3. Segregation of pollen restoring genes in inbreds used as pollen parents and seed parents.

When the inbreds NC77, Tx127 and Ky21 used as restorers on T cytoplasm are studied separately it is found that they segregate differently in $F_2$ selfed progenies. All of these inbreds used alone or in single cross combinations produced all normally fertile plants in the $F_1$ generation grown in 1954, 1955 and 1956 in combination with WF9T, 38-11T, C106T, KysT, K4T, CI7T; not all combinations were grown in each of the three years. These $F_1$ fertile plants were selfed and the $F_2$ segregating progenies were grown in 1955 and 1956 and the results combined.

Of the three restoring inbreds used as pollen parents Tx127 segregated in a 9:7 ratio, Ky21 and NC77 segregated in 3:1 ratios. The differences between observed and calculated are not significant. Of the inbreds used as seed parents with these pollinators WF9T and 38-11T segregated in a 9:7 ratio, while C106T, KysT and K4T segregated 3:1. Again the differences between observed and calculated are not significant. However, in view of the wide differences in the two different years and in different progenies the results are only indicative of differences in the number of restoring genes involved in the crosses of the different inbreds used.

4. Segregation of fertile and sterile plants in backcrossed progenies of different inbreds.

That different numbers of genes are involved in the restoration of different sterile inbreds is also borne out by the behavior of backcrossed lines in the process of conversion to complete restoration. Many of the standard corn belt inbreds widely used in the northeastern and northcentral corn growing regions are in process of conversion by taking the S or T cytoplasmic sterile versions of these inbreds, crossing them as females by several different restoring inbreds followed by backcrossing the restored fertile plants repeatedly on the sterile inbreds. These inbreds have been backcrossed from two to six generations and then self pollinated for one or two additional generations. The segregation of fertile and sterile plants is quite different in many inbreds. A few illustrations are given here.

A158 is completely sterile in both S and T types of cytoplasm and in five additional sources. No anthers shedding pollen appeared on any plants in 10 backcrossed generations in the S cytoplasm and 5 generations in the T cytoplasm. Both the S and T steriles are completely restored by Ky21. Anthers appear and pollen is shed in normal amount about 5 days before the first silks appear in the original, fertile inbred, and this same pattern is shown by the restored fertiles. The backcrossed S steriles in 5 generations of backcrossing and 1 generation selfed usually produced no sterile plants. Small progenies of 15 to 20 plants were grown each generation but several progenies were grown each year.

The fact that few sterile plants appeared indicates that there are a large number of genes any one of which alone can restore pollen production to the S type of sterile cytoplasm.

The backcrosses on the T type of sterile cytoplasm have segregated approximately 1:1 sterile and fertile in each backcrossed generation, and 3:1 in each selfed generation although the total numbers are small.

The inbreds C103 and Kr (187-2) also give clear cut segregation, 1:1 in backcrossed, and 3:1 in selfed progenies having T sterile cytoplasm. They have not been tested with the S type. A fairly large number of progenies have been grown. The Kr inbred has been selfed twice after backcrossing 4 and 5 generations, and a number of progenies in $F_3$ give all fertile plants as expected.

The behavior of WF9 and Hy inbreds is quite different. WF9 is completely sterilized by both S and T cytoplasms, also by four other sources. Five additional sources have given a few partially fertile plants in the first or second generations of backcrossing.

WF9T and S sterile plants are completely restored by Tx127, Ky21, and WF9T by I153 and many other lines. These restored T steriles have been backcrossed on WF9T sterile for 1 to 3 generations and have all segregated into fully fertile or completely sterile plants. In 22 progenies grown in 1956 there are 382 fertile and 933 sterile plants. This is a significant departure from a 1:1 ratio being a 1:2.4 ratio. This indicates that WF9T sterile requires more than one restorer gene to produce pollen and these genes must all be present to be effective.

One selfed progeny of (WF9T x Ky21) grown in 1955 gave 58 fertile and 36 sterile plants which is fairly close to a 9:7 ratio, and two back-crossed progenies gave 39 fertile and 120 sterile plants, a very close 1:3 gametic ratio, again indicating two dominant complementary genes for fertility. The $F_2$ generation of crosses with Tx127 and Oh41 gave fewer fertile plants, indicating more than two genes involved or less potency in the dry year of 1955.

In contrast to the results with WF9 is the behavior of Hