-sized tapetum persists longer than usual. This phenomenon seems to be associated with endomitotic divisions of the tapetal cells. A more detailed cytological examination of the tapetum development is underway.

Gabelman (1949) has postulated that the presence of one or more particulate units in the microspore results in sterility. Rhodes (1933, 1950) suggested that differences in cytoplasmic inclusions might be responsible for the sterility. Staining tests to compare the mitochondriome of the sporocytes of fertile and sterile lines were made. No obvious differences in mitochondria are observed. The sporocytes were treated via the Feulgen reaction to determine the possible presence of particulate bodies in the cytoplasm. No Feulgen-positive bodies are found. Staining with the Giemsa stain is being attempted.

The possibility that pollen sterility is a result of virus infection has not been fully explored. Attempts have been made to transmit sterility from sterile plants to fertile ones by inoculating normal seedlings with expressed juice of the sterile tassel. Later pollen counts will be made on these inoculated plants. Meanwhile, the expressed juice was mechanically inoculated into series of local-lesion test plants, none of which produced any local lesion. Transmission by means of dodder was also tried, but the parasite fails to establish on corn due chiefly to the rapid enlargement of the culm which ruptures the dodder strands wound around the stem. Heat treatment to inactivate the causal agent on the assumption of it being a virus has been undertaken. Leaves and rachis of sterile plants were examined in comparison with those of normals for vascular disorders and cellular inclusion bodies which are often associated with virus infection. The evidence obtained to date all point in the negative direction.

A study of the cytoplasmic pollen-sterile lines in comparison with genic pollen-sterile lines appears promising. Hence, parallel crossing of the two groups of sterile lines to common inbreds has been initiated to produce lines of isogenic germplasm.

T. T. Chang

B. Preliminary studies have been made at Cornell involving comparisons of fertile and sterile plants of an inbred line (Oh 26), a single cross hybrid (Oh 26 x NY 16), and a hybrid double cross (Conn. 554), in which three Latin square designs were employed, respectively. Measurements of more than 500 plants per entry during several stages of development showed no significant difference in plant or ear height between comparable fertile and sterile plants. Likewise, cytoplasmic male-sterile plants did not differ significantly from fertile plants in their yielding ability. In only one instance, that of a very preliminary determination of disease reaction to Ustilago zea and Giberella zea was there any statistically significant difference between fertile and sterile plants, increased susceptibility being associated with the sterile condition.

H. L. Everett and P. Loesch

2. Monoploids in maize.

The use of a delayed pollination technique has been found to increase the frequency of monoploid plants occurring in the single cross B8 x Oh51A. The relative ages of silks at the time of pollination were designated as the number of days after glassine bags were placed on the ear shoots of the seed parent.

As shown in the following table, the greatest frequencies of monoploids occurred when ear shoots were held 18-20 days before pollination.

Age of Ear at Time of Pollination	Number Progeny Screened for Monoploids	Number of Monoploids	Frequency per 1,000
20 days	6,366	22	3.5
18 "	14,489	21	1.5
16 "	8,311	6	.72
8 "	29,764	11	.37
4 "	31,926	14	.44

Robert R. Seaney

FEDERAL EXPERIMENT STATION
Mayaguez, Puerto Rico

Synthesis of a red pigment in corn seedling breis

In the course of experiments with aqueous leaf extracts it was noted that breis prepared from homozygous blue fluorescent-1 seedlings formed a red pigment upon overnight incubation. (blue fluorescent-1, described by Teas and Anderson in 1951, is characterized by bright blue fluorescence of the seedling leaves when illuminated with 3650 A. ultraviolet light. Anthranilic acid was shown to be accumulated by the mutant.) Breis prepared from non-blue fluorescent seedlings (i.e. from various inbreds, albinos, and yellows) developed no color under the same conditions, but red pigment was

formed in all extracts if anthranilic acid was added. It was at first surmised that the production of pigment was due to an enzymatic conversion of anthranilic acid since boiling the breis for a short time destroyed their ability to produce the red pigment. However, the possibility of an enzymatic reaction was eliminated when it was found that the red color formed at a slow rate spontaneously when the ether extract of breis was allowed to stand with anthranilic acid. This colorless, thermolabile material from the breis showed a broad peak at R_f .6 to .8 on ascending paper chromatograms run in water-saturated butanol. The red color precursor in seedling leaf breis apparently is either not present or does not react in vivo, since bf-1 seedlings contain sufficient anthranilic acid to give a bright red color in vitro but appear green in ordinary light. Older corn seedlings as well as seed fail to give a color. Inasmuch as neither N-acetyl anthranilic acid nor methyl -anthranilate give the color, the reaction appears to require that the amino and carboxyl groups be free. Tests with over thirty other aromatic compounds revealed that the property of forming colored substances with leaf breis is not limited to anthranilic acid. In the case of p-aminobenzoic acid, the pigment which is formed is orange-red and can readily be separated from the red anthranilic acid pigment by paper chromatography. If treatment with acid is involved in the isolation of the red anthranilic acid pigment, the colored material obtained has different mobility on paper chromatograms from the original. It appears that one form in which the anthranilic acid pigment can be isolated contains a sugar, determined to be glucose by chromatography.

Howard J. Teas and
Hugh Forrest (Cal. Inst. of Technology)

HARVARD UNIVERSITY
Cambridge, Massachusetts

1. Primitive prehistoric maize.

From La Perra Cave in the state of Tamaulipas in Mexico, excavated by Dr. Richard MacNeish of the National Museum of Canada, we have found primitive cobs (dated by radiocarbon determinations of associated remains at circa 2500 B.C.) which represent a prototype of a race of maize, Nal-Tel, still grown by the Indians of Yucatan and Campeche. This prehistoric form of Nal-Tel is characterized by small eight-rowed ears with relatively long glumes and extremely hairy capules, all characteristics of modern Nal-Tel in somewhat accentuated form.

The husks of this maize are relatively long, several times as long as the cobs, and show little evidence of having been distended by the ears which they once contained. The shanks are quite slender and short indicating (according to Galinat's data on Argentine pop) that the ear was borne high on the stalk.

The Nal-Tell race of today is distinctive among Mexican races in its early maturity, short stalks, small number of leaves and small ears borne

relatively high upon the stalk. If we can assume that in ancient Nal-Tel these characteristics, like the characteristics of the cob, were accentuated, then we may conclude that this primitive maize was short in stature, early maturing and bore small ears enclosed in long husks immediately below the tassel.

The second expedition to Bat Cave in New Mexico, led by Mr. Herbert Dick, then of the Colorado State Museum, has turned up some maize cobs which are even more primitive than those described by Mangelsdorf and Smith (1949) from the first expedition.

These cobs are scarcely larger than a one-cent piece. Although dated at 5600-5900 years by radiocarbon determinations of associated charcoal, some of them are remarkably well preserved. These primitive cobs are characterized by very slender rachises, long soft glumes and lemmas and paleas, and very long rachillae. The ears bore about fifty kernels and the remains of two of these suggest that they were about the size of small kernels of Lady Finger pop. A well developed abscission layer at the point of attachment of the kernel to the rachilla suggests that in this early maize the ears were capable of shedding their kernels at maturity.

The cupules of the Bat Cave corn are almost completely glabrous and are quite different in size, shape and other characteristics from the La Perra corn. This suggests the possibility that the domestication of maize may have involved at least two different geographical races of wild maize, one in the highlands and another in the lowlands.

The husks of the early Bat Cave maize, like those of the La Perra maize, are much longer than the ears, and one specimen suggests that the husks flared open at maturity exposing the ears. Small sub-tassel ears of pod corn occurring in our experimental cultures have had this same characteristic.

Among the Bat Cave specimens is a fragment of the basal part of a tassel, bearing pistillate spikelets and indicating that at lease some of the maize was tassel-seeded.

All of these facts combine to suggest that the earliest maize was a form of pod corn, but perhaps not the extreme form represented by the Tu gene. As previously reported in the News Letter there are several alleles at the Tu locus.

There is no way of determining whether this maize was growing wild in New Mexico, but certainly in its characteristics it is not far removed from a grass capable of perpetuating itself in the wild.

On the basis of the characteristics so far studied in both the Bat Cave and LaPerra maize we have made a tentative reconstruction of the wild maize plant. The stalk was short and slender. The tassel was sometimes, if not always, unbranched and bore pistillate spikelets at the base. The ear, borne at the first node below the tassel, was no larger than an average-sized strawberry. At silking time the ear was completely enclosed in relatively long husks, but these flared open at maturity to expose it. The freely-tillering habit of some of the modern small-eared popcorn varieties

suggests that wild maize, like many other grasses, may have had the ability to produce tillers. But we suspect that in competition with other vegetation tiller production was a latent characteristic and that wild maize often produced only a single stalk.

It is almost certain that this reconstruction will be modified in some details as additional prehistoric material is studied. It merely illustrates our tentative conclusions based upon the evidence now available. We are, however, reasonably certain that the ancestor of maize was maize and that it was a form of maize not basically different except in size from modern cultivated maize.

Paul C. Mangelsdorf and
Walton C. Galinat

2. Archaeological evidence on the role of teosinte.

The characteristics of both the La Perra and Bat Cave maize seem to rule out any possibility that maize stemmed from teosinte or anything closely resembling it. Yet other prehistoric material shows clearly that teosinte (or Tripsacum) has played an important role in the later evolution of maize. Cobs from Cebollita Cave in New Mexico, excavated by Mr. Reynold Ruppe, show that the earliest maize was "pure" maize and the more recent material highly tripsacoid. The most tripsacoid prehistoric maize yet discovered has come to us from caves at Montezuma National Monument in Arizona, excavated by Mr. Lloyd Pierson. Only a small fraction of the several thousand cobs can be classified as "pure" maize.

Many of the specimens in both the Cebollita Cave and Montezuma Castle material are almost exact counterparts of segregates from maize-teosinte hybrids and can be matched detail for detail with these modern specimens. The resemblance includes among other characteristics the lignification of the tissues. This can be measured quantitatively in terms either of specific gravity or solubility in sulphuric acid. There is good reason to believe that one of teosinte's principal contributions to the evolution of modern maize has been to provide structural strength which has in turn permitted the development of large ears.

Paul C. Mangelsdorf and
Walton C. Galinat

3. Mutations induced by teosinte introgression.

A second contribution which teosinte introgression has made to the evolution of maize is to speed up the mutation rate. Some of these mutations are reported in the 1953 Maize News Letter. Additional mutations have been found during the past season. All of the mutations so far identified are deleterious but it seems probable that the same mechanism which is producing these (perhaps a bridge-breakage-fusion cycle) is producing minute duplications and other variations not easily detectable, which, under domestication, can serve as building blocks of evolution.

Paul C. Mangelsdorf

4. Argentine popcorn as a modern relic of prehistoric corn.

Argentine popcorn, one of the 10 "standard exotics" of Anderson and Brown (News Letter 25), has at least 4 characteristics which are typical of the oldest prehistoric corn known. These features are tiny ears, tiny kernels and sub-tassel ears with short shanks. The multi-eared condition and late maturity of this popcorn may be modern features developed during domestication in contrast to the majority of varieties in which increased productivity and its associated late maturity evolved along lines of increased ear size. Under favorable conditions the plants may develop as many as 12 tiny ears distributed at successive nodes along the culm. The shank of the uppermost ear may be extremely short and be borne at a node just below the tassel while the shank of the lowermost ear may be long and tiller-like and be borne close to the ground level. There is a progessive reduction in the length of these ear shanks borne at successive nodes above the crown in acropetal order along the culm as follows:

Length of Ear Shanks Borne at Successive Nodes in Acropetal Order Along Culm of Argentine Popcorn.

Node	Length (cm.)
1	13.4
2	10.4
3	9.7
4	7.8
5	5.2
6	4.8
7	4.5
8	3.9
9	3.7
10	3.0
11	1.9

Walton C. Galinat

5. The origin and possible evolution of sub-tassel ears in maize.

It has been suggested by Mangelsdorf (unpub.) that a sub-tassel ear, with its little parcel of grain, may have attracted man to domesticate an otherwise earless form of primitive wild maize. The discovery of a series of types ranging from a small adnate spathe subtending the lowermost tassel branch to a well developed leaf or pair of leaves subtending a small sub-tasel ear has increased the plausibility of this theory. This adnate or vestigial spathe with its axillary branch and their derivations were found in over 70 per cent of a population of 1000 tassels from North, Central and South America. The present variability in development of this sub-tassel ear or its rudiments might be attributed to its presence in only one or a few of several geographical races of wild maize. It may also have been variable in its expression in wild maize, perhaps dependent on growing conditions.

In many tassel specimens the auricles on either side of an otherwise adnate spathe may elongate to monstrous proportions. The spathe may become acentric in regard to the branch with the result that a part of the spathe becomes highly developed to one side and reduced on the other side. Various configurations of twisting may distort the spathe, rachis, and peduncle as the branch tends to become opposite rather than adjacent to its associated spathe. A pair of leaves may develop at this node although distortion may cause them to appear as being separated by a short and twisted internode. In extreme cases of spathe development, a single spikelet or tassel branch as a whole may be modified to form a small shank terminated by a small ear. The morphological change from either a spikelet or tassel branch to a many ranked ear involves a change from bilateral to radial symmetry. Such a transformation is common in maize. Depauperate ears frequently exhibit reductions from a radial to a bilateral condition. One might expect that if there were a reduction during evolution of a leaf terminal to the culm, then there might also be a corresponding reduction of its axillary ear to a bilateral tassel branch.

Walton C. Galinat

JOHN INNES HORTICULTURAL INSTITUTION
Hertford, England

Our inbreeding programme has narrowed down to 6 inbred lines, originating from different sources. These are adaptable to our local growing conditions in England. I have now combined these reciprocally as F_1 single-crosses which will be tested here in 1954. These hybrids are the first to be raised from sweet corn inbreds that have been selected for growing in England.

The soil block experiments have been analysed. It is clear that they are the solution to frit fly attacks and poor germination from early sowings in this country.

Gordon Haskell

MISION BIOLOGICA DE GALICIA
Pontevedra, Spain

Blanco and Oliveira reported (Genetica Iberica; Vol. II, 15-28) the CHAIN CROSSING SYSTEM as a method to utilize, continually, hybrid vigor. They reported that n-way crosses, ((((A . B) x C) x D) x E) x F, are equal or superior to the single crosses of the two last lines: E x F.

In 1953, eleven 4-way crosses, ((A . B) x C) x D, and fourteen single crosses, (all possible combinations between the inbreds of the 4-way crosses), were tested together in one randomized block trial.

Using the equation ((A . B) x C) x D = 1/2 (C x D) + 1/4 (B x D) + + 1/4 (A x D), and assigning to it the yields of the single crosses, the theoretical yields of the 4-way crosses were calculated. Theoretical and real yields of the 4-way crosses manifested a correlation coefficient = 0.9988; $P < 0.01$.

Significant differences of the trial = 861 Kgs./Ha., $P < 0.05$
1,143 " ./ " $P < 0.01$
Extreme yields 11,192 Kgs./Ha. and 7,413 Kgs./Ha.

José L. Blanco, &
Mariano Blanco

THE PENNSYLVANIA STATE UNIVERSITY
State College, Pennsylvania

Department of Botany

1. Male sterility from Vestigial glume plants and its restoration.

A case of cytoplasmic male sterility, previously known but apparently not reported, was uncovered in certain Vestigial glume lines of Coop origin. In attempting to transfer Vg into sweet corn, numerous crosses and backcrosses to open pollinated varieties, inbred lines, and hybrids have been made. Both Vg and normal progeny from these crosses maintained a high degree of sterility. A few anthers were extruded in some plants but no viable pollen was detected.

A check of the Coop records disclosed no note of this sterility in Vg stocks from their accession from Sprague's material in 1937 until the present observations were made in 1949. However, Dr. R. A. Emerson's records reveal that he had noted this sterility to be associated with certain Vg lines used in his chromosome 1 linkage studies as early as 1944.

Seed of this sterile type was sent last year to Dr. D. F. Jones who kindly furnished the following information. "R. R. St. John from the DeKalb Seed Company and G. H. Sprague at Iowa also obtained sterile plants from this source and these seem to be of the cytoplasmic type. Sprague's material was crossed with Iojap which Rhoades has found to be connected with the induction of cytoplasmic sterility. -----Unfortunately, St. John did not write up his results before his death."

In contrast to the constancy of this sterility in crosses to normal sweet corn, Vestigial x Tunicate hybrids showed pollen fertility in all segregation classes -- Vg, Tu, VgTu, and normals. Restoration appears to be complete, and from advanced generation and backcross populations there is evidence that it is under the control of a single dominant gene. This pollen restoration by Tunicate lines is partially responsible for the previously reported recovery of glumeless lines which shed pollen well (News Letter, 1952, p. 36). It may be of additional interest that Mr. Robert Snyder (see

below) obtained restoration of the above sterility type with certai. marker lines.

J. E. Wright

2. Inheritance of target spot.

In 1951, an F_2 population grown for class aleurone color studies segregated for plants with peculiar lesions and subsequent necrosis of the leaves. These lesions begin as tiny dots and enlarge into large concentric spots an inch or more in diameter with alternately light and dark rings within. Coalescence of these spots leads to necrosis of the leaves which may become so severe on the bottom leaves that they die. This character is expressed when the corn is about two months old and continues to maturity. It is so similar to the description of "target spot" diseases of other plant species that it was tentatively given that name. Isolations were made from the lesions to determine if some micro-organism were responsible. An Alternaria species was repeatedly isolated but it lacked pathogenicity on unrelated corn. The reason for this became apparent when it was shown that susceptibility is heritable.

In 1952 The Plant Disease Reporter contained two articles describing the occurrence of a corn disease which closely fits the above description. McKeen (April 15, 1952) described its occurrence on a Guatemalan strain grown in Ontario, while Semeniuk and Vestal (May 15, 1952) found it on a Congo corn grown in Iowa. In both instances the disease killed the plants before maturity; in our cultures this is not the case and there is little obvious reduction in vigor.

Reciprocal crosses were made between the original target spot plants and a limited number of marker strains. All F_1 populations in 1952 were normal, while plants from selfed seed all showed target spots. Large F_2 and backcross populations were grown in 1953. Segregation was typical of that expected on a monohybrid basis except that in most cultures there was a deficiency of target spot plants which could be ascribed to lack of infection. Translocations 1-9a and 2-9a had been included as markers. Results in the accompanying table indicate that the recessive gene for susceptibility to target spot (ta) is located on chromosome 9.

