would be expected if the Gl locus were included in the inversion because it would then be placed relatively closer to the A locus. The A locus is distal to point .75 and proximal to .95 in the long arm.

Paracentric inversion In 3c has breakpoints very near the centromere and the tip of the long arm--i.e., the inverted segment includes nearly all of the long arm. The frequencies of PMC's with two bridges and two fragments (arising from 4-strand doubles) in the In 3a, In 3b, and In 3c heterozygotes are as follows:

In 3a = 1.2%
In 3b = 1.0%
In 3c = 8.5%

The much higher percentage of 4-strand doubles in In 3c heterozygotes indicates that double crossovers arising from 2- and 3-strand doubles should be relatively frequent. The following data from a small test-cross show that this is so. The Gl, Lg and A loci appear to be included within the inverted section. Linkage data from homozygous inversion plants which are heterozygous for the Gl Lg A loci will be decisive in determining if these loci all are in the inverted segment.

In A Lg Gl / N gl lg a X gl lg a  Σ = 526

| (0) | (0) | (1-2) | (1-2) | (1-3) | (1-3) | (1-4) | (1-4) | (2-3) | (2-3) | (2-4) | (2-4) | (3-4) | (3-4) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| In | N | In | N | N | In | N | In | In | N | In | N | In | N |
| Gl | gl | Gl | gl | gl | Gl | Gl | gl | Gl | gl | gl | Gl | gl | Gl |
| Lg | lg | Lg | lg | Lg | lg | Lg | lg | lg | Lg | lg | Lg | Lg | lg |
| A | a | a | A | A | a | A | a | A | a | A | a | A | a |
| 268 | 200 | 3 | 11 | 1 | 3 | 1 | 4 | 14 | 11 | 8 | 0 | 2 | 0 |

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3. Linkage studies with chromosome 3.

Two backcrosses were made of $F_1$'s segregating for $lg_2$ $na_1$ $a_1$. $F_1$ plants of family 24575 had knobless chromosomes 3 while $F_1$ plants of family 23529 were heterozygous for a large knob at 3L .6. The two families are not closely related; one of the parents of 24575 was inbred KYS which is not present in the 23529 material. The backcross data are presented below. The order of the genes is lg-na-a. Previous studies with heterozygous knobs have shown that crossing over is reduced in regions near the knob. The finding of a higher Lg-Na value and a lower Na-A value in K3/k3 plants might be taken to indicate that the knob is distal to na. However, comparisons of the two sets of data are not valid because of the different genetic backgrounds.

| Constitution of backcrossed families | Lg Na A | Lg Na a | Lg na A | Lg na a | lg Na A | lg Na a | lg na A | lg na a | Σ | % Lg-Na | % Na-A |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 24575 Lg Na A / lg na a k / k | 333 (0) | 163 (2) | 2 (1-2) | 6 (1) | 9 (1) | 0 (1-2) | 145 (2) | 278 (0) | 936 | 1.8 | 33.1 |
| 23529 Lg na a - k / lg Na A - K | 43 (1) | 17 (1-2) | 436 (2) | 1061 (0) | 1240 (0) | 486 (2) | 11 (1-2) | 31 (1) | 3325 | 3.1 | 28.6 |

Since the knob was thought to be close to Lg, sporocytes were collected from crossovers between Lg and Na (in the progeny of the 23529 backcross) and the chromosomes examined for presence or absence of the knob. Twelve Lg Na A plants had the knob as did four Lg Na a plants. One Lg Na a plant was knobless. Two lg na a plants and one lg na A plant had knobless chromosomes 3. The knob is closer to Na than to Lg; it cannot be proximal to Lg, but it is uncertain whether it is proximal or distal to Na.

Studies on the effect of knobs on crossing over have been extended to include plants homozygous for a large knob at position 3L .6. As reported earlier (MNL No. 31, 1957) recombination in the Lg-A region, which includes the knob, is significantly less in plants heterozygous for the knob than in plants which have homozygous knobless chromosomes 3, but the recombination values in plants with two knobbed chromosomes 3 remained to be determined. The following data were obtained from three classes of sib plants all of which, however, are heterozygous for abnormal 10.