Crosses	Testcross progeny			
x + ta	S.S. +	S.S. ta	+ +	+ ta
$\frac{\text{T 1-9a}}{+} \times \frac{+}{\text{ta}}$	218	72	154	159
$\frac{\text{T 2-9a}}{+} \times \frac{+}{\text{ta}}$	37	1	38	13

J. E. Wright and
Dean Foley

3. Crazy Top of Corn

Following a heavy rain May 25-26 a portion of the corn disease nursery was submerged for several hours. At tasselling time Crazy Top symptoms were apparent in cultures throughout the flooded area and close counts were made. At the end of the season the following tabulation summarized the occurrence of the outbreak.

Table 1. The distribution of Crazy Top corn plants among open pollinated varieties, single crosses, dwarf lines and selfed cultures of maize at State College, Pa., 1953.

	Crosses with									
	Mo 940*	Tr*	38-11*	Hy*	L317*	Other	Open pollinated	Dwarf lines	Selfs	Total
No. rows	6	15	35	45	46	47	111	28	97	430
Rows with Crazy Top	2	2	1	16	8	4	21	5	4	63
% rows Crazy Top	33.3	13.3	2.8	35.5	17.3	8.5	18.9	17.1	4.1	14.6
No. Crazy Top Plants	3	2	1	32	14	4	23	6	11	97

* recovered lines of corn belt origin

Crazy Top of corn is thought to be caused by Sclerospora macrospora, an obligate parasite. Because the organism cannot be cultured, the evidence so far remains circumstantial. It seems highly unlikely that swimming or floating spores in a pond of approximately one acre in area should become associated exclusively with certain randomly planted cultures, unless those particular cultures were exclusively susceptible. It is therefore suggested that susceptibility to this disease has a heritable basis.

4. Blight Resistant Synthetics of Field Corn

For the 1953 season, S_1, S_2 and S_3 cultures of maize resistant to Helminthosporium turcicum and H. maydis were divided on the bases of maturity into early, intermediate and late lots. Fifty-seed samples of each culture were mixed for isolation block planting. The late lot was grown in isolation by Dave Matthews, Eastern States Farmers' Exchange, at Feeding Hills, Massachusetts. The early and intermediate lots were grown side by side in an isolation block at State College, Pennsylvania.

From each open-pollinated lot two samples were taken: (a) 100 ft. of row and (b) selection among the better plants for root, stalk and ear characters. Small amounts of seed are available to interested workers. It is planned to carry the early and intermediate lots through a second open pollinated generation and to distribute the synthetics through the Foundation Seed Stocks Program.

C. C. Wernham

Department of Horticulture

5. Notes on the Inheritance of Restoration of Pollen Production in Cytoplasmic Male Sterile Lines of Corn

In the Fall of 1952 a project dealing with the inheritance of restoration of pollen production in cytoplasmic male sterile lines was initiated. Linkage tester lines were obtained from the Maize Genetics Coop. The Texas type sterile lines were used in all field corn crosses and were obtained from Dr. D. F. Jones and Dr. O. H. Pearson. This is a brief report of the findings made to date.

It has been known from the breeding work of others that linkage tester lines currently available will restore pollen production to cytoplasmic male sterile lines with much greater frequency than will normal inbreds. In the present study, four out of ten linkage testers restored viable, mature pollen to cytoplasmic male sterile lines. The sources of these lines, along with the chromosomes they mark and the segregation for fertility in the F_1 progenies of sterile x tester, are given in the following table.

Sterile x Linkage Testers	Chromosome Marked	No. Plants Segregating			Possible Genotypes of Linkage Testers
		Fertile	Sterile	Semi-Sterile	
C106^{T6} x Coop 51-80	1	86	29	0	$S_1s_1S_2s_2$
x Coop 50-88	1	0	80	0	$s_1s_1s_2s_2$
x Coop 50-32	1	30	0	0	$S_1S_1S_2S_2$, $S_1S_1s_2s_2$ or $s_1s_1S_2S_2$
x Coop 50-105	2	0	30	0	$s_1s_1s_2s_2$
x Coop 49-26					
Selection 1	3	126	0	0	$S_1S_1S_2S_2$, $S_1S_1s_2s_2$ or $s_1s_1S_2S_2$
Selection 2	3	23	18	0	$s_1s_1S_2s_2$ or $S_1s_1s_2s_2$
Selection 3	3	0	30	0	$s_1s_1s_2s_2$
x Coop 51-17	4	0	2	0	$s_1s_1s_2s_2$
x Coop 49-37					
Selection 1	5	0	240	0	$s_1s_1s_2s_2$
Selection 2	5	0	47	14	$s_1s_1s_2s_2$?
x Coop 51-36					
Selection 1	6	0	90	0	$s_1s_1s_2s_2$
Selection 2	6	9	9	0	$s_1s_1S_2s_2$ or $S_1s_1s_2s_2$
x Coop 47-52	7	0	130	2	$s_1s_1s_2s_2$?
x Coop 51-10	Multiple Tester	0	30	0	$s_1s_1s_2s_2$

An explanation for the observed segregations could be that duplicate genes are controlling the inheritance of pollen production in these particular crosses. With this assumption, the possible genotypes of the linkage testers are presented in the last column of the table.

The ultimate goal of this study is to assign pollen restoration genes to specific linkage groups.

Robert L. Snyder

PIONEER HI-BRED CORN COMPANY
Johnston, Iowa

Department of Plant Breeding

1. Pollen volume - style length relationship.

Cursory examination during the past several years of a number of morphologically extreme types of maize has suggested a possible relationship between size of pollen grain and style (silk) length. Mangelsdorf (News Letter, 1953) has also found that in Mexican maize, pollen size tends to be positively correlated with ear length. During the summer of 1951 two short silk varieties, Ladyfinger Pop corn and Zapalote chico of Mexico and two long silk varieties, Parkers Flint and J.H.L.E. (corn belt dent) were grown for purposes of studying this relationship. All measurements were made on fresh material at the time tassels were fully shedding and when silks had attained their maximum lengths. Pollen diameters, measured in arbitrary units with an eyepiece micrometer, were converted to volumes. Silks from the basal one inch of the ear only were measured. The summarized data are as follows:

Varieties:	Z. chico	Ladyfinger	Parkers F.	J.H.L.E.
Pollen Vol. (means)	953.11	1180.08	1285.48	1296.82
Silk length (means)	16.6 cm	15.7 cm	31.3 cm	34.3 cm

It is apparent that for these four varieties, those with long silks tend to have pollen grains of greater volume than do the short silk varieties. The fact that plants of Zapalote chico are considerably larger than either Ladyfinger or Parkers Flint suggests further that pollen size is not merely an expression of overall size differences in these varieties.

2. Random inbreeding in open pollinated corn belt maize.

For purposes of comparing the effects of selection upon the range of variation in corn belt inbreds, a series of inbred lines have been developed without selection other than that imposed by nature. These have undergone five generations of selfing from open pollinated material and are more or less equally distributed among four varieties, namely, Midland, Reids, Krug, and Lancaster. The total number of lines emerging from the project is approximately 1600. Each of these lines has been scored for approximately twenty morphological characteristics and although the morphological analyses are still incomplete it is apparent that for certain plant and ear characteristics some of the random inbreds are outside the range of variation of selected inbreds of the corn belt. In 1953 each of the random inbreds were grown out

in ear to row progenies where they were observed by corn breeders and classified as to desirability for breeding purposes, a type of selection essentially like that practiced by most corn breeders during the process of inbred development. It is interesting to note that approximately 90% of the total number of lines available failed to pass this observational screening and had they been a part of a regular breeding program would have been discarded prior to top crossing. In a regular breeding program the number of lines eliminated by visual selection would probably be somewhat more than 90% since the selection would continue over a period of years as opposed to a single year in the case of this material. Nevertheless, so far as I am aware, these figures are the only ones available on the percentage of lines one might expect to survive the usual process of visual selection. Of the 90% of these lines which failed to survive visual selection, 73.8% were discarded because of susceptibility to root and stalk lodging, susceptibility to disease, and barrenness, all of which are factors of major practical importance. The remaining 26.2% however, were eliminated largely because they did not fit the corn breeders mental picture of what a corn plant should look like.

A number of these random inbreds will be used in experiments in heterosis for which, it is felt, they may provide more critical material than the usual selected lines.

William L. Brown

3. Cytoplasmic male sterility: Influence of environment on degree of sterility.

The fact that environment may affect the degree of pollen sterility in cytoplasmic male sterile maize has been noted by several workers (Josephson and Jenkins, 1948; Rhoades, 1931; Rogers, 1952; and Stringfield, 1953). In all of these cases, however, only one source of sterility has been observed at a time in the various environments, and in most of the cases the effect was not reproduced.

In the course of a routine survey of sterilizability of various inbred lines when crossed on A (USDA) and T (Texas) cytoplasmic male sterile inbreds, a pronounced and regular variation in sterility has been reproduced in two successive years by growing the material in three widely different locations. In any one complete season, the same single crosses (about 30 in 1951-2, and 50 in 1952-3) were grown (1) near Homestead, Florida, in the wintertime; (2) in a greenhouse at Des Moines, Iowa, in the wintertime; and (3) in the field at Johnston, Iowa (near Des Moines in the summertime.

It was found that: (1) Certain crosses were entirely fertile and others were entirely sterile no matter where they were grown. (2) Crosses falling in the intermediate group (partially sterile) were most strikingly affected by changes in the environment. (3) Partial steriles in T cytoplasm shed: (a) the greatest amount of fertile pollen when grown in the greenhouse, (b) the least when grown out-of-doors at Johnston, and (c) slightly more pollen (but much less than in the greenhouse) when grown in Florida in the winter time. (4) Partial steriles in S cytoplasm shed the greatest amount of fertile pollen when grown in Florida in the wintertime and shed little, if any, more pollen in the greenhouse than when grown out-of-doors at Johnston. (5) When partial steriles grown in any one location were ranked (by cross)

in order of increasing fertility, roughly the same ranking (on a different level of pollen fertility) could be made when these crosses were grown in either of the other two locations.

The conditions in the three locations which were responsible for differences in pollen fertility are not known. However, several possible causes may be ruled out. For example: (1) Day length would appear to have little effect on T Steriles, since Florida (10-12 hrs.) and Johnston (13-15 hrs.) gave nearly the same effect. (2) Light intensity would not seem to have a marked effect on S steriles, since greenhouse (weak light) and Johnston (summer sun) gave about the same results.

In a second experiment, several partially sterile crosses, both S and T, were grown in two fields near Johnston, located about a mile apart. One field was highly fertile, and well watered; the other field was sandy, low in nitrogen and potassium and the corn ran low on water and nitrogen before tasseling. Both fields tasseled at about the same date.

Both S and T crosses showed an increase in number of exerted anthers (although not usually an increase in amount of fertile pollen per anther) when grown on the low fertility field, as compared to the high fertility field. This resulted in a small increase in actual amount of fertile pollen shed. The increase was not nearly so great as that induced by the greenhouse for T-steriles, nor that induced by Florida for S-steriles.

In this second experiment, one can rule out variable effects of temperature, light intensity, humidity and day-length, leaving for consideration such variables as nitrogen balance and internal water supply in the plants.

4. Cytoplasmic male sterility: Separation of Ky21 restorer into T-restorer and S-restorer components.

Several inbreds have been shown to act as fertility restorers on more than one type of sterile cytoplasm. It is important, both theoretically and practically, to know whether this multiple restoring ability is due to the same or to different genes.

Ky21 fully restores fertility when crossed on either S or T sterile inbreds. In the course of transferring the Ky21 restorer gene (or genes) to a non-restorer inbred (utilizing a backcross - testcross method) three types of backcross sub-lines have been obtained. When test-crossed to $WF9^{S}$ and $WF9^{T}$ the three types will give: (1) fertility in approximately 50% of the plants in both S and T crosses; (2) fertility in 50% of the plants in S, but none in T crosses; (3) no fertile plants in S, but fertility in 50% of the plants in T crosses.

This would indicate that two different genes govern the Ky21 fertility restoration in S and T cytoplasm. However, the data at hand do not rule out the possibility that some of those sub-lines which still restore fertility on both S and T may carry a third locus which acts as a restorer on both S and T.

5. Cytoplasmic male sterility: genetics of fertility restorers.

Restoration of pollen fertility by a fertility restorer (FR) inbred may appear to be inherited as a single gene, or as two or more complementary dominant genes, depending on the cytoplasmic sterile line used as a tester. This has been noted for four different FR lines. Table 1 illustrates the results of tests on one FR line.

Table 1.

Pedigree		Fertile %	Partially Sterile %	Sterile %	Total No. Plants.
$K4^T$		0	0	100	
Kys^T		0	0	100	
$K4^T$ x Kys		0	0	100	
$WF9^T$		0	0	100	
F_1 ($K4^T$ x Kys) WG3		100	0	0	
F_1 $WF9^T$ x WG3		100	0	0	
F_2 ($K4^T$ x Kys) WG3		72	3	24	239
F_3 ($K4^T$ x Kys) WG3 (5 seg. progenies combined)		76	1	23	331
F_2 $WF9^T$ x WG3	prog. 1	59	0	41	29
	prog. 2	44	4	52	27
	prog. 3	51	2	48	183
3 progenies combined		51	1	48	237
B.C. $WF9^T$($WF9^T$ x WG3)	rep. 1	21	1	78	96
	rep. 2	21	7	73	165
B.C. ($WF9^T$ x WG3) WF9	prog. 1	26	0	74	46
	prog. 2	29	0	71	28
3 progenies combined		22	3	75	335

As is shown in Table 1, WG3 completely restores fertility to $K4^T$ x Kys and to $WF9^T$. In F_2 and F_3 generations of ($K4^T$ x Kys)WG3, pollen restoration segregated as a clear 3:1 ratio of fertile: sterile plants. However, the F_2 of $WF9^T$ x WG3 shows a segregation which is closer to a 9:7 ratio of fertile: sterile plants than it is to a 3:1 ratio. Likewise, the backcross (B.C.) of $WF9^T$ x WG3 shows segregation of 1:3 for fertile:sterile plants, so that both F_2 and B.C. ratios of $WF9^T$ x WG3 indicate segregation of two dominant complementary genes for pollen restoration.

This apparent discrepancy between segregating populations of the two crosses may be resolved by assuming the following genetic compositions for the inbreds involved:

K4 -aaBB
Kys -aaBB
WF9 -aabb
WG3 -AABB

The genotype: A-B- would be required for pollen fertility (in sterile cytoplasm). The cross ($K4^T$ x Kys)WG3 would have the genotype: AaBB, and therefore Aa, alone, would segregate in further generations as a single gene. $WF9^T$ x WG3, on the other hand, would be heterozygous for both loci: AaBb. In either F_2 or B.C. to WF9 (aabb) it would therefore give 9:7 and 1:3 segregations, respectively.

It is apparent that several other crosses may be made among these four inbreds to test this hypothesis further. Since this effect was not expected they have not been made, but they will be made in the near future.

The possibility that some corn belt inbreds may be sterile (in sterile cytoplasm) as lines and in single crosses, but contain one or more dominant factors required for fertility restoration, is important from the point of view of producing commercial cytoplasmic male sterile double crosses. If a FR line of WG3 genotype (AABB) were used in a double cross in combination with three other lines of K4 and Kys genotype (aaBB), 50% of the plants in the double cross would have fertile tassels. If, however, the other three inbreds were of WF9 genotype (aabb) only 25% of the plants would have fertile tassels. This would be too small a percentage to insure complete pollination in the farmer's field.

It is not known what proportion of the inbreds used in double crosses today are similar to WF9, with respect to alleles of the WG3 FR, and what proportion are similar to K4 and Kys. However, if most of them should be like K4 and Kys, one might regard the WG3 FR as governed by a single gene, for all practical purposes. On the other hand, if most inbreds are like WF9, the WG3 restorer must be regarded as a two-factor restorer.

It would seem, therefore, that one cannot predict the general usefulness of any FR from a study of segregating populations resulting from any one cross.

Donald N. Duvick

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1. Gametophyte factors in the "standard exotics".

The "standard exotics" of Anderson and Brown were tested this past summer to determine the allelic state at the Ga/ga locus for each variety. The tests were those which we commonly use for determinations of this type--i.e., a number of plants of the variety pollinated by ga pollen and the same plants used as pollinators for Ga^S/Ga^S plants. A variety may fall into one of three categories: full seed set with ga pollen and inability to fertilize Ga^S/Ga^S plants (expected from ga/ga varieties), full seed set with ga pollen but the ability to fertilize Ga^S/Ga^S plants (Ga/Ga varieties), and no seed set with ga pollen and the ability to fertilize Ga^S/Ga^S plants (Ga^S/Ga^S varieties).

With these tests the "standard exotics" are classified as follows:

Variety	Allele
Maiz Chapalote	$\underline{Ga}^s$
Ladyfinger Pop	$\underline{Ga}^s$
Papago	$\underline{Ga}$
Zapalata Chica	$\underline{Ga}$
Argentine Pop	$\underline{ga}$
Gourdseed	$\underline{ga}$
Tama Flint	$\underline{ga}$
Parker's Flint	$\underline{ga}$

Tom Thumb pop went out entirely with bacterial wilt so that there was no opportunity to test it. All other tests were satisfactory with little variation between plants within a variety.

The finding that Argentine Pop was $\underline{ga}/\underline{ga}$ was unexpected since almost all of the primitive popcorns are $\underline{Ga}^s/\underline{Ga}^s$. Another Argentine pop from Mangelsdorf, which was much like the one included in the "standard exotics" except for being earlier and less profusely tillered, was unmistakeably $\underline{Ga}^s/\underline{Ga}^s$. In connection with the classification of some varieties as $\underline{Ga}^s/\underline{Ga}^s$ and others as $\underline{Ga}/\underline{Ga}$, it should be noted that reasonable doubt exists that these are discrete alleles. The supposed $\underline{Ga}^s$ allele after being separated from most of its original genic background by backcrossing may act in cross-pollination tests as one would expect the $\underline{Ga}$ allele to behave.

2. Mutation from r → R in the aleurone.

A few of the F_2 seeds from a cross of sweet corn inbred P51 and South American popcorn inbred 24-6 showed irregular spots of color in the aleurone layer. Selection in subsequent generations resulted in stocks where all of the seeds were heavily mottled. No fully colored seeds have appeared so there are apparently no germinal reversions.

Tests showed both parents and the mottled stocks to be A_1, A_2, C, and r. Considering the genotypes of the two parents, it seemed unlikely that a mutable r was involved.

A mottled stock was crossed reciprocally by a stock from Laughnan which was heterozygous ($\underline{r}/\underline{r\text{-}m}$) for the mutable r which he reported in the 1952 News Letter. When the Purdue mottled stock was the female parent, seeds arising from fertilizations by gamets carrying r-m showed both types of mottling: the relatively light color over most of the aleurone layer typical of the Purdue stocks and the much more intense color associated with the mutable r. Seeds arising from fertilizations by gametes carrying r showed only the mottling typical of the Purdue stocks. When the $\underline{r}/\underline{r\text{-}m}$ stock was used as the female parent, seeds from r megaspores were usually lightly mottled as in the Purdue stocks although some were colorless. Seeds from r-m megaspores were heavily mottled. On some of these, however, could be detected the more diffuse Purdue mottling.

When such an F_1 (Purdue mottled x r-m) was pollinated by an R tester, one-half the resultant seeds were mottled due to the action of r-m. The other half were either mottled as in the Purdue stocks or colorless. Significantly, some of the kernels on every ear showed both types of mottling. When the R tester was used as the female parent, one-half the kernels showed r-m mottling. Most of the other kernels were colorless. Only rarely did a kernel show Purdue-type mottling.

The above data are indicative that the mottling in the Purdue stocks is due to a rather complex genic background which is necessary if r or a mutable r is to function as R, rather than a mutable r which is relatively independent of genetic modification, or a simply inherited mutator which acts on r as Dt does on a.

Oliver E. Nelson, Jr.

3. New Cross-Sterility Factors in Maize

A gametophyte factor Ga^s/ga in corn has been shown to be linked with the sugary locus Su/su. There are 12.5 to 15 per cent sugary seeds in the F_2 progeny of various crosses of $Ga^s/Su/Ga^s/Su$ x ga su/ga su. Corn homozygous for Ga^s sets no seed with field corn pollen, ga, but Ga^s pollen will induce seed set in ga/ga stocks. The cross-sterile types found previously have been compatible with each other.

Several years ago Mr. James Murray of the Central Popcorn Co. noticed that 401-127, an inbred derived from Minnesota Superb, which is non-reciprocally cross-sterile with field corn, would not set seed with South American inbreds (Ga^s/Ga^s). Two years observation at Purdue has demonstrated that 401-127 plants set little seed with Ga^s pollen and fail to induce a full set on Ga^s/Ga^s stocks. The factor producing cross-sterility in 401-127, is not located at the Ga^s/ga locus as crosses with ga su/ga su plants result in 25 per cent sugary seeds in the F_2.

Several inbreds have been found at Purdue that do not show the usual cross sterile reaction. The inbred 4513-K2, derived from Baby Golden, will not set seed with ga or Ga^s pollen, but it will set seed with 401-127 pollen and induce a full seed set on the 401-127 stock. It appears from these results that 4513-K2 may also carry the same factor for cross-sterility that 401-127 does.

The inbred 4501-LA, obtained from South American, sets no seed with 401-127 nor with two Ga^s stocks. It has a reduced set with another Ga^s stock. Sixteen per cent sugary seeds occurring in the F_2 progeny of the cross P51B (ga su/ga su) x 4501-LA indicates an allele of the Ga^s type at the Ga^s/ga locus in 4501-LA. The sterility reactions of 4501-LA; that is, the lack of seed set with Ga^s stocks but a reduction in the percentage of sugary seeds in the F_2 of a cross with ga su/ga su, could be caused by 4501-LA carrying Ga^s plus one or more sterility factors not linked with sugary.

Leland R. House

4. Fertility Restorers.

Some 25 single crosses were grown for observation in 1952, representing combinations of widely used inbred lines with the Texas strain of cytoplasmic male sterile WF9 obtained from Dr. D. F. Jones. Of those tested only one yellow line, Ia 153, completely restored fertility of every plant in the single cross. Three F_1 plants of this cross were both selfed and backcrossed onto $WF9^T$, and the progeny grown in 1953 with the following results:

	F_2			
	Fertile	Intermediate	Sterile	Total
1-27 S	67	7	70	144
1-40 S	86	10	78	174
1-45 S	73	15	86	174
Total	226	32	234	492
Observed	258		234	
Calc. 9:7	276 3/4		215¼	492
	Backcross			
$WF9^T$ x 1-27	20	9	63	92
$WF9^T$ x 1-40	40	6	128	174
$WF9^T$ x 1-45	26	1	100	127
Total	86	16	291	393
Observed	102		291	
Calc. 1:3	98¼		294 3/4	393

If the intermediate tassels are classified with the fertile tassels the results fit reasonably well to a hypothesis of two complementary factors necessary to restore fertility. Deviations as large as observed in the F_2 population could occur by chance 9% of the time and in the backcross population could occur over 50% of the time. Small backcross populations used to introduce fertility restoring genes to other lines tend to confirm this hypothesis.

5. A second occurrence of a pleiotropic gene.

In the 1944 News Letter (18:2-3) the writer reported a mutation in inbred lines Kys in which a selfed ear segregated approximately 3:1 for normal yellow and ivory colored kernels. The yellow kernels produced green seedlings with a few exceptional albinos, and the ivory kernels produced albino seedlings with a few exceptional greens. It was concluded that a single gene was involved and that the exceptional individuals were due to hetero-fertilization.

A selfed ear from the single cross WF9 x Ia 153 grown in 1952 unexpectedly segregated for dark yellow and light yellow kernels in approximately a 3:1 ratio. When germinated, the dark yellow kernels produced mostly green seedlings and the light yellow kernels produced albino seedlings. Of 19 progeny plants grown from the dark yellow kernels in 1953, 6 were homozygous dark yellow and produced only green seedlings and 13 were

segregating dark and light yellow kernels which when germinated produced mostly green and albino seedlings respectively. Actual counts from the 13 segregating ears were as follows:

	Seeds produced	Seeds planted	Green Seedlings	Albino Seedlings
Dark yellow	5031	650	624	3
Light yellow	1606	650	11	609

Of 4 progeny plants grown to maturity from the exceptional green seedlings arising from light yellow seeds, all were heterozygous and segregated for seed color and albinism.

Apparently the behavior is exactly the same as in the case described previously. Unfortunately the Kys stocks are lost so that appropriate tests for identity of the genes cannot be made.

A. M. Brunson

6. Some Observations on Pollen Tubes with Respect to Differential Fertilization

Inbred lines of Hulless ($\underline{Ga_1}^s/\underline{Ga_1}^s$), White Rice ($\underline{Ga_1}/\underline{Ga_1}$), and U. S. 13 ($\underline{ga_1}/\underline{ga_1}$) were crossed and self pollinated in order to determine the rate, the extent, and the variabilities of the pollen tube growth with respect to differential fertilization.

A squash method was developed for examining the pollen tubes within the styles (Adams and Mackay, Stain Tech. 28 : 295-298).

Pollen tubes were measured from material removed from the plants at the following time intervals after pollination: 20, 30, and 40 minutes, 8, and 24 hours. The average pollen tube lengths at 20, 30, and 40 minutes after pollination are given in table 1. An analysis of variance indicated

Table 1. Average Pollen Tube Lengths at 20, 30, and 40 minutes After Pollination and Estimated Time of Germination of the Pollen.

	Est. time pollen germ. (minutes)	Minutes after Pollination 20	30	40
		(length of pollen tubes in u)		
$\underline{Ga_1}^s/\underline{Ga_1}^s$ X $\underline{Ga_1}^s/\underline{Ga_1}^s$	5	233.5	285.2	454.3
$\underline{Ga_1}^s/\underline{Ga_1}^s$ X $\underline{Ga_1}/\underline{Ga_1}$	11	118.5	253.8	360.4
$\underline{Ga_1}^s/\underline{Ga_1}^s$ X $\underline{ga_1}/\underline{ga_1}$	27	0	38.4	159.6
$\underline{Ga_1}/\underline{Ga_1}$ X $\underline{Ga_1}^s/\underline{Ga_1}^s$	7	165.4	288.1	380.8
$\underline{Ga_1}/\underline{Ga_1}$ X $\underline{Ga_1}/\underline{Ga_1}$	6	141.1	244.4	391.8
$\underline{Ga_1}/\underline{Ga_1}$ X $\underline{ga_1}/\underline{ga_1}$	5	145.8	288.9	329.3

a significant difference at the 30 and 40 minute periods after pollination when all crosses were involved in the analysis. No analysis was determined for the 20 minute period. If all crosses except $\underline{Ga_1}^s/\underline{Ga_1}^s$ X $\underline{ga_1}/\underline{ga_1}$ were involved in the analysis, there was a significant difference only at the 20 minute period. There was not significant difference at the 40 minute period when the following crosses were analysed: $\underline{Ga_1}/\underline{Ga_1}$ X $\underline{Ga_1}^s/\underline{Ga_1}^s$, $\underline{Ga_1}/\underline{Ga_1}$, and $\underline{Ga_1}/\underline{Ga_1}$ X $\underline{ga_1}/\underline{ga_1}$. No analysis was determined for the 20 and 30 minute periods.

At 8 and 24 hours after pollination the pollen tubes were well established in all crosses. The average distance from the base of the average silk is given in table 2.

Table 2. Average Distance of Pollen Tubes from the Base of the Average Silk

	Hours after Pollination	
	8	24
	(distance from base of silk in mm.)	
$\underline{Ga_1}^s/\underline{Ga_1}^s$ X $\underline{Ga_1}^s/\underline{Ga_1}^s$	----	3.4
$\underline{Ga_1}^s/\underline{Ga_1}^s$ X $\underline{Ga_1}/\underline{Ga_1}$	1.5	----
$\underline{Ga_1}^s/\underline{Ga_1}^s$ X $\underline{ga_1}/\underline{ga_1}$	25.2	11.8
$\underline{Ga_1}/\underline{Ga_1}$ X $\underline{Ga_1}^s/\underline{Ga_1}^s$	----	9.8
$\underline{Ga_1}/\underline{Ga_1}$ X $\underline{Ga_1}/\underline{Ga_1}$	----	0.0
$\underline{Ga_1}/\underline{Ga_1}$ X $\underline{ga_1}/\underline{ga_1}$	----	19.0

$\underline{Ga_1}^s$ and $\underline{Ga_1}$ pollen rarely produced tubes which had swollen tips or swollen areas along the pollen tube regardless of the genotype of the silk. However, such swellings were produced abundantly when $\underline{ga_1}$ pollen was used on $\underline{Ga_1}^s/\underline{Ga_1}^s$ and $\underline{Ga_1}/\underline{Ga_1}$ silks.

From these data the rate of pollen tube growth apparently has no effect on differential fertilization. However, if $\underline{Ga_1}^s$ and $\underline{ga_1}$ pollen were used to pollinate $\underline{Ga_1}^s/\underline{Ga_1}^s$ styles, the $\underline{Ga_1}^s$ pollen will effect fertilization. This could be true if the first few well established pollen tubes inhibited the growth of slow growing or late establishing tubes. The data in table 1 indicates that $\underline{ga_1}$ pollen is slow in germinating, and at 40 minutes after pollination the tubes have progressed less than half the distance of the $\underline{Ga_1}^s$ tubes. The swelling of the $\underline{ga_1}$ pollen tubes occurred one hour after pollination. This swelling was interpreted as reducing the rate of, but not terminating, growth of the pollen tube. Thus, the early advantages of the $\underline{Ga_1}^s$ pollen tubes over $\underline{ga_1}$ pollen tubes in $\underline{Ga_1}^s/\underline{Ga_1}^s$ silks may be a contributing factor to differential fertilization.

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Relationship Between Chromosome Knob Number and Yield in Corn.

In a study of the races of corn in Mexico it was found that races which were derived from the intercrossing of two other races in general had a higher chromosome knob number than the average of the putative parents. In certain races of hybrid origin the knob number was higher than either one of the parents. This led us to believe that there might be some relation between chromosome knob numbers and yield.

In order to obtain more precise data on this relationship, knob numbers were counted in lines of high and low combining ability (as determined in top-crosses on two different testers) from each of 12 different open-pollinated varieties. The average chromosome knob number of the high combiners compared to that of the low combiners within each of these 12 different varieties may be seen in Table 1.

Table 1. Average Number of Chromosome Knobs in High and Low Combining Inbred Lines from 12 Different Varieties.

	Arg	B I	Gto.20	Gto.29	Gto.58	Gto.61	Jal.35	Jal.37	Jal.58	Jal.99	L II	M30
High	6.29	6.28	4.23	4.92	3.95	6.51	3.49	6.05	5.14	6.57	4.89	9.10
Low	5.20	4.13	5.82	3.70	3.80	5.85	5.38	4.85	3.16	4.96	4.64	4.28
Diff.	1.09	2.15	-1.59	1.22	0.15	0.66	-1.89	1.20	1.98	1.61	0.25	4.82

Mean = 0.97 ± .47

The number of high or low combiners involved in the counts for each of the varieties varied from 2 to 6. It is evident from the table that the lines with high combining ability have a higher average knob number in all the varieties except varieties 3 and 7. The average difference is 0.97 ± 0.47. Although the differences are very small in some of the varieties, the data clearly indicate some relationship between knob number and combining ability.

Why this relationship should exist we are not sure. It could be that the knobs themselves have some useful purpose or they merely may be associated with germplasm obtained from Teocinte or Tripsacum that has some favorable effect on yield.

Corn is grown in Mexico from sea-level up to 10,000 feet elevation. The high knobbed Tripsacums and Teocintes are generally found at the lower elevations up to 5,000 feet. The varieties of corn listed in Table 1 are all best adapted to the intermediate elevations of around 5,000 feet and could well have obtained much of their drought resistance and general toughness, or ability to produce under adverse conditions, from Teosinte or Tripsacum.

Table 2. Average Knob Numbers of High Combining Inbred Lines Compared to the Varieties From Which They Were Derived at High Altitude.

	1	2	3	4	5	6	7	8	9	10	11	12	13
Variety	6.40	5.51	5.74	5.86	6.28	5.58	4.26	5.22	4.90	5.47	3.98	5.04	5.01
Lines	7.68	3.53	5.13	4.34	2.57	5.39	3.61	2.53	5.70	3.62	3.05	4.37	5.68
	-1.28	1.98	0.61	1.52	3.71	0.19	0.65	2.69	-0.80	1.85	0.93	0.67	-0.67

Mean = 0.93 ± .39

Table 2 shows data obtained with a different type of corn at high altitude. In this table average knob numbers of the high combining inbred as obtained from inbreeding and testing at 7,500 feet elevation, are compared to the knob number of the open-pollinated varieties from which they were derived. In ten out of the 13 comparisons, the average knob number of the high combining lines was lower than the knob number of the varieties from which they came. The average difference of all the comparisons is 0.93± .39. The 13 varieties involved in the comparisons were all late varieties from the race Chalqueño and the majority of them were best adapted to an elevation of 6,000 feet slightly lower than the station where the inbreeding and testing were done. It is apparent that selection for high combining ability at 7,500 feet elevation resulted in a reduction in chromosome knobs. If knobs are associated with Tripsacum germplasm and are indicative of the amount of Tripsacum or Teocinte introgression into the different varieties, then we might expect selection for high combining ability at high altitude to have a tendency to eliminate knobs since Tripsacum is primarily a tropical plant and not well adapted to elevations of 7,500 feet.

In conclusion, these data suggest that there is a relationship between knob number and yield factors. At low altitude the high knobbed inbred lines tend to be better combiners than the low knobbed ones. At high altitude the reverse seems to be true; the low knobbed lines tend to be the best combiners.

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Collections of corn in the Andean Region.

The corn collections in the Andean Region of South America have been continued during the past year. We have found many different color patterns in the pericarp and aleurone. Several different orange, brown, pinto and variegated types have been added to the collection. All of these types are available to anyone who desires to study them.

To date, we have made the following number of collections from various countries in the Andean Region of South America:

Colombia	1,297	Peru	796
Venezuela	468	Bolivia	250
Equador	478	Chile	117

One of the collections was found growing in Peru about 60 meters above Lake Titicaca at 12,500 ft. above sea level. So far, this is the highest point at which we have found corn growing.

Several Tripsacums have been added to our collection. These collections are being grown at Medellin, Colombia. Dr. R. W. Pohl, Department of Botany, Iowa State College has agreed to identify the species upon receipt of the necessary plant specimens.

Besides the Andean Region there are collections from the following countries:

			201
Argentina	7	Trinidad	18
Haiti	15	Costa Rica	5
Italia	1	Brazil	3
Mexico	116	Puerto Rico	1
Cuba	62		
	201	Total	228

Foreign collections	2,337
in Colombia	1,297
Total	3,634

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Material Available for Selection for Niacin in Maize

The following account describes the source and status of maize breeding stocks containing differential concentration of niacin which will be made available to anyone who may wish to continue selection or research with such material. Selection for high and for low niacin concentration in selfed lines of maize has been continued through several generations. (Richey and Dawson: Plant Physiology, 23: 238-254. 1945). The choice of Huffman in starting niacin selection was fortunate and otherwise. The variety seemed particularly amenable to modification because of the variability among the S_1 ears assayed, and it is believed that this potentiality has been fulfilled. On the other hand, it is white (it should be for meal in the South), is very late and rank growing with consequent difficulty in maintaining the lines after a few generations of selfing. But considerable progress has been made in obtaining higher-niacin lines, and it seemed undesirable to lose this advance because of varietal limitations. Accordingly, high-and low-niacin selections of Huffman were crossed with single-crosses of Corn Belt inbreds and selections from these crosses then made. The concentration of niacin in the parent Corn Belt singles, as shown in table 1, is that for a selfed F_2 composite of several ears. This eliminates the differential influence of male and female parents. The niacin in the F_1 ears of Huffman x Corn Belt, as reported, are affected by this differential influence; the S_1 data are not. The number of S_2 ears assayed, their average concentration and range, suggest that possibilities for obtaining higher-niacin yellow corn are excellent. The genetic base from Huffman is restricted, of course, by the few lines available. An effort was made to compensate for this in using Corn Belt single-crosses mostly instead of inbreds as parents.

The number of selfed and/or crossed ears obtained from these progenies in 1953 is shown in table 2. It is from these that we will be glad to supply anyone interested.

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Table 1. Niacin concentration (micrograms per gram) in parents and progeny of crosses between Corn Belt material and Huffman niacin selections.