K10 k10 Lg K A/ lg K a -- 42.7% recomb. Lg-A Σ = 2129

K10 k10 Lg K A/ lg k a -- 30.5% " " Σ = 3003

K10 k10 Lg k A/ lg k a -- 34.1% " " Σ = 973

These data exhibit, although to a lesser degree, the previously reported reduction in heterozygous knobbed plants as compared to knobless plants, but the somewhat unexpected feature is the high crossover value found in homozygous knobbed plants. One can only speculate about the cause of this increase. It is true that a knobbed chromosome is longer, by the length of the knob, than is a knobless chromosome, but for this to have significance would seemingly require that crossovers occur in the heterochromatin comprising the knob. Perhaps a more likely hypothesis is that the fusion of knobs known to occur during interphase leads to earlier and possibly more intimate pairing in meiosis of the homologous regions flanking the knob and hence to an increase in crossing over.

Data presented in the 1957 News Letter suggested that the linear order, proceeding from the centromere, was Rg $Gl_6$ $Lg_2$ $A_1$, but the 4-point backcross population consisted of only 341 individuals. That this order is indeed correct is shown by the following test-cross data:

$\frac{Rg\ gl\ lg\ a}{rg\ +\ +\ +}$ X rg gl lg a $\Sigma$ = 1165

| (0) | (0) | (1) | (1) | (2) | (2) | (3) | (3) | (1-3) | (1-3) | (2-3) | (2-3) | (1-2-3) | (1-2-3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rg | rg | Rg | rg | Rg | rg | Rg | rg | Rg | rg | Rg | rg | Rg | rg |
| gl | + | + | gl | gl | + | gl | + | + | gl | gl | + | + | gl |
| lg | + | + | lg | + | lg | lg | + | + | lg | + | lg | lg | + |
| a | + | + | a | + | a | + | a | a | + | a | + | + | a |
| 256 | 270 | 4 | 7 | 89 | 97 | 196 | 162 | 2 | 4 | 38 | 39 | 1 | 0 |

Rg-gl = 18 ÷ 1165 = 1.5%
gl-lg = 264 ÷ 1165 = 22.7%
lg-a = 442 ÷ 1165 = 37.9%

Order is Rg gl lg a.

These data together with those from the lg-na-a backcross and from linkage data previously reported give the following linear order of genes in the long arm of chromosome 3, which is one of the best-marked arms of the maize chromosomes.

$$Rg\ \ gl_6\ \ ts_4\ \ lg_2\ \ na_1\ \ a_1\ \ sh_2\ \ et\ \ ga_7$$

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## 4. Tassels with 4N sectors.

In the course of pollen examination in a backcross population segregating for a translocation, it was noted that many tassels were sectored for two types of anthers. One type had small grains of the usual size and the other had larger grains. In plants expected to be heterozygous for the translocation, the first type of anther showed 50% abortion but the second type had mostly normal grains. Three plants were used as males in crosses to a 4N pr stock. Two of these carried the translocation and the other had normal chromosomes. The resulting ears had many plump seeds as well as some shrivelled seed. One ear had all Pr seed while the others were segregating Pr and pr. Ratios of 62 Pr: 15 pr and 91 Pr: 24 pr indicate the pr allele was in duplex as would be expected if doubling had occurred in a Pr/pr plant. Apparently the tassels contained tetraploid sectors. No such sectors were found in related material the previous year. The population in question was located downhill from an experiment involving treatment of seeds with various chemical mutagens. It is possible that washing of these chemicals affected the developing tassels and caused somatic doubling.

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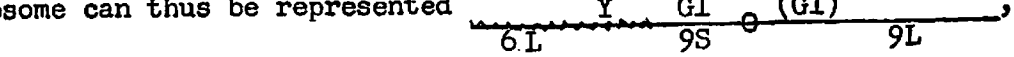
## 5. Linkage of $Gl_{15}$ and $Y_1$ in homozygous T6-9b.

A population of 1070 plants from a backcross of y T Gl wx c / Y T gl Wx C was found to give 34.3% recombination for C-Wx, 7.3% Y-Gl recombination and independence of Wx-Y and Wx-Gl. The 9 chromosome can thus be represented 

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