	P *	F_1	S_1	S_2 (1952 crop) No.	Av.	Range	Planted 1953 Ear no.	Niacin	Index**
(893 x 751)	24.8								
	42.0	32.7	35.3	4	34.3	29.0-40.9	1415-2	40.9	A
(893 x M14)	27.9								
x H29-7	51.0	49.3	33.1	7	31.7	23.1-44.9	1416-2	44.9	B
x H38	38.0	43.4	33.1	7	30.6	22.6-41.3	1417-2	41.3	C
(893 x 38-11)	21.9								
x H29-3		28.0	41.4	7	39.5	28.6-54.6	1418-2	48.1	D
							-3	40.9	E
							-6	40.4	F
							-7	54.6	G
x H14	42.0	26.4	27.2	4	26.7	22.5-30.0	1419-2	30.0	H
(07 x Hy)	31.0								
x H29-7	51.0	29.7	42.4	6	37.1	29.5-44.3	1420-2	44.3	I
							-6	41.1	J
(RL x Ill.A)	17.4								
x H29-7	51.0	35.7	24.6	8	28.8	22.4-44.5	1422-2	44.5	K
x H8-7	14.0	21.1	16.9	5	16.1	11.9-18.2	1423-3	11.9	L
(M14x051A)	29.5								
x H29-7	51.0	41.1	32.1	6	30.4	25.3-36.1	1424-2	34.8	M
							-3	36.1	--
x H6-5	16.0	24.2	19.1	8	20.1	17.4-22.1	1425-2	17.7	N
							-7	17.4	O
(Oh28 x W22)	25.2								
x H29-8		40.3	45.6	8	38.0	30.9-46.9	1426-4	43.8	P
							-6	46.9	Q
							-7	40.8	R
							-8	41.4	S
x H6-5	16.0	28.8	22.4	5	20.5	18.1-22.0	1427-1	20.2	T
							-3	18.1	U
893	24.0								
x H29-7	51.0	28.8	35.8	4	32.3	24.8-39.0	----	----	----
x H38	38.0	28.1	35.5	3	31.7	28.6-33.8	----	----	----
(205 x 289)	27.8								
x H29-3	?	32.3	27.2	10	29.6	24.8-36.8	----	----	----

*The values for the Corn Belt singles are based on assays of an F_2 composite. Those for the Huffman inbreds are estimates of the modes of the families in the 1952 crop, except for H29-3 which was not grown in 1952.

**See table 2 for seed obtained.

Table 2. Seed obtained in 1953 from the progeny of crosses between Corn Belt material and Huffman Niacin selections

Selfs		Crosses	
Index*	No. Ears	Index	No. of Ears
A	1	B x J	2
B	2	C x G	3
C	5	G x C	3
D	5	G x Q	1
E	5	Q x G	3
F	9	H x A	3
G	3	K x B	3
H	6	K x J	3
I	4	L x O	3
J	4	O x L	1
K		N x L	1
L	4	N x T	1
M	1	T x N	2
N	6	U x O	4
O	5		
P	5		
Q	2		
R	4		
S	6		
T	5		
U	11		

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The Genetical Basis of Heterosis

In a previous communication (Jinks and Hayman 1953) a new method for the analysis of diallel crosses, based on the partitioning of D and H as described by Mather (1949), was put forward and its application to three sets of maize yield data described.

In this method dominance is measured by the ratio $\frac{H_1}{D}$. When this is zero there is no dominance, when it is equal to 1 there is complete dominance, and when it is greater than 1 there is over-dominance. In all three sets of maize data there was a high degree of apparent overdominance, i.e. $\frac{H_1}{D}$ significantly greater than 1. Furthermore, all the data showed suggestions of interaction between non-allelic genes. The data of Kinman and Sprague, which was the most complete of the sets of data analysed, consisted of a 10 by 10 F_1 diallel and

the F_2 progeny of these F_1 families. In these data the interaction was traced to the progeny of specific inbred lines, by the regression of array covariance on array variance. The interacting lines were mainly B2, and to a lesser extent Hy and Oh07.

A further test of interaction has now been applied, namely, the F_2 scaling test (Mather 1949). For this purpose the diallel crosses can be separated into the individual crosses each consisting of the two parents, an F_1 mean and an F_2 family mean. The expectations in terms of d, h and the mid parent M being

$\bar{P}_1 = M + d\Sigma$ (Σd refers to the balance of the genes in opposition

$\bar{P}_2 = M - \Sigma d$

$\bar{F}_1 = M + \Sigma h$

$\bar{F}_2 = M + \Sigma \frac{1}{2}h$

so that for each cross of the diallel table $\frac{1}{4}\bar{P}_1 + \frac{1}{4}\bar{P}_2 + \frac{1}{2}\bar{F}_1 - \bar{F}_2 = 0$ in the absence of non allelic interaction. One can, therefore, test for non-additivity of gene action by testing this equality. For greater accuracy the modified scaling test proposed by Cavalli (1953) was used. The test consisted of estimating by weighted least squares the three parameters Σd, Σh and M, taking as weights the reciprocals of the squared standard errors of each generation mean. These parameters can then be tested for consistency over generations by a χ^2 for one degree of freedom.

Applying this test of additivity of gene action to Kinman and Sprague's data we find that the inbred lines fall into six groups, A,B,C,D,E and F, such that an A parent interacts with a B but neither of these interacts with any of the others, similarly C interacts with D, while E interacts with C and F.

A	B	C	D	E	F
Hy	R46	B2	WF9	Oh04	K159
C114	38/11		Oh07	WV7	

This ties up as well as can be expected with the F_1 regression test for non-allelic gene interaction, which picked out the array B2 as the main source of interaction, since B2 interacts with four other inbred lines, i.e. groups D and E. In view of the widespread nature of the interactions it is not surprising that the F_1 method failed to detect all the interaction present since it depends to a large extent on different arrays showing different intensities of interactions.

The mean yield of the F_1 families showing genic interaction is 90•2748 compared with 77•2971 for the non interacting F_1s, the mean of the parents giving rise to these F_1's being 29•4905 and 27•9103 respectively. On the average, therefore, the F_1 families showing genic interaction yield 13 bushels

per acre more than those showing no interaction. It would thus appear that although combining ability may be due to the operation of dominance in the F_1 families, genic interaction must be at the root of the special combining ability which leads to outstanding F_1 families. It may prove worthwhile to extend to all existing inbred maize lines this type of classification into interacting pairs, described here for those used by Kinman and Sprague.

A similar situation has been met within a diallel between Nicotiana rustica varieties (Jinks 1954). Here the apparent overdominance for the character height, i.e. $\frac{H_1}{D} > 1$, was traced to one pair of interacting groups of lines, Group A including 2 and 4, and Group B including lines 1, 3 and 6, out of 8 original lines used. In F_1's grown over three seasons 2, 4, 1 and 6 were picked out by the F_1 regression test, while for the last two seasons all the interacting lines were picked out by the scaling test, using parents, F_1, F_2 and backcross family means. The same genetical situation has also been found in a variety of other data (Table 1).

Table 1.

Source \ character	Flowering time	Height	Yield	Shape indices
N. rustica 1950-53 F_1, F_2 and B (Jinks 1954)	H_1 = 0·50 - 0·56 No genic interaction	= 2·6 - 4·0 genic interaction		
Maize F_1 and F_2 (Kinman and Sprague 1945)			$\frac{H_1}{D}$ = 8·5-7·4 genic interaction	
Galeopsis sp. 1947-50 F_1's (Haberg.)	1. $\frac{H_1}{D}$ = 0·12 - 0·24 No genic interaction 2. 3.	= 1·64 - 2·04 genic interaction = 6·6 genic interaction = 0·61 no genic interaction		
Rye F_1's (Haberg.)			$\frac{H_1}{D}$ 70·0 genic interaction	
Egg Plant F_1 (Sokohi 1953)			$\frac{H_1}{D}$ = 0·49 no genic interaction	$\frac{H_1}{D}$ = 0·15-0·4 no genic interaction

In every one of the cases where heterosis is due to apparent over-dominance the presence of genic interaction has been proved from the data. In the one case where it has been possible to reanalyse after eliminating the interaction, viz. N. rustica data, only complete dominance, i.e. $\frac{H_1}{D} = 1$, remained. The evidence suggests that the heterosis, which is of such importance to plant breeders, results from interactions between non-allelic genes brought together in the hybrid F_1.

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1. Auxin relations

The auxin relations for a number of dwarf mutants are being studied in terms of auxin production, inactivation of auxin, response of decapitated coleoptiles to added IAA, and the response of coleoptiles to the switching of normal and mutant coleoptile tips. An allele to dwarf-1, obtained from Dr. Anderson at CIT, has been studied in some detail (Robert Harris, Ph. D. thesis, 1953). The amount of diffusible auxin obtained from 5 day old dwarf coleoptile tips was consistently .4 that of normal tips. This is confirmation of Van Overbeek's original work on the auxin content of dwarf-1 coleoptiles. In addition, ether extraction techniques gave an auxin ratio of .5, mutants to normals. Time experiments with diffusion methods suggested that the lower auxin value in dwarfs is due to a lower rate of production of auxin. Inactivation studies showed that auxin differences were not due to differences in rates of inactivation. Both diffusates and ether extractions were tested for inactivators. Surprisingly enough, inactivation by dwarf coleoptiles was not more but less than that found for normal coleoptiles. Normal coleoptile tips on decapitated dwarf coleoptiles did not result in elongation of the dwarf coleoptiles.

One dwarf mutant (4963, CIT) gave no curvature (i.e. less than 5°) from diffusion studies using 10 and 15 coleoptile tips per block. Normal controls gave 23° curvature using 10 tips per block. Practically no elongation occurs in the mesocotyl (first internode) of this mutant; the final length of the dwarf coleoptiles is $\frac{1}{2}$ that of normals.

2. Environmental effects

The effects of the environment on the kinds and amounts of plastid pigments from selected seedling mutants are being studied. Work is being continued on the virescent pale-yellow-1 gene (from Anderson, CIT) to show the temperature sensitivity of mutant plants during later stages of growth.

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1. Results of Further Inheritance Studies of the Kys Type of Cytoplasmic Male Sterility in Corn

As reported by Schwartz (Genetics 36:676-696. 1951), male sterile plants of the Kys sterile have (1) sterile cytoplasm [] , (2) dominant $\underline{Ms_2}$ gene, and (3) recessive suppressor gene $\underline{s^{ga}}$. The alternative condition of any one of these factors gives normal fertile plants. It was also reported by Shwartz that the suppressor gene $\underline{S^{ga}}$ exhibits male gametophyte competition with recessive $\underline{s^{ga}}$, so that in a $\underline{S^{ga}s^{ga}}$ plant the dominant $\underline{S^{ga}}$ functions to the exclusion of recessive $\underline{s^{ga}}$ through the pollen. A large number of sparse pollinations, where $\underline{s^{ga}}$ pollen might be deposited on a silk where no $\underline{S^{ga}}$ pollen grains are present, failed to transmit $\underline{s^{ga}}$ through the pollen. Screening (74 micron) pollen composed of a mixture of $\underline{S^{ga}}$ and $\underline{s^{ga}}$ pollen grains was successful in transmitting $\underline{s^{ga}}$ through the pollen, but at an extremely low rate.

Further observations revealed that heterozygous plants ([] Msms $S^{ga}S^{ga}$) produce 50% pollen grains which are partially filled with starch, the remaining 50% are normal. In a segregating population, plants were classified as to whether they produced partial pollen grains as shown below.

Genotype	Pollen	Test Cross Result
[] MsMs $S^{ga}S^{ga}$	Normal	All fertile
[] Msms $S^{ga}S^{ga}$	Normal	All fertile
[] MsMs $S^{ga}s^{ga}$	50% Partial	1:1 for sterility
[] Msms $S^{ga}s^{ga}$	50% Partial	3:1 for sterility

Individual plants in the segregating population above were outcrossed to the recessive tester [] msms $s^{ga}s^{ga}$. If partial pollen indicates segregation of $S^{ga}s^{ga}$ all such plants when crossed with the tester should segregate either 1:1 or 3:1 for sterility. All plants with normal pollen would give all fertile progeny when crossed onto the tester. Such results were obtained, so the presence of 50% of the pllen grains partially filled with starch indicates the plant is heterozygous $S^{ga}s^{ga}$. The partially filled pollen grains are not shrunken, but the remainder of the grain is filled with a clear liquid. Adjustment of the light source so light is refracted by the pollen grains facilitates the detection of the partial pollen.

Microscopic examination revealed that it is not a case of simple gametophyte competition (pollen tube growth, etc.) when $\underline{S^{ga}}$ functions to the exclusion of $\underline{s^{ga}}$, but rather, the $\underline{s^{ga}}$ (partial) pollen grains abort, as none

were observed to germinate on silks. Recessive s^{ga} pollen is abnormal only when developing in competition with Sga pollen in the same plant since pollen from ♀ msms $s^{ga}s^{ga}$ plants is normal. Further, when pollen from ♂ Msms $S^{ga}S^{ga}$ and ♀ msms $s^{ga}s^{ga}$ plants was composited, so we have a mixture of Sga and s^{ga} pollen, no competition existed as both kinds of pollen functioned.

This information makes it possible to introduce this type of sterility into standard inbreds without having to transmit s^{ga} through the pollen. Certain genotypes can be identified in testcross and backcross populations by examination of the pollen without resorting to test crosses for identification.

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2. Evidence for crossing-over between non-homologs during megasporogenesis of monoploids

During a study of microsporogenesis of maize monoploids, a striking aberation was found. Approximately 17 percent of the anaphase I figures possessed at least one bridge-like configuration, and a few were found that had two. These "bridges" closely resembled the bridges found in heterozygous inversion stocks, except that acentrics were never found, even after an exhaustive search. It was tentatively assumed that exchanges had occurred between members of the genome, and that the "bridges" were actually non-terminalized chiasmata.

During the summer of 1953, 84 plants were grown from seed produced by crossing normal diploid males with monoploid females. Pollen from each of the F_1's was examined. Four had abortive pollen; three were 50 percent abortive. These four plants were self-pollinated and outcrossed to Oh51A. At harvest, the plants that were 50 percent abortive, were also 50 percent abortive on the ear. The plant that was less than 50 percent pollen abortive also had a higher seed set.

Seeds from the selfed plants were planted in the greenhouse this winter, and the pollen mother cells are to be examined for the presence of heterozygous translocations. Should translocated chromosomes be found in these plants, there can be no doubt that crossing-over occurred between non-homologous chromosomes during megasporogenesis of the monoploid plants.

3. "Single gene" heterosis

Spontaneous non-allelic mutations to dwarfism have been found in inbreds Illinois Hy2, Wisconsin W8, and Ohio 07. Each of the mutants was crossed with the parent inbred. The F_1's and the parent lines were planted in a 5-replicate split plot design at Urbana in 1952. Certain data were collected, and are summarized in Table 1.

Table 1. Comparisons of inbreds and inbred x dwarf mutants.

	Plant height in.	Days to half silk	Corrected field weight* lb.
Hy2 x Hy2 dwarf	78	64	6.8
Hy2	73	66	5.4
Difference	5	-2	1.4
W8 x W8 dwarf	73	62	5.7
W8	63	60	4.0
Difference	10	2	1.7
07 x 07 dwarf	90	66	6.1
07	84	68	5.6
Difference	6	-2	0.5

*Corrected to uniform stand and moisture.

A parallel experiment was also conducted at the same location and the same year involving sub-strains and the official stocks of each of the long-established inbred lines Indiana WF9 and USDA CI. 187.2. The "sub-strains" were established by maintaining selfed families within official stocks of these lines. Data from this trial are summarized in Table 2.

Table 2. Comparisons of sub-strains and sub-strain crosses.

Pedigree	Plant height in.	Days to half silk	Corrected field weight lb.
187-1	69	69	4.1
187-1 x 187-10	67	66	5.0
187-10	64	66	4.3
187-3	69	65	4.4
187-3 x 187-8	68	66	4.9
187-8	70	66	4.3
WF9-5	76	66	5.7
WF9-5 x WF9-30	82	62	6.9
WF9-30	82	61	6.4
WF9-36	82	65	6.5
WF9-36 x WF9-35	80	63	5.5
WF9-39*	69	62	3.8

*Seed of WF9-35 was not available for this trial.

Statistical treatment of the data is summarized below:

Character	Significant at 5% level	Significant at 1% level
Dwarf x normal vs. normal		
Yield (grain)		yes
Plant height	yes	
Days to half-silk	yes	
Sub-strain F_1's vs. standard inbred		
Yield		yes
Plant height	no	
Days to half-silk	yes	

There is no question that hybrids between mutant dwarfs and normal stocks of the same inbred were more vigorous than the non-mutated self-pollinated plants. In addition, crosses between sub-strains of inbreds were usually higher-yielding than selfed sub-strains. To attribute the higher yield of the F_1 alone to heterozygosity of the dwarf gene is inconsistent since similar differences exist between selfed sub-strains and hybrids between sub-strains within an inbred.

Critical evidence for single-gene heterosis must come from experiments involving crosses between lines that are isogenic, except for the locus under study. It is doubtful that this sort of evidence has ever been obtained in corn.

D. E. Alexander

4. Studies with dwarf and brachytic stocks.

Studies of dwarfing in maize begun in 1948 have been broadened to include physiological and anatomical aspects, in addition to genetic and agronomic studies.

Conversion of the standard inbred lines WF9, 38-11, L317, and Hy2 (parental lines of U.S. 13) to brachytic-2 versions has been continued. Brachytic-2 versions has been continued. Brachytic-2 lines thus far developed have been somewhat disappointing in agronomic characteristics, particularly disease resistance, but F_1 hybrids between certain br2 stocks bear ears which approach normal size.

Three separate and distinct mutant stocks homozygous for br-2 have now been obtained, and there appears to be evidence that mutations to this type occur with unusual frequency. The three stocks ("R4 dwarf", "Oakes dwarf", and "W28 dwarf") differ phenotypically in both the mature and seedling stages, but give brachytic F_1's when intercrossed. "R4 dwarf" plants are indistinguishable from normals in the seedling stage, and classification in segregating cultures is difficult until shortly before tasseling. Seedlings of

both "Oakes dwarf" and "W28 dwarf" show some shortening of the mesocotyl in the early seedling stage, but this has not been found sufficiently consistent to make classification in segregating populations reliable. Physiological and anatomical studies with br-2 are in progress, and include among their objectives evaluation of the effects of this gene (or gene complex) on agronomic characters of the plant. Linkage studies also are in progress.

Similar studies of the genetics, physiology, and anatomy of the "W8 dwarf" mutant also are being conducted. This mutant can be classified easily in segregating populations by its production of very short leaf-sheaths of the earliest foliage leaves. In several thousand seedlings observed, the development of leaf blades, coleoptile, and mesocotyl has been normal in homozygous "W8 dwarf" plants. Mature plants of this mutant are essentially brachytic in growth form. All crosses between the "W8 dwarf" and other dwarf and short stocks in our collection have given normal F_1's.

Our collection of dwarf and short mutant types of maize now includes between forty and fifty stocks. We would be grateful to receive seed of any dwarf or short types, and would be happy to furnish limited quantities of seed of our stocks to anyone interested in having them.

Earl R. Leng
Nguyen-van Mung
Robert Fields

5. Vestigial - tunicate crosses.

Substantial populations of the F_1 between heterozygous vestigial-glume and heterozygous tunicate plants have been grown in two seasons. As previously reported by Langham (Maize News Letter 1940), the Vg vg Tu tu plants from this cross show the vestigal condition on the tassel but have tunicate ears. However, in our stocks, the tassel glumes of such plants are longer than those of Vg vg tu tu plants, while the ear glumes only partially enclose the kernels. A better description of the Vg vg Tu tu phenotype would be "tassel glumes weak vestigial, ear glumes weak tunicate". F_1's between Vg vg tu tu and vg vg Tu tu, therefore, produce the following genotypes and phenotypes in a 1 : 1 : 1 : 1 ratio :

Genotype	Phenotype	
	Tassel glumes	Ear glumes
Vg vg Tu tu	weak vestigial	weak tunicate
Vg vg tu tu	vestigial	vestigial
vg vg Tu tu	tunicate	tunicate
vg vg tu tu	normal	normal

Earl R. Leng

6. Illinois Chemical Strains.

The fifty-fourth generation of continuous selection for oil and protein content in the Illinois Chemical strains was completed in 1953, but the results of the analyses are not yet available. Five generations of reverse

selection in these strains have given evidence that genetic variability still exists in all strains except possibly Illinois Low Protein; the conclusions about the latter strain are indefinite as yet.

Earl R. Leng
C. M. Woodworth

Department of Botany

1. Further studies on crossing over in inversion 3a.

Backcross data from plants heterozygous for Lg_2 and A_1. In every combination listed in column one, the A allele is in the left-most chromosome. The first 8 entries are from Rhoades and Dempsey (1953).

Chromosome structure	Linkage phase	Heterozygous parents	Lg A	lg a	Lg a	lg A	Total	Recomb. %	S.E.
N/N	C	♀ and ♂	522	568	203	219	1512	27.8	1.16
In/N	C	♀	3015	2482	24	84	5605	1.9	.18
In/N	C	♂	1410	1215	6	8	2639	0.5	.14
In/In	C	♀	514	420	401	356	1691	44.8	1.21
In/In	R	♀	393	340	610	592	1935	37.9	1.11
In/In	R	♂	333	311	606	566	1816	35.5	1.12
In Df-Dp/In	R	♂	823	68	1335	229	2455	36.3	.97
In Df-Dp/In	R	♀	192	18	255	34	499	42.1	2.21
N Df-Dp/N	R	♀	564	1045	2052	1031	4692	34.3	.69
N Df-Dp/N	R	♂	32	399	1773	86	2790	33.4	.89
N/N*	R	♀	738	767	1522	1485	4512	33.4	.70
In/In	C	♀	1087	988	880	922	3877	46.5	.80
In/In	C	♂	350	385	341	334	1410	47.9	1.33
In/In	R	♀	307	365	509	475	1656	40.5	1.20
In/In	R	♂	302	311	422	462	1497	41.0	1.27

*The lgA chromosome was derived from a double exchange from an In/N plant.

The average unweighted percentage of recombination between Lg_2 and A_1 in N/N plants is 30.6 while in the homozygous inversion plants where A is nearer the centromere and Lg is more distal the percentages of recombination varied from 35.5 to 47.9 with an unweighted mean of 42.0 percent. The difference in recombination percentages in N/N and In/In plants can be accounted for by a centromere effect on crossing over. Since both Lg and A are in the inverted segment it can be argued, on the basis that closer proximity to the centromere results in a decrease in exchange frequency and conversely an increase in crossing over when further removed, that the physical distance of the proximal break of the inversion from Lg is less than the distance of the second break from A.

The Df-Dp chromosomes derived from In 3a/N plants have varying portions of the proximal part of the long arm of chromosome 3 in duplicate. One of these Df-Dp chromosomes was tested to determine whether or not the gl_6 locus, which is proximal to lg_2, was included in the duplicated segment of the Df-Dp

chromosome. The following crosses were made:

$\underline{Gl_6}$ $\underline{A}$ $\underline{N\ Df\text{-}Dp}$ X gl_6 a

$\underline{gl_6}$ $\underline{a}$ $\underline{N}$

(0) Gl A	(x) gl A	(x) Gl a	(0) gl a	A:a ratio on ear
289	255	600	597	585:1250 (31.9% A)

ξ = 1741

Gl_6-A recombination = 49.1%

% Gl_6 in seedlings = 51.1

% A in seedlings = 31.2

Since earlier studies showed that approximately 26% of Df-Dp ovules function, is clear from the Gl:gl ratio that $\underline{Gl_6}$ is not included in the duplicated piece of 3L for if it were there should be approximately 50 percent more Gl than gl seedlings and a 1:1 ratio was obtained. This argument is based on the following table. It is clear from the 49.1 percent recombination between $\underline{Gl_6}$ and A that at least one crossover occurred between $\underline{Gl_6}$ and the Df in all, or nearly all, megasporocytes so we can eliminate the products of no exchange bivalents and consider only single and double exchanges.

Gl NDf-Dp

Gl N Df-Dp

gl N

gl N

Type of exchange	Gl not in duplication				Gl in duplication			
	N gl	N Gl	Dp-Df gl	Dp-Df Gl	N gl	N Gl	Dp-Df gl	Dp-Df Gl
singles	1	1	1	1	1	1	0	2
2 strand doubles	2	0	0	2	2	0	0	2
3 strand doubles	2	2	2	2	2	2	0	4
4 strand doubles	0	2	2	0	0	2	0	2
	5	5	5	5	5	5	0	10

If $\underline{Gl_6}$ is not in duplication a 1:1 ratio is expected. This was found,

If $\underline{Gl_6}$ were in duplication, a ratio of approximately 1.5:1.0 should occur. The observed ratio of Gl:gl deviates significantly from 1.5:1.0 but is very close to a 1:1.

2. Ears from crosses of $\underline{Bt_1}/\underline{bt_1}$ plants with $\underline{sh_3}$ showed a 1:1 segregation for a shrunken kernel type. Although the phenotypes of $\underline{sh_3}$ and $\underline{bt_1}$ are quite dissimilar, they are allelic.

3. A new gl was found on chromosome 5. Its linkage relations with $\underline{A_2}$ and $\underline{Bt_1}$ are shown below. Only colored seeds ($\underline{A_2}$) were used since another aleurone factor was segregating.

$$\frac{\begin{matrix}(1) & & (2)\\ gl & A_2 & Bt_1\end{matrix}}{\begin{matrix}Gl & a_2 & bt_1\end{matrix}} \quad X \quad gl\ a_2\ bt_1$$

(0)	(1)	(2)	(1-2)
gl A2 Bt	Gl A2 Bt	gl A2 bt	Gl A2 bt
1281	15	69	0

$\Sigma = 1365$

Region (1) $gl\text{-}A_2 = 15 \div 1365 = 1.1\%$

Region (2) $A_2\text{-}Bt = 69 \div 1365 = 5.1\%$

The order is: gl — A_2 — Bt

(1) (5)

On the basis of negative allelism tests with unplaced glossies, the new gl was designated gl_{17}.

M. M. Rhoades and
Ellen Dempsey

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1. Tests for linkage of unplaced genes.

A. The bm_4 character has been tested for linkage with genetic markers in all the groups except 1 and 4 and no linkage found (Bothun News Letter 24, p. 58). Since then the B-translocations have been used, also with negative results: TB1a and b, TB3, TB4a, and TB7b. A set of translocation testers marking most of the chromosome arms has finally been resorted to. Preliminary trials with a partial set of these were run last summer. The T6-9 (C23) gave an indication of linkage: 16.5% recombination based on 97 backcross plants. Since no evidence of linkage

had been obtained with ms, and su_2 in group 6, or with sh, wx, and W^c in group 9; bm_4 may prove to be in a region at a considerable distance from previously known markers; and not, as so frequently happens, in a region already well-marked.

C. R. Burnham and E. Clark

B. sh_3. This was found by Dr. Stadler in the progeny of irradiated material, one of several characters he furnished us and on which linkage tests are being made. This sh_3 has been reported to be in group 5 (News Letters 18, p. 15; 20, p. 16). In those reports it was designated as sh_2. Since in a subsequent publication the sh linked with et has been designated sh_2 - (Journ. Hered. __), this one is now sh_3.

The following F_2 data have been obtained:

159 Sh Ys_d + 75 Sh ys + 29 sh ys = 45.7% recombination, and 189 A_2 Ys + 62 A_2 ys + 52 a_2 Ys + 42 a_2 ys = 38% recombination. Further tests are needed, since earlier tests indicated a closer linkage with a_2.

E. Clark and C. R. Burnham

C. Tests of gl_{11} vs midget (mi), nl_2 vs. C, and nl_2 vs. sh showed independence. Tests of crossing over in male vs. female in the fl-v_4 region of chromosome 2 show a difference, that in the male being higher. In the test through the male, the crossover classes are unequal.

Yaacov Ventura

D. The T-B translocations were used to test for the location of several new and unlinked genes. The only positive results were between yg S-3 (a yg from irradiated material from Stadler) and TB3; and between a new stripe and TB7b (a stripe found by Clark).

John Longwell

2. Tender pericarp in sweet corn.

A group of 13 different chromosomal interchanges was used to test for association with the tender pericarp character in an inbred line of sweet corn (S_4) derived from a cross of Golden Bantam with Hayes White (tender).

Associations were found with 6 interchanges. At least four factors may explain the associations found.

A. Mohamed

3. Tester set of translocations

The tester set of translocations for use in testing linkage with genes in any of the 20 chromosome arms is reasonably complete. It consists of a basic set of 15 translocations which gives at least one test with each arm, and a supplemental set of 7 translocations which furnishes at least one more test with the arms which have only one test with the basic set. The basic

set may be used for simply inherited characters, or as a preliminary test for the more complicated ones. Dr. A. E. Longley and Dr. E. G. Anderson have been generous in supplying stocks and additional cytological information.

C. R. Burnham

4. Gametophyte factor studies - specificity tests.

Stocks have been built up to test the specificity of the Ga interaction between silks and pollen. That is, if the silks are carrying the Ga factor in chromosome 4, will pollen from plants heterozygous for bt and the Ga factor in chromosome 5 show the differential effect resulting in deviating ratios for bt? The reverse test: silks carrying the Ga factor in chromosome 5 against pollen from plants heterozygous for su and the Ga factor in chromosome 4 has been set up also. The scheme of the tests has been to establish two Bt Bt Su Su stocks: #1 carries Ga in chromosome 4 and not the Ga in 5; and #2 carries the Ga in 5 and not the one in 4. Number (1) is crossed with su to produce the heterozygote and these plants are crossed on stock #2 to check the specificity of the interaction between silks and pollen and they are also crossed on stock #1 as a check on the results. The progeny are grown in open-pollinated blocks with su or Su su borders and interspersed rows. Counts on the number of Su Su and Su su plants are made when the ears are mature. Tests of silks carrying the Ga in 5 against pollen from plants heterozygous for su and for the Ga in 4 gave 115 Su Su and 128 Su su plants, while the check test of silks with the Ga in 4 pollinated with the same Ga gave 144 Su Su and 47 Su su, showing that when the Ga in 5 is present in the silks it does not permit the expression of the differential effect of Ga in 4 in the pollen. The tests of silks with the Ga in 4 against the Ga in 5 in the pollen are not complete.

One of these crosses involving a pop corn segregated for normal vs. fasciated ears in a 9:7 ratio.

C. R. Burnham and E. Clark

5. Gametophyte factors in pop corns.

Tests of Black Beauty Pop Corn were made to determine how many of the chromosomes carry a ganetophyte factor.

Chrom. 1 - Certain plants gave low ratios for zb_4 which may indicate a Ga factor. (classification difficult for zb_4).

" 2 - a few plants gave slightly deficient ratios for v_4, but normal ratios for gl.

" 3 - Five out of 10 plants gave low ratios for a.

" 4 - two out of 15 plants gave very low ratios for su.

" 5 - The 12 plants tested all gave low ratios for bt.

" 6 - normal ratios for Y.

Chrom. 7 - normal ratios for gl

" 8 - normal ratios for v_{16}

" 9 - normal ratios for c

" 10 - normal ratios for r

Other popcorns were tested for ratios for bt in 5 and su in 4:

Supergold pop corn gave normal ratios with bt and su. A red pericarp pop corn gave low ratios for su, slightly low ones for bt

A hairy sheath pop corn: 2 plants gave low ratios for both bt and su.

An a-tester gave normal ratios for bt and su.

E. Clark

6. Technique

A. Ear bags for pollination. For the past few years we have used a 35 lb. white parchment ear bag with much more satisfactory results than the old glassine bag. The size is 2½" x 9 1/8" (one flat side is 9 7/8" to give a lip) made up with waterproof glue (test every new shipment that is received, as we still get occasional shipments made up with non-water proof glue in spite of the specifications). The longer bag stays on much better and leaves more room for the growing ear and the silks as they push out. It has a tendency to flop or bend over after being first put on but after the first dew or rain the material stiffens and when straightened up usually remains that way. A bag an inch shorter may be a little better. Here where we have heavy rains accompanied by strong winds and occasional hail, the glassine bags were very unsatisfactory. The one advantage of the glassine bag is the clear view it affords of the silks. Although the parchment bag is only semi-transparent, when in doubt the worker can always check the quantity of silks by pinching the bag between his fingers at the ear tip.

For a long period of time the corn breeding project here has used for covering ear shoots a larger 35 lb. parchment bag, 4" x 12" with side gussets; with 1" overlap and a double strip of waterproof glue at top and side seams. These are placed over the young ears and held in place around the stalk with a paper clip or staple. It is placed over the ear earlier and needs no further attention until pollination.

C. R. Burnham

B. Labels for plants and ears. This is another very useful item, first put in use, I believe, by L. C. Saboe (Ohio Agric. Expt. Sta.) when he was a student here. Sheets of tagboard, #6 or heavier weight, are perforated according to the size of tag desired. One useful size is from sheets that are 17" by 22", with 9 rows of perforations in the long dimension and 7 rows running in the other direction, making 80 tags per sheet which are 1 3/4" x 2 3/4".

For some uses in the field, the numbers can be stamped on the tags in the sheets in the laboratory. In barley we have used it for numbering plants from which pollen samples are being taken and on which records for other characters are being made. For each plant, two tags attached end-to-end and stamped with the same plant number are used. When heading starts, the first tag is placed around the plant at the 3rd or fourth internode and stapled in place so the plant number can be read and the second tag free to be removed later. The pollen sample (a whole or part of a head) is taken, the second tag removed, folded to enclose the head, stapled so as to hold the head tightly in place, and dropped in a jar of 70% alcohol. This sytem ensures that the pollen sample and plant will have the same number, and also it is no problem to determine which plants are still to be sampled. A larger tag could be used for corn. They are quicker to attach than string labels and also are easier to see on the plant.

Recently we have stapled a tag on the inside edge of the pollination bag before pollination. The record of the cross is written on this at the time of pollination, the tassel bag being placed over the ear after pollination. At harvest this tag is completed and transferred to the ear, nailed on with a "fine" lath nail.

Precautions: staples. The ordinary staples used in the hand stapling machine will rust in alcohol and obliterate numbers which contact them. Staples made of brass gave no trouble, but they were not available last year. Aluminum ones are available and are almost as satisfactory. ink: The stamping inks in some cases are not color fast in alcohol and must be tested. Some are not color fast in the field when subjected to rain and sun although they may be waterproof. This latter has been found to be true of the inks used in some of the wick pens when used for field stake labels.

C. R. Burnham

C. Containers for sporocyte collection and storage. An innovation introduced by L. L. Inman is the use of the glassine envelope used by stamp collectors in place of the glass bottle or shell vial. The size 2 7/8" x 1 3/4" has been used for barley, wheat and oats. Two or three holes are punched with a paper punch in each envelope about $\frac{1}{2}$" from the bottom to permit more rapid entrance of the killer. The culture and plant number are written on the envelope with India ink, the sample taken, placed in the envelope and immersed in a jar of killer (the wide-mouth pint fruit jar is a convenient size - the lids have to be replaced at times due to action of the killer). The envelopes with the samples can be placed in order in bundles, and a large number stored in each

jar. The changing to 70% alcohol is also a more rapid job, although several changes with some time between each are probably necessary.

7. Monoploid Study

Brown marker a_1A_2CRBPl was crossed to nineteen different single crosses and six topcrosses, as sources of monoploids. These sources contain inbreds of known or suspected high frequency of monoploidy. Approximately 186,000 F_1 seed were put through the germinator in the spring of 1953. Putatives were transplanted directly to the field. Three-hundred of these transplants were subjected to colchicine treatment - three levels of concentration (.025, .50, .10) using two methods of application (vacuum and hypodermic). Out of 835 original transplants, approximately 500 survived and approximately 250 failed to develop color (haploid or other). Plants which could not be selfed were crossed with more fertile plants. These selfed and crossed plants will be grown in the 1954 season.

The study also includes a comparison of the effectiveness of scutellum aleurone, plumule and root screens in different marker stocks. It is hoped that these stocks may also be studied as to differences in stimulation of parthenogenicity.

E. E. Gerrish

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1. Redesignation of pa.

In many respects the pale aleurone mutant (pa), reported in the 1953 News Letter, resembles the bz gene found by Rhoades. It produces similar though possibly darker aleurone color than bz. It also produces a reddish brown plant color when B and Pl are present, and has little effect on cob color in the presence of Pwr. Since it resembles bz in most respects (except for mutability), it is proposed that the pa designation be changed to bz_2, or in the case of the particular allele found, bz^m_2.

2. Activator of bz^m_2 mutability.

The bz^m_2 allele is dependent for its mutability upon another factor, tentatively designated M. Whenever bz^m and M are in the same cells, bz^m mutates at a very high frequency back to types resembling normal Bz_2. In the absence of M, bz^m is quite stable. The behavior of M resembles that of McClintock's Ac agent in several respects, the most important of which are (a) frequent changes of state, and (b) similar dosage relationships. That is, M, when in one dose, causes bz^m to mutate early, producing frequent large sectors, but when present in 2 or 3 doses, causes bz^m to mutate later, producing many small sectors. These two characteristics of M are in contrast to the behavior of the other important group of mutators, the Dt loci, which are relatively stable and which show an increase in mutation frequency of the affected locus (a) at all stages if the dose of the mutator is increased.

3. Location of Dt_2, Dt_3, and bz_2: Xray deficiency method.

The genes Dt_2, Dt_3, and bz_2 (pa), all reported in the 1953 News Letter, have been placed on the chromosome map by the use of Xray induced deficiencies. Any new mutant can be placed on the correct chromosome by the treating of pollen carrying its dominant allele and crossing it on silks that are homozygous recessive, by finding among the progeny plants deficient for the dominant allele, and finally, by examining these plants cytologically to determine which chromosome has lost a segment. This segment will include the locus of the mutant in question. Such a method works very well for locating mutants affecting seedling or plant characters, but for endosperm characters a modification of the above method had to be developed because deficient endosperms induced by pollen treatment are associated with normal embryos. To overcome this, treatment of the pollen was made early in the development of the microsporocytes, before the second microspore division which separates the nucleii that fertilize that endosperm and embryo. The best stage was found to be that just following the first microscope division, since treatment at this stage produces many deficient endosperms which are associated in more than 60% of the cases with deficient embryos (corresponding cases). The stage of treatment is quite important as microspores treated before the first division yield very few deficiencies, while those treated after the mid-point between the first and second division produce many deficiencies but they are almost always the non-corresponding type. That is, the deficient endosperm is associated with normal embryo and vice versa. Deficiencies produced by this method have been simple ones involving only one chromosome, but ranging in size from that expressed by a small buckle on a pachytene chromosome to that which included almost all the long arm of another one.

Using the above method bz_2^m has been located on the long arm of chromosome #1 about 0.6 of the distance out from the centromere. Three plants that were deficient for Bz_2 and also for portions of the long arm of #1 were examined, but the diagnostic case was one that had a small deficiency buckle at the position mentioned above.

The Dt_2 gene was previously reported as being linked to Y with 22.5% recombination. By using the above mentioned deficiency method, a plant deficient for Dt_2 was obtained and found to have lost all but the two dark staining proximal chromomeres of the long arm of chromosome #6. Therefore, since Dt_2 is in the long arm of 6, and since Y is very near the centromere, this must mean that Dt_2 is about 23 units distal to Y or in the neighborhood of Pl.

In a similar fashion a plant deficient for Dt_3 was produced and found to have lost the segment of the long arm of #7 distal to the common interstitial knob. The break appeared to be immediately adjoining or possibly within the knob itself, though the knob was not visibly diminished in size. Appropriate crosses have in one way supported this in that they have clearly shown that Dt_3 was not allelic to either Dt_1 or Dt_2.

The three locations of Dt activity are as follows: Dt_1, near the end of the short arm of chromosome #9; Dt_2, on the long arm of #6 near Pl and 23 units from Y; Dt_3, on the terminal fourth of the long arm of chromosome #7.

4. Modifiers of Dt activity.

Almost every genetic culture that has a^m and Dt expresses Dt activity at a slightly different level, but two have had a striking effect. The first, designated the Lansing stock and carrying the genes a, sh_2, dt_1, has been found by subsequent tests to possess a gene (or genes) which can completely inhibit the dotting of one and sometimes two doses of Dt_1 (with a^m), and markedly reduce the dotting of 3 doses. This agent, designated Id, has segregated in F_2 cultures but has not given consistent Mendelian ratios. Instead it has expressed itself in nearly all of the seeds from any cross in which Dt and Id come from the same parent even though that parent is only heterozygous for Id. When selfed, heterozygous Id id plants which are a^m a^m Dt Dt produce seeds with four intergrading classes of dotting ranging from 0 to a moderate dotting level. Seeds of the three levels that have some dots also have frequent sectors of the next lower dotting level suggesting instability of the normal id allele in this heterozygous condition. In preliminary linkage trials Id has shown a linkage to Wx with about 38% recombination. It has not shown close linkage to Dt_1.

The second culture designated the Huntsdale stock was homozygous a dt and also carried a modifier called Md, which reduces Dt_1 activity but does not completely inhibit it. The expression of Md is much less drastic than that of Id but their behavior is similar. They probably are not alleles as different plants of the progeny from a plant with both included some which expressed each of these two effects and also some that expressed their normal alleles. Linkage data are not available for Md.

A similar effect, not yet identified, has been found in the Peruvian race from which Dt_3 was extracted.

M. G. Nuffer

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1. Studies on the enzymes of corn.

Published methods of assaying catalase, cytochrome oxidase, peroxidase, phosphatase, and polyphenoloxidase activities have been adapted for use with preparations of corn tissues, and the specific activities (based on protein nitrogen content) of preparations of embryos, sprouts, and seedlings have been estimated. The variety Krug and the single cross L289 x 1205 have been used in these studies. Excised embryos from ungerminated kernels which had been incubated for a few hours between wet paper towels were used in making the embryo preparations. Sprout preparations were made from sprouts of kernels incubated between wet paper towels for various times at 75°F. in the dark; and seedling preparations were made from the above-ground parts of seedlings grown in the greenhouse. The data presented in table 1 represent results obtained in typical experiments.

Table 1. Comparisons of specific activities of five enzymes in corn preparations. (7-day sprouts taken as 100 in each case)

Specific Activity	Preparations of: Embryos	Sprouts: 3- day	Sprouts: 7-day	Seedlings: 14 day
Catalase	55	60	100	15
Cytochrome oxidase	30	65	100	25
Peroxidase	1	10	100	35
Polyphenoloxidase	less than 1	5	100	80
Phosphatase	20	35	100	35

At present comparisons are underway between preparations of untreated and irradiated corn with respect to the five enzyme activities listed.

F. A. Haskins

2. Effects of irradiating dormant maize seeds on translocation frequencies at meiosis.

Dormant seeds of a maize single cross hybrid, $L289/_{1205}$, were irradiated with various dosages of X-rays or thermal neutrons at the Brookhaven National Laboratory in the spring of 1952. The effects of the irradiations on the immediate generation were described in the 1953 Newsletter. Microsporocyte samples were taken from these same plants in order to determine the interchange (translocation) frequencies at different dosages. These results for the two planting dates are presented in table 2, along with the mature plant stand expressed as a percentage of the control. In addition to the X-ray dosages listed, treatments of 24,000 r and 32000 r units were also given, but the stands were negligible at both planting dates, indicating that the upper range of dosages was too severe. There were no mature plants for the May 15 planting date of the 16,000r X-ray treatment and of the two highest thermal neutron treatments. This was due to the dry soil crust at the time of emergence of the second planting, which killed the seedlings most severely affected by the irradiations.

In those cases where sufficient stands were obtained at the two planting dates, a comparison of the interchange frequencies for the two dates within a treatment can be made. For each of the four lowest thermal neutron treatments there was no significant difference in interchange frequency between the two planting dates, and for 4000r the difference was barely significant. On the other hand, for 16,000r and for two of the thermal neutron treatments, namely, 18.9 and 24.8 x 10^{12} N_{th}/cm^2., the differences were highly significant. The only plausible reason advanced to account for these results is that the plants having chromosomal aberrations were later in maturing than those lacking them, and that sampling at the first planting date was done over too short a period of time to include the later and more aberrant plants.

Because of the discrepancies between two planting dates it is difficult to make any comparisons between the X-ray series and the thermal neutron series. There is some indication in both series of a leveling-off in interchange frequency at the higher dosages.

Table 2. Interchange frequency at microsporogenesis in maize for different dosages of X-rays and thermal neutrons and for two planting dates.

Treatment	Planting Date	Survival (o/o of Control)	No. of plants sampled	Interchange* Frequency Total No.	Interchange* Frequency Per 100 Plants
Control	(May 3 and	100 ($^{803}/_{1000}$)	135	1	.7
X-rays	(May 15, 1952				
4,000 r	May 3	110.3	118	11	9.3
	May 15	87.7	84	16	19.0
8,000 r	May 3	96.9	133	34	25.6
	May 15	25.2	86	66	76.7
16,000 r	May 3	21.2	54	23	42.6
	May 15	No plants	--	--	----
N_{th} ($x10^{12}/cm^2$)					
5.8	May 3	102.6	75	14	18.7
	May 15	98.6	44	5	11.4
10.5	May 3	103.1	84	15	17.9
	May 15	116.1	80	14	17.5
10.7	May 3	103.1	85	12	14.1
	May 15	89.2	52	14	26.9
17.3	May 3	94.6	85	19	22.3
	May 15	96.1	67	23	34.3
18.9	May 3	109.1	107	47	43.9
	May 15	106.1	123	100	81.3
24.8	May 3	103.1	87	52	59.8
	May 15	49.3	47	52	110.6
31.4	May 3	86.2	123	86	69.9
	May 15	No plants	---	--	-----
41.7	May 3	46.3	68	52	76.5
	May 15	No plants	--	--	---

*An interchange involves two chromosomal breaks.

3. Translocations between homologous chromosomes in maize.

Among the plants described in the previous section which were examined at diakinesis for the presence of interchanges, occasional samples were observed with nine bivalents and two separate globules of chromatin, each roughly half the size of a bivalent, but sometimes differing in size. Similar globules had been observed in experiments with X-rayed dormant barley seeds by Caldecott and Smith, (Cytologia 17:224-242. 1952), who thought that they originated from translocations between opposite arms of homologous chromosomes, with the reunions involving homologous arms. These authors used the term "pseudo-ischromosome" to include two homologous arms, a centromere, and a short interstitial segment involving the opposite arm, as distinguished from a true isochromosome which has two homologous arms and is telocentric.

The frequency in the maize experiments of interchanges between homologous chromosomes for the combined X-ray and thermal neutron treatments was 18 out of 1636 samples (including the 1602 samples for the two irradiation series in table 2 and 34 samples from the X-ray treatments of 24,000r and 32,000r). The distribution of the 18 occurrences among treatments was as follows:

X-rays (r units)	
4,000	1
8,000	4
32,000	1
N_{th} ($\times 10^{12}$/cm.^{2})	
17.3	1
18.9	5
24.8	1
31.4	4
41.7	1
	18

The chromosomes involved have been identified in 11 out of the 18 samples and include chromosome 2 (two positive and two questionable identifications), chromosome 4 (one occurrence), chromosome 6 (three occurrences), chromosome 8 (two occurrences), and chromosome 10 (one occurrence). Pachytene observations indicate that in some cases the homologous arms of a pseudo-isochromosome pair regularly, with the centromere slightly subterminal, suggesting that a very short iterstitial segment involving the opposite arm is present. In the case of chromosome 10 there was variability in pairing of homologous arms, with the centromere shifting from a terminal to a subterminal position in different cells. There was no association between the two pseudo-isochromosomes at pachytene, although at later stages they were sometimes seen in close proximity. Lagging of one or both pseudo-isochromosomes was fairly common at anaphases I and II. Further cytological work is in progress.

Rosalind Morris

4. Associations of quantitative characters with the gene determining variegated pericarp.

As a part of a survey study made for the purpose of locating genes affecting quantitative characters, individual plants of a maize genetic stock homozygous for variegated pericarp (V/V)[1] were crossed with individual plants of two inbred lines, rec. L289 and N6, each of which produce colorless pericarp (W/W). The F_2 progenies were grown in replicated randomized blocks to test for associations of quantitative differences with F_2 genotypes. Individual plant measurements were made for the 10 quantitative characters shown in Table 3. Genotypic classification of F_2 plants was made on the basis of phenotypic ratios for variegated pericarp in the progenies of open-pollinated F_2 plants.

Analyses of variance of the 10 quantitative characters were made on means for genotypes within plots in the F_2 generation. In the case of six quantitative characters, days to silking, days to shedding pollen, plant height, ear height, ear weight and ear length, the analyses indicated that genotypes reacted differently in the F_2(V/V x rec. L289) cross than in the F_2(V/V x N6) cross. Where this interaction was found, separate analyses were made within the F_2(V/V x rec. L289) cross and the F_2(V/V x N6) cross. Wherever the analyses indicated a difference between genotypes, the least significant differences between genotype means were calculated and are presented in Table 3 with their respective means.

Although it may appear that an incomplete dominance type of gene action is involved in the case of days to silking, days to shedding pollen, plant height, and ear height, the differences observed may be due to interaction of different types of gene action. Similarly, it may appear that an over-dominance type of gene action is involved in the case of leaf width, stalk diameter and possibly ear weight. However, the observed differences might be explained by dominance of linked genes in the repulsion phase, or by interaction of different types of gene action.

Norman D. Williams
E. F. Frolik

Erratum. In the 1953 News Letter contribution from the University of Nebraska, Volume 28, page 71, table 2, just below the heading of the table and above the black lines there should be inserted on the left side "Corn" and on the right side "Barley".

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[1]The P alleles, P^{vv} and P^{wr}, are represented as V and W respectively.

Table 3. Mean values for 10 quantitative characters in the F_2 genotypes of crosses between a maize genetic stock homozygous for variegated pericarp (V/V) and two inbred lines, a recovered L289 (W/W) and N6(W/W), respectively.

Quantitative character	Inbred used in cross with V/V	F_2 genotype			L.S.D.	
		W/W	V/W	V/V	5%	1%
Days to silking	rec. L289	67.2	67.3	67.0		
	N6	70.5	69.0	68.1	0.86	1.23
	Mean[1]	69.7	68.6	67.8		
Days to shedding pollen	rec. L289	66.4	66.5	66.3		
	N6	70.4	69.1	68.8	0.68	0.90
	Mean	69.4	68.4	68.2		
Plant height (in.)	rec. L289	87.6	87.5	80.8		
	N6	79.1	73.7	69.5	2.83	3.75
	Mean	81.2	77.1	72.3		
Ear height (in.)	rec. L289	27.8	27.8	26.7		
	N6	27.1	25.8	23.8	1.18	1.56
	Mean	27.3	26.3	24.5		
Leaf width (mm.)	rec. L289	103.8	109.7	105.5		
	N6	88.1	91.2	89.1		
	Mean	92.0	95.8	93.2	2.15	2.84
Stalk diameter (1/32 in.)	rec. L289	32.2	32.6	32.2		
	N6	30.5	31.0	30.3		
	Mean	30.9	31.4	30.7	0.62	0.82
Ear weight (gm.)	rec. L289	156.9	166.6	146.1		
	N6	195.4	210.6	203.2		
	Mean	185.8	199.6	188.9		
Ear length (cm.)	rec. L289	19.19	19.38	19.11		
	N6	17.56	17.65	17.07		
	Mean	17.97	18.08	17.58		
Ear diameter (cm.)	rec. L289	4.16	4.11	3.99		
	N6	3.98	4.01	4.01		
	Mean	4.03	4.03	4.00		
Number of kernel rows	rec. L289	13.1	12.9	12.8		
	N6	12.9	12.6	12.7		
	Mean	12.9	12.7	12.8		

[1]Weighted mean of the rec. L289 and N6 crosses.

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1. Indigenous races of maize.

1-1) An excursion to north-western Argentina, in 1952, (with the help of Dr. Vallegas, from Buenos Ayres and the authorities of the University of Tucuman), and subsequent studies of the material collected, resolved the relations between the Andean races, which evidently migrated from North to South in the high valleys, and the lowland races. Actually three very different groups of races met in this region, without becoming mixed to any appreciable degree: The Andean races, coming down from the north of the high valleys, the lowland races, also coming from the north of the Guarani tribes and a completely new group of races, found in the Calchaqui valley and which may have been cultivated by the Indian of this name (also called Diagueta) who are known to have had a considerable level of culture.

The Andean races found were the following: There seem to be, in the region of the Quebrada de Humahuaca, two main races: Capio a dented soft corn, with strongly pointed kernels owing to the formation of a beak by the base of the stigma, fairly large and conical ears with high row numbers. The color varies greatly (yellow, white, rosado (perhaps cherry) red (pericarp) and variegated, "carapato" (mottled aleurone)). Apparently there are no very strict distinctions between these races, and they are now pure for their color, though different Indian farmers may have preference for some colors. Amarillo de ocho a yellow corn, with eight rows, which are very salient, forming in transversal sections a very pronounced cross, cylindrical ears. A fair amount of intermingling must occur, and many intermediate ears between the two races were observed. Achilli has all the characteristics of an old synthetic from Capio and Amarillo de ocho.

Chulpi is a variant of Capio, carrying a sugary factor. The ears collected contained both starchy and flint kernels. The offspring from the former, when selfed should have yielded both pure starchy ears and others with a segregation of 3 starchy: 1 sugary, but only the first were found in a total of 10 ears. The descendants of sugary kernels should only give sugary seeds, but the opposite occurred though some kernels still showed a sugary region at the tip of the kernels. It should however be remembered that we reported earlier results of crosses of Andean sweet corn, from Bolivia, with normal sugary (su su, chromosome 4). The ears of the descendants gave any proportion from nearly all sugary to nearly all starchy. It should also be mentioned, that both in the original Bolivian material and in descendants obtained in Piracicaba, the effect of the su-factor causes frequently a transparent region at the tip of the kernels. Chulpi thus contains a su-allel and many modifiers.

As far as color is concerned, Chulpi of Humahuaca is mostly of white color, though other colors may occur, just, as in Capio. Pisincho is the name for the pop corn of the valley, and its form may vary, from the irregular type of pointed pop corn, known to us from the Bolivian highlands, with a tendency to double kernels, to a slightly conical type with about 12 to 14 salient rows, somewhat similar to the Guarani pointed pop corn. The

colors may vary, but white seems more frequent. Morocho is a peculiar white flint corn with fairly large kernels, numerous rows, short cylindrical or round ears. Bola seems related to this race, being only in all character smaller. Culli is a peculiar type with black aleurone, but only a few ears were sampled. Culli, with almost black (pericarp) kernels and purple plant, used for obtaining an alcoholic drink, seems not to be a race, but a mixture of any representatives from any race giving this color combination. No sign of tunicate ears could be found, nor of any knowledge by the Indians regarding this type.

The so-called Altiplano-Type with its small, almost spherical ears, was not found with any of the farmers visited, not even at altitudes around or over 3.000 meters. One farmer, (altitude around 2.000m) had bought several sacks of maize, which contained a fair amount of ears of the altiplano type, which however he called "degenerated corn". Since we know that this altiplano type really exists, at least from Bolivia, it should be interesting to find out with more accuracy in what special localities, altitudes or exposures it is cultivated.

The Calchaqui races are all flinty. The most common type is a very hard white flint corn. There are still two other races, one yellow and the other white, with smaller kernels and ears.

The Guarani races are the same as described under (1-3) for Paraguay. It seems, however, probable that the Guarani white flint came originally from the Calchaqui, since this race is lacking among the Guaranis of Brasil and Bolivia, occurring only in Paraguay, and in Brasil to some extent as an old cultivated form ("Cristal").

In the lowlands around the Parana and LaPlata, there are now four main types or races: Cuarenton, and hard orange flint corn, with small cylindrical ears and very tightly packed kernels; this race is rather early. Amarillo a large grained yellow to orange flint, with large and generally cylindrical ears. Canario de ocho is a rather peculiar eight rowed hard flint, with large kernels of a canary-yellow color (there is no evidence of any relations to the Canary Islands, though there is some unfounded popular belief among the farmers). Pisincalla is the name, given to all pop corns, and also to the typical argentinian pop, with very small, generally red kernels, round on very small ears which may be cylindrical or almost spherical.

1-2) Uruguay (in collaboration with Dr. Gustavo Fischer and Dr. Veaceslao Gheorghianov). The main type is represented by the many forms of Amarillo. There is also some Cuarenton. But both Canario de Ocho and the race Pisancalla known from Argentina, are absent. Dr. Fischer showed me documentary evidence, proving that Amarillo was cultivated in Uruguay at least 200 years ago, another definite proof, that this orange flint corn, of the Caribean type basically, is not a rather recent introduction from Italy, as stated in some standard text books, and believed by many farmers. Evidently, Italian immigrants meeting with this old and indigenous race recognized its relation to Piemontese and other Italian types, derived after Columbus from the Caribean Races. However we have no doubt, that the orange flints of the Atlantic coast of South America to the LaPlata are very old and indigenous, though the history cannot be followed up any more, since all

coastal Indian tribes have vanished. Their pre-Colombian distribution was in all probability from the Caribean area in the North towards the South and after a time many quite distinct races were formed.

There is also evidence in Uruguay of the existence of Guarani races, such as Guarani Yellow and Pipoca (pointed pop corn).

F. G. Brieger

1-3) Paraguay (Studies of the Brazilian Seed Center) A collecting trip in 1953 showed the existence of the following races, cited in the order of their frequency; Guarani Soft corn (Avati Moroti) with large round kernels, yellow aleurone and perhaps creamy endosperm, large cylindrical ears. There are a number of color variants, especially with regard to pericarp color. White Flint corn (Avati Tupi). It should be remembered that the word "tupi" means wild, strange and even foreigner, and this strengthens our idea, that this flint corn may have been introduced, perhaps in rather remote times, from other tribes such as the Calchaqui group, as stated above. Round Pop corn (Avati pichinga) has small kernels, generally white, though color variations occur, small cylindrical ears. Pointed pop corns seem to be very rare, and only a few samples were found. White flour corn (Avati-ti) was sometimes found, but it seems only a derivative of the Guarani Yellow. A special variant from the Guarani Yellow represents also the Avati-Guapi, with the same type of kernels on short, strongly conical ears with irregular row arrangement, and plants of rather reduced size.

There are also some, evidently recent, introductions in the area: Orange Flint corn, of the type of the Brazilian Cateto, called in Paraguai "Canario", yellow and white dent corns, of north-american origin. Orange Flint, introduced during the last three years only, but occupying large areas, and known to be the variety celled ("Venezuela I").

J. T. A. Gurgel and
E. Paterniani

1-4) The Gaingang races of Southern Brazil (Studies of the Brazilian Seed Center). Since it is known, that the Gaingang Indians occupied in pre-Colombian times a very large area, from the States of Mato-Grosso, through Sao Paulo, Parana, into Sta. Catarina, however always rather distant from the Atlantic coast, it seemed interesting to make a careful survey of those remaining, still preserved in a few reservations, but probably soon becoming extinct or "assimilated". The dominant race in all reservations is the white soft dent corn, with a certain amount of variation in the denting towards a round soft corn. Guarani Yellow is sometimes grown, and also a pop corn which seems identical to the Guarani pointed Pop corn. A detailed analysis of all characters of this material is underway, of special importance since it contains the only case of predominance of typical dent corn in the South American lowlands. Dent corn seems to have existed, also as an isolated type, around the mouth of the Amazon, and it occurs in several typical races in the Andes, such as the Capio, above mentioned, which occurs in the Andean high valleys from northern Argentina to Peru, or the Cariaco from Colombia, a typical dent yellow, with very long and narrow kernels, and large cylindrical ears with very high row numbers.

E. Paterniani

1-5) General report of the Brazilian Seed Center. Under a joint agreement by the National Academy of Sciences and the University of Sao Paulo, collecting has been carried out during 1953, and the following samples were put in store: Brasil 340, Paraguay 108, Uruguay 143, Argentina 132, various 37 -- Total 760. The material is being classified according to plant, tassel, ear and kernel characters. Seed samples received are first tested for uniformity, while ear samples are stored without initial tests, at least so far.

J. T. A. Gurgel and
E. Paterniani

2. Genetical studies.

2-1) Linkage tests. Since our old stocks have unfortunately been lost, owing to some unforeseen circumstances, the material is being reorganized, both from the remaining material and from new introductions. Again the same difficulties, as before, were encountered. Many "good" genes such as golden, purple plant, virescent, etc., appeared so highly variable phenotypically, thus being of little use for linkage tests. Other new strains showed a sufficient genetic adaptability to the climate, improving after selfing or sibbing, from year to year, while others lack this ability and must be immediately backcrossed to Brazilian selected stocks. A very good sample of translocations was obtained from Dr. Brink and is being tested for usefulness here, both with and without crossing to Brazilian stock.

J. T. A. Gurgel

2-2) Distribution of color genes in South America. We found out that the use of linkage testers is of little use, owing to the complications, caused by the effect of modifying factors, mainly with regard to aleurone color. These testers have not, in general, strong enough modifier complexes, to balance the effects of the strong modifier complexes of old colorless races. Thus the following method was adopted. All old colorless indigenous races were crossed to one old indigenous colored type, Negrito from the Baranquilla area in northern Colombia, where samples were collected in 1949 both from farms and from Indians. The segregation in the F_2 ears (on F_1 plants) caused an apparent randomization of the two modifier complexes, that of the purple Negrito in favor of color and that of the colorless races in favor of colorlessness. The color of F_1 ears cannot serve as a very clear indication of genes present, owing to the lack of equilibrium of the modifier complexes in the triploid endosperm, and consequent differences between reciprocal crosses. Some ears showed a clear segregation, but segregations into groups with different ratios. The F_2 segregations in about 20 F_2 ears of some 50 crosses for purple versus colorless aleurone showed that most colorless races have one or two recessive color inhibitors. The segregations thus correspond to a 3:1 segregation or 9:7 ratio, but owing to incomplete dominance and interactions in the triploid endosperm about 32% colorless kernels instead of 25% were observed in the first case and up to 60 or 65% colorless kernels instead of 43% in the latter. The percentage may go up to 70 or even 80%, indicating that the incomplete dominance of the color factors must have changed into recessiveness. So far no clear evidence of the existence of different allels for either recessive, intermediate, or dominant inhibitors for anthocyanin were found. The segregations for colored (brown

or yellow) aleurone against colorless followed either a 3:1 or a 15:1 ratio and the same occurred for the contrast yellow/colorless endosperm. With regards to the latter contrast, it should be mentioned that some ears showed in F_2 only yellow endosperm, though one parent (Negrito) has white endosperm.

The unexpected result of these crosses was that all three color contrasts may be caused by either one or two, generally recessive inhibitors of color. In each case we must further assume, that one of each of these three factor pairs has a more general distribution, since colorless x colorless always gives colorless. Thus an interesting evolutionary problem arises, and we must explain why a second recessive mutant character can be accumulated to a rather high degree, even though it has generally no phenotypic effect; the complete inhibition of color is already caused by one of the recessives, when homozygous. We may furthermore say that the only selective advantage of the presence of two recessive inhibitors should be the fact, that in this way mutations of either one remain hidden in the populations.

Many new crosses were carried on between Negrito and colorless races from Mexico, received from Dr. Wellhausen, and with the Caingang races of our collection. The ears of F_2 will be collected in a few weeks.

F. G. Brieger

2-3) Distinction between hard flint (transparent) and floury (opaque). The material mentioned under (2-2) was used also for studying the contrasts mentioned in endosperm structure. The results so far obtained were rather confusing, since Negrito behaved rather ambigously: when crossed with pop corn, a segregation of 3 transparent to one opaque was generally obtained; when crossed with a soft dent corn we obtained either a segregation of 1 transparent to 1 opaque or of 3:1; when crossing with opaque (floury) the segregation was on the whole 1:1. It should be remembered, that Negrito is an opaque, but not very soft "flour" corn. From many other crosses between either transparent-flint races or opaque-floury races between themselves, we know that no segregations occurred or that thus no genetic differences between races of the same type are present. The segregation between groups gave (Mezzacappa unpublished) generally a 3:1 or 1:1 segregation for the contrast Transparent/opaque and exceptionally a 1:3 ratio, with further abnormalities when yellow-orange endosperm color was involved. The study of "hard floury" races should be extended and their connection with the question of the origin of the true floury races explained by future work.

F. G. Brieger and
F. Taborda

2-4) Cross-Sterility of Pop corn. This very interesting character has been studied recently in great detail by Nelson (1952). We found that cross-sterility occurs sporadically in South American pop corn races, both from Colombia (Pira) and from Brazil (Pointed Pop corn). A test is under way, and will be harvested in a few weeks, for about 20 different South American pop corn races with regards to the frequency of cross-sterility and the possible influence of the male parent of the cross. The occurrence of these cross-sterility factors in the oldest racial group, the pop corns, may become of importance for the question of origin of corn as already pointed out by Nelson. The thesis should also be remembered stated by Fisher (1941) for heterostylous plants, that any recurrent mutation altering reproduction may cause gene changes, without special selecting tendencies operating, and its

extension by Brieger (1952), that any recurrent mutation, favoring reproduction by selfing or by consanguineous matings, in an originally random mating population, should become accumulated automatically, unless counterbalanced by heterotic mutations occurring or present at the same time. Thus the occurrence of the cross-sterility genes in maize requires special attention.

J. T. A. Gurgel

2-5) Tunicate Factor. It has been shown previously, that tunicate homozygotes are both fertile as males or females in the tassel. When using the lateral ears with a full set of kernels, of selfed plants, they always proved to be heterozygous Tu/tu, but when planting only the kernels from poorly filled selfed tunicate ears, it could be shown, statistically, that some of ears came from Tu/Tu plants. The studies on a half tunicate from Colombia continue. Teosinte, in spite of its glumes completely covering the kernels, contains a normal allel of the tu-locus.

F. G. Brieger

2-6) Self-sterility in Tripsacum australis. In the three clones, derived from the original material collected by Cutler, two are definitely self-sterile, while the self-sterility is less complete in the third. It should be interesting to find out how wide self-sterility is present in other species of Tripsacum. A clone of T. laxum never did seed, while this a clone from tetraploid dactyloides produces some seeds.

J. T. A. Gurgel

3. Breeding work.

The work on sweet corn and pop corn (Mezzacappa) continues. As a breeding program for obtaining balanced synthetics the following procedure has been adopted, after a number of preliminary trials: (1) When using completely new material variety crosses with S_0 plants are made to see the extent and nature of heterosis in general. Some races were for instance eliminated since they gave in this test extreme heterosis of plant and ear height, but not of ear size or weight. (2) S_1 tests for general combining ability by top crosses with the original or another test variety. (3) Continued selfing with strong selection for the desired agricultural characters, except productivity and some ear characters until S_3. (4) Top-cross for general combining ability with S_3 and simultaneously continuation of the S_3 families by sibbing. (5) Tests for special combining ability of the selected S_3 populations.

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1. Relation Between Activator (Ac) and Modulator (Mp)

Studies have been made on the possible relationship of Ac (Activator) a hereditary element described by McClintock that controls certain types of mutable loci in maize, to Mp (Modulator) the unit postulated by Brink and Nilan as a component of the variegated pericarp allele, P^{VV}.

McClintock's Ds, at its standard position in the short arm of chromosome 9 without Ac in the nucleus, was introduced in 1952 into plants containing one or more representatives of the following P alleles: variegated; mosaic; "Q36" (a possibly new unstable type); stable colorless pericarp, red cob (P^{WR}); and stable orange. Ds also was introduced into the P^{WR} inbreds to which the above stocks were being graded by repeated backcrossing. The objective was to test whether any element at the P locus, or known to cause modifying effects on alleles at this locus, would promote Ds events similar to those which McClintock described as occurring when Ac was present with Ds. Such Ds events would be recognizable insofar as the breaks caused the loss of dominant endosperm markers on the short arm of chromosome 9 distal to Ds, resulting in the phenotypic expression of the recessive alleles. Kernels with variegations for aleurone color which appeared to be comparable to those resulting from Ds events were then selected and grown in 1953. Testcrosses were then made on an A R c sh_1 wx stock which afforded a definitive test of the ability of any of these pericarp characters to promote Ds events expressed as losses of C (or I), Sh_1, or Wx, in the short arm of chromosome 9.

From the results of the above crosses it was clear that a promoter of Ds events was present in plants with the variegated allele (P^{VV}) and in some nonvariegated segregates from variegated plants. This promoter was not present in the corresponding P^{WR} inbreds or in plants with mosaic (a highly unstable allele), Q36, or orange alleles. On testing the variegateds the expected proportions of Ds events were obtained consistent in most cases with an hypothesis that one Ac was present in the parent being tested. This held for both of the two possible dominant-recessive combinations at the C locus, C/c and I/C, and for the sh_1 and wx loci. The element promoting these Ds events also is similar to Ac in that, associated with somatic divisions, changes of dosage frequently occur. These dosage changes result in an alteration in the time and frequency with which Ds events take place, so that kernels or sectors of kernels appear with changed patterns of aleurone variegation. This promoter may be identical with or similar to Ac, or it may only contain Ac. It seems reasonable to conclude, however, that the promoter is Mp (Modulator).

P. C. Barclay

2. The Analysis of a Twin Mutation of Medium Variegated Pericarp.

Somatic mutation of medium variegated pericarp sometimes results in the formation of twin spots. One of the latter is red (self-colored) and the other is light variegated. The change of variegated to red is due to mutation of P^{VV} (variegated pericarp and cob) to P^{RR} (red pericarp and cob).

It was earlier shown (Brink and Nilan, 1952) that the light variegated component of the twin carries an unaltered $\underline{P}^{VV}$ allele but has acquired, at one or another position in the genome, an unusual kind of genetic unit (termed transposed Modulator) which sharply reduces the number of mutations of $\underline{P}^{VV}$ to $\underline{P}^{RR}$. The transposed Modulator (tr-Mp) interacting with $\underline{P}^{VV}$ allele thus gives rise to the light variegated phenotype. Brink and Nilan suggested that the variegated allele, $\underline{P}^{VV}$, was a compound structure comprising $\underline{P}^{RR}$, the stable gene for red pericarp and cob, and Modulator (Mp) a unit adventive to the locus, which suppressed the pigment-producing capacity of $\underline{P}^{RR}$. It was postulated that mutations of variegated to red result from the loss of Mp from the P locus. Twin spots were assumed to arise on medium variegated plants heterozygous for the stable colorless pericarp, red cob allele ($\underline{P}^{VV}/\underline{P}^{WR}$) in a mitotic division in which (1) $\underline{P}^{VV}$ divided to give $\underline{P}^{RR}$ and $\underline{P}^{VV}$, respectively and (2) the Modulator unit lost from the P locus in the change of $\underline{P}^{VV}$ to $\underline{P}^{RR}$ became affixed at some other site in the chromosome complement passed to the same daughter nucleus as the unchanged $\underline{P}^{VV}$ allele borne by the other daughter chromosome.

It would be expected on this hypothesis that (1) plants from the light variegated kernels of the twin spot, mated with non-variegated would produce light and medium variegated offspring as a result of segregation of transposed Modulator (2) the kernels in the red component of the twin should lack Modulator in any location and (3) medium variegated kernels surrounding a twin spot should yield no light variegated offspring except as new mutations of $\underline{P}^{VV}$ in the germ line occur.

One case of twin spotting on a $\underline{P}^{VV}/\underline{P}^{WW}$ x $\underline{P}^{WW}$ ear has now been tested, and the above three relationships were confirmed. Sixteen plants from the red component, each of which had a 50% chance of carrying transposed Modulator if the latter had been distributed at random between the two daughter nuclei resulting from the original differential mitosis, were assayed for tr-Mp. All were negative. Likewise the four medium variegateds (outside the twin spot area) tested were negative. Of two plants from the light variegated component of the twin spot, one carried transposed Modulator. The other plant was negative, a result in accordance with expectation in view of the presumed hemizygous condition of tr-Mp in the original light variegated kernels.

The test used in assaying the plants derived from the red kernels of the twin spot was definitive from transposed Modulator except if the latter occupied a position in the $\underline{P}^{RR}$ chromosome close to the P locus.

R. A. Brink

3. Reduplication of Transposed Modulator in a Variegated Pericarp Strain.

A new variegated pericarp phenotype, termed "very light", appeared in an inbred line as a mutation from light variegated. The latter previously had been shown to differ from ordinary medium variegated in possessing a unit called transposed Modulator (tr-Mp) which markedly reduces the frequency of $\underline{P}^{VV}$ to $\underline{P}^{RR}$ mutations. Very light variegated was found to carry two doses of tr-Mp at different loci. The evidence makes it probable that the second tr-Mp unit in the very light variegated phenotype originated from a reduplication (and transposition) of the single transposed Modulator present in the

light variegated parent. The formulae of the three classes of variegated pericarps mentioned above thus may be written:

$\underline{P}^{VV}$ = medium variegated

$\underline{P}^{VV}$ + 1 transposed Modulator = light variegated

$\underline{P}^{VV}$ + 2 transposed Modulators = very light variegated.

Determination of the number of changes of variegated to red of three size classes, namely, one kernel, one-half kernel, and one-quarter kernel, show that increasing doses of transposed Modulator reduce the frequency of $\underline{P}^{VV}$ to $\underline{P}^{RR}$ mutations exponentially. A single dose of tr-Mp (light variegated) as compared with the absence of tr-Mp (medium variegated) reduced the frequency of $\underline{P}^{VV}$ to $\underline{P}^{RR}$ mutations 59.7%. The corresponding value for two doses of tr-Mp (very light variegated) as compared with one dose, was a reduction of 86.8%. The extremely frequent, late-occurring mutations giving rise to very small ill-defined stripes and diffuse pigmentation characteristic of medium variegated, can not be detected in the light and very light variegated phenotypes.

R. A. Brink

4. Effect of the Variegated Pericarp Allele ($\underline{P}^{VV}$) on Pr and Wx Losses in Endosperm Tissue.

Pollen of two near-isogenic Pr Pr stocks, one heterozygous for medium variegated pericarp and colorless pericarp, red cob ($\underline{P}^{VV}/\underline{P}^{WR}$) and the other homozygous $\underline{P}^{WR}$ was placed on the silks of an inbred $\underline{ACRprP}^{WR}$ line. The resulting kernels were scored for pr sectors under a low-power binocular microscope. A similar test was made for waxy sectors following the application of comparable lots of Wx $\underline{P}^{VV}/\underline{P}^{WR}$ and Wx $\underline{P}^{WR}/\underline{P}^{WR}$ pollen to wx $\underline{P}^{WW}$ plants. The results obtained are summarized in tables 1 and 2.

The frequency of sectoring for pr was more than three times as high following the use of pollen from $\underline{P}^{VV}/\underline{P}^{WR}$ plants as after the control $\underline{P}^{WR}/\underline{P}^{WR}$ matings. The difference is highly significant.

Only a few kernels have been scored for waxy sectors, but again the use of Wx pollen from plants carrying the $\underline{P}^{VV}$ allele results in more losses of the Wx phenotype than in the control $\underline{P}^{WR}$ matings. It is interesting to note, however, the frequency of sectoring in the controls also is high, namely, about one sector per two kernels on the average. The technique used in scoring probably disclosed all but the very small mutant sectors throughout the endosperm.

Table 1. Effect of $\underline{P^{VV}}$ on the frequency of Pr to pr changes in the endosperm tissue following pollination of ACR pr plants with near-isogenic $\underline{P^{VV}}/\underline{P^{WR}}$ Pr/Pr and $\underline{P^{WR}}/\underline{P^{WR}}$ Pr/Pr individuals.

Med. var. ♂ plants (P^{VV})	No. kernels with pr-sectors per 1000 kernels	Total kernels counted	Control ♂ plants (P^{WR})	No. kernels with pr-sectors per 1000 kernels	Total kernels counted
F220 (16)	58.75	5,634	F225 (1)	22.11	6,286
F220 (22)	114.01	2,263	F225 (2)	19.84	6,554
F220 (32)	120.52	2,987	F225 (4)	37.64	5,871
F220 (38)	145.27	3,263	F225 (18)	49.58	6,232
Sum	--	14,147		--	24,943
Mean	109.64			32.29	
s	34.98			13.98	

difference of the two means = 77.35**

Table 2. The frequency of Wx to wx changes in the endosperm tissue following pollination of waxy plants with near-isogenic $\underline{P^{VV}}/\underline{P^{WR}}$ Wx/Wx and $\underline{P^{WR}}/\underline{P^{WR}}$ Wx/Wx individuals.

Med. var. ♂ plants (P^{VV})	Total kernels counted	% kernels with waxy sectors	Total waxy sectors	Control ♂ plants (P^{WR})	Total kernels counted	% kernels with waxy sectors	Total waxy sectors
F219 (7)	100	61	172	F227 (10)	100	29	38
F219 (8)	100	59	155	F227 (11)	100	28	32
F219 (21)	100	63	161	F227 (23)	100	54	89
Total	300	183	488		300	111	159

Cheng-Mei Fradkin

5. Mutagenic Effect of Mustard Gas on Yield in Inbred Lines.

The effect of nitrogen mustard gas [methyl-bis (β-chlorethyl) amine] on the yield of two unrelated inbred lines of yellow dent corn, W22 and W23, was studied. Two groups of sublines from W22, descendants from separate ears, and one group from a single ear of inbred W23 were used. Freshly collected pollen was exposed to near-lethal doses of the gas vapors for three successive generations, using the procedures described by Gibson, Brink and Stahmann (1950).

Yield comparisons of two kinds were made: (1) treated selfs were compared with the corresponding untreated selfs and (2) hybrids between the treated and the corresponding untreated selfs, were compared with the respective sibbed untreated inbreds; in addition W23 was also compared with the selfed control.

Treated selfs vs. Untreated selfs

Sixteen sublines of each of the three groups were tested against four sublines of the corresponding control in a split-split plot design experiment, replicated six times. The results are as follows: Inbred W22: The first group yielded 103.1% of the control, with eleven sublines exceeding the control, but only five of the differences were significant. In the second group, all the sublines yielded less, but only eleven were significantly less, and the average of the group was 90.6% of the control. Inbred W23: The average yield for the group was 102.8% of the control. Thirteen sublines yielded higher than the control, two of the differences were significant.

Treated x untreated vs. Untreated controls

Inbred W22: Sublines, previously screened for fertility, of each group were put in two randomized complete block design experiments, in comparison with the sibbed control. The first group yielded 96.1% of the control and only two of the twenty-eight sublines tested yielded slightly more, but not significantly more, than the control. The twelve sublines of the second group average 67.1% of the control. All the differences were highly significant. Inbred W23: Two yield trials were conducted, one comparing the sublines against the selfed control in a split plot design trial. The average yield was 102.8% with twelve out of the sixteen sublines yielding more than the control. Three of these differences were statistically significant. The second yield trial compared the sublines against their sibbed control in a randomized complete block design experiment. The mean yield was 101.7% of the control. Twenty-three from the thirty-two sublines tested yielded more than the control, but only three were significantly higher.

There were no conspicuous morphological differences between the treated groups and the untreated inbreds from which they were derived. But in regard to yield, it would seem possible to conclude that inbred W22 behaved differently, and was more susceptible to the gas damage and less stable than inbred W23. Moreover, the data indicate that, at least with inbred W23, favorable yield mutations were induced by the nitrogen mustard gas. There is no clear-cut evidence whether genes showing dominance or over dominance, or both, are responsible for the increased yields.

E. S. Kassem

6. Effect of Plant Vigor on Variegation of Pericarp.

It is of interest to know in what ways a mutable system such as variegated pericarp (P^{VV}) is subject to environmental influences. The effect of marked differences in plant vigor induced in two distinct ways was measured. In one experiment F_1 hybrids were compared with the respective inbreds under favorable conditions for plant growth. In the second experiment a comparison was made between F_1 hybrids (a) severely dwarfed by crowding and (b) well grown.

A variegated allele of a particular origin was incorporated into four near-homozygous inbred yellow dent lines. The six possible hybrids between these four inbred lines were then made and grown in comparison with the four

inbreds on fertile soil with normal spacing. Theoretically these two groups of material have the same frequencies for all their genes, the only distinction being a much higher proportion of heterozygous loci in the hybrid group. Any difference in the variegated phenotype of these two groups can therefore be ascribed to the direct effect of hybrid vigor or nonadditive action of modifier genes.

Variegated ears were scored for frequency of mutations to red within various stages in the development of the ear. The most useful stages were found to be those represented by mutant areas covering 1/4 to 1/2, 1/2 to 1, and 1 to 2 kernels, after allowing for the lack of symmetry in the development of the kernel as far as possible. Earlier and later stages did not give additional information. The effect of transposed Modulator (an element which markedly reduces mutations to self color) was eliminated by excluding all light variegated ears from the scored material. The results, expressed in mutations per thousand kernels and based on about 110,000 kernels in total, are given in table 1. With the exception of the two values marked with an asterisk there is no difference between values for hybrids and their component inbreds which can not be explained by partial to complete dominance of modifiers. Hybrid vigor, as such, appears usually to be without significant effect.

An additional comparison was made in which the effect of nonadditive action of genetic modifiers was excluded. Remnant seed from the variegated hybrids was planted very densely in poor soil, and the minimum amount of thinning was done. The resulting ears were reduced in weight about two to three fold, even below the level of normally grown inbreds. The values obtained (based on a total of about 100,000 kernels) after scoring in the usual way, are given in table 1 in the columns headed "stunted". With the exception of hybrid 8 x M14C the stunted material shows a distinctly lower mutation rate, on the average, 0.54 of the normally grown hybrids. Therefore, lack of vigor thus induced does have a conspicuous depressing effect on the mutability of the variegated pericarp allele.

Table 1. Mutations per thousand kernels for different strains at three successive developmental stages.

Strain	Developmental stages represented by mutations covering ¼ - ½ kernel		½ - kernel		1 - 2 kernels	
	Normal size	Stunted	Normal size	Stunted	Normal size	Stunted
F_1, 8 x 22R	32.5*	12.4	10.7	5.0	2.5	1.5
F_1, 8 x 23	39.9	20.5	17.5	9.6	5.4	2.1
F_1, 8 x M14C	28.8	20.5	8.5	6.2	1.5*	1.6
F_1, 22R x 23	34.1	17.7	14.5	5.4	5.6	1.5
F_1, 22R x M14C	25.6	14.5	9.2	5.8	3.0	0.9
F_1, 23 x M14C	30.3	16.5	13.8	9.4	5.7	3.1
Inbred 8	25.7		9.6		3.5	
Inbred 22R	15.8		6.4		2.1	
Inbred 23	38.3		20.6		10.7	
Inbred M14C	24.4		9.2		3.0	

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Experiments in previous years have indicated that inbred lines resistant to the leaf blight caused by Helminthosporium turcicum differ greatly in value as breeding sources of resistance to this disease. The resistance of Mo21A has been transferred readily to other lines although Mo21A does not itself have as high a rating for resistance as many other lines tested. Other resistant lines (for example T528) have been very disappointing as breeding sources of resistance.

In a continued search for better sources of resistance a number of resistant lines were crossed with the highly susceptible lines R_4 and Tr. F_2 populations of several of these crosses were grown in 1953 and the plants were inoculated with H. turcicum and classified for blight. The blight data on these progenies are reported in the following table.

Table 1. Frequency distributions of leaf-blight ratings on F_2 plants from crosses of resistant and susceptible inbred lines.

Cross	Percentages of plants with the grades indicated										
	0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
K175 x R4		15	19	15	15	24	8	3	1		
H547 x R4	3	7	10	10	10	14	18	19	6	1	2
H548 x R4	4	15	22	19	16	13	7	2	2		
H875 x R4		7	4	13	16	20	21	10	1	1	7
H898 x R4		16	19	12	11	15	12	5	4	3	3
Pd2287-2 x R4	14	21	33	7	14	7	3	1			
B3510 x R4	7	19	33	14	14	7	2	3			1
Wh4971 x R4	29	30	27	9	4	1					
GT169a x R4		1	12	14	21	18	20	4	3	1	6
WHF3-431 x R4	1	6	19	11	15	10	11	8	10	3	6
K175 x Tr		4	24	19	22	16	12	3			
H547 x Tr		4	21	16	20	11	22	4	2		
H548 x Tr		7	28	21	17	11	11	3	1		1
H875 x Tr		8	22	20	23	16	9	1	1		
H898 x Tr	4	12	24	18	14	9	8	6	2	1	2
B3510 x Tr	22	30	30	11	6	1					

In progenies from the crosses with R_4 the plants falling in the two most resistant classes (0 and 0.5) ranged from a low of one per cent to a high of 59 per cent. Lines Pd2287-2, B3510 and Wh4971 seem to be rather promising sources of resistance. B3510 also is the most promising of the lines crossed with Tr.

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Cooperative Program for Corn Investigations
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1. Maize Germplasm Collection.

An extensive collection program has been carried out for the past two years cooperating with the Rockefeller Foundation Agricultural Program in Colombia, in trying to sample as thoroughly as possible the different corn producing areas of Peru.

From this collection program a number of approximately 900 corn samples have been obtained, covering approximately 3/5 of the various corn areas of the country. These samples are in storage at the Andean region seed center in Medellin, Colombia, while a duplicate sample is being kept under refrigeration at the local maize germplasm bank at the National College of Agriculture, La Molina, Lima, Peru.

The collections are being, at the present time, subjected to evaluation under conditions similar to those of their original habitats. A test of high altitude corns for agronomic and general biometric characteristics, is under way at the Agricultural Experiment Station of the Central Highland Region of Peru, at 3,300 meters above sea level, which is probably the highest region in the world where corn is cultivated on a large scale. Another evaluation test with lowland materials is being conducted at LaMolina.

Classification of data on the collections, both qualitative and quantitative, is being started with the use of punch card systems.

2. Stalk Glucose Content and Incidence of Insect Attack.

Differential attack of the shoot and leaf worm Laphygma frugiperda on several propagation plots of improved varieties and hybrids, lead to a test of whether there was any association between stalk sugar content, expressed only as glucose, and incidence of attack.

Two composite samples made up by picking several plants at random within each variety, were analyzed for glucose, and the results expressed in percentage on the basis of dry weight. These are shown below:

Variety	Percentage of glucose		Score for insect attack
Hybrid LM N° 2	(1)	2.60	4 (highest attack)
	(2)	3.25	4
Harland SNA Synthetic	(1)	4.20	1 (lowest attack)
	(2)	3.60	1
Seleccion Limoncarro	(1)	1.46	1
	(2)	4.07	1

There was apparently no association between stalk glucose content and incidence of insect attack. It was observed, rather, a higher visual association between height of plants and incidence of attack, in which the lower

plants suffered a higher insect attack.

Alexander Grobman

3. Effect of Carbon/Nitrogen Ratios on the Expression of Cytoplasmic male sterility.

An experiment was set up in order to ascertain whether varying carbon/nitrogen ratios in the corn plant, induced by controlling factors of the soil environment, would affect the expression of cytoplasmic male sterility.

The F_1 of a cross of the Texas male sterile single cross 203MS x 61M with the local mass selected open pollinated variety Amarillo LM, was used as experimental material. Replicated field plots on which four nitrogen and three irrigation levels were applied, served to yield data on percentage of plants shedding pollen per plot, and also on percentage of tassel ramifications shedding pollen per plant. It was assumed that the frequency of fertility restoring genes contributed by the variety to the F_1 under test would be evenly distributed among the different plots, so that any environmental influence on fertility restoration would be detected by any significant deviation from the mean of pollen shedding plants per plot.

Even though a complete statistical analysis on the data is not available as yet, first examinations indicate a larger frequency of pollen shedding plants in the high carbon/nitrogen ratio plots.

Alexander Grobman and
Jorge Pretell

4. Study on single, double, and triple pollinations in relation to silk receptiveness.

Self and cross pollinations were effected on plants from two open pollinated varieties, divided into twenty groups, according to time of silk emergence, from the first to the twentieth day after silk emergence, following three different patterns: (a) one single self pollination on each of four to five plants per group; (b) one pollination the day after silk emergence, and a second pollination on each of the twenty day-after-emergence groups, also on four to five different plants per group; (c) triple pollination pattern, made up by making a first pollen application the day after silk emergence, a second pollen application the next day, and a third application on each of twenty day-after-emergence groups of 4-5 plants each. The data were expressed as angular transformation values of percentage of grain set on each pollinated ear.

For each of the three pollination patterns it was observed that maximum silk receptiveness occurred when the last pollination was made before the 8th day after silk emergence. After this date there was a progressive decrease in percentage seed setting, as the silks became older. With triple pollinations, however, the decrease in seed setting with increased silk age at pollination time, was not so sharp as with the other two patterns. In general, for any day-after-emergence group, the percentage of grain set was larger for the triple pollinations than for the double ones, and in turn, in these it was

larger than for the single pollinations. The mean pollination pattern angular values over all groups were 51.18, 48.17, and 44.08, for the triple, double, and single pollinations, respectively.

The highest grain settings were obtained with double pollinations, where the first one was made the day after silk emergence, and the second pollination three days after the first, and also with triple pollinations where the third pollen application was made 10 days after the second application. The analysis of variance did not disclose significance of differences among either dates within patterns of pollination or among "date classes", whether made up by pooling either three or four consecutive day-after-emergence groups.

Alexander Grobman and
Antonio Manrique

5. Relation between air temperature, relative humidity, and grain setting.

Self and cross pollinations were made at random on 17 open pollinated varieties and hybrids in two different seasons: in the spring time when the mean daily air temperature over a 15 day pollination range was 15.6°C, and in early summer when the mean air temperature over a 12-day pollination period was 21.5°C. In the summer series, further, there were two types of pollination: one using tassel paper bags, and another with the bottle method of pollination. The mean relative humidities for both seasons were 87.1%, and 77.6%. The variation in temperature was not larger than two degrees at either side of the mean in both seasons. The variation in humidity was of 5% at either side of the mean in both seasons. The number of ears studied for percentage of grain setting, attention being paid to silk age when pollinated, was of over 300 for the spring series, and 130 for the summer series.

Linear correlation coefficients were calculated between the variables mean air temperature, relative humidity and percentage of grain set on the ear for both seasons, with values shown below:

	Spring (15.6°C)	Summer (21.5°C)	
Correlation between:		Tassel bags	Bottles
Temperature and grain set	0.175	-0.717	-0.882
Humidity and grain set	0.335	0.069	0.079

While the air temperature was below 18°C, there was a low but positive correlation between air temperature and grain setting. As the air temperature went above 18°C, a highly significant negative association between air temperature and grain setting became established. No effect of relative humidity, at the values prevailing at the time of the study, on grain setting was apparent.

Alexander Grobman and
Antonio Manrique

6. Chromosome-knob numbers of Peruvian coastal maize.

A survey of chromosome-knob numbers has been started on local material. It has been suspected that most coastal flint varieties are rather recent introductions from Colombia and the Caribbean area. An analysis of chromosome knob numbers of such material, as compared to the highland or typical Andean maize varieties should provide a definite clue to this problem.

Counts are being made on one to three tassels of the original varieties, propagated at La Molina, kept in acetic acid-alcohol, using four check cells per anther at zygotene-pachytene. The first twenty varieties which were examined are distributed as follows:

Chromosome-knob numbers	0-3	1-4	2-5	3-6	5-8	7-8
Number of varieties	3	11	3	1	1	1

Alexander Grobman and
Ulises Moreno

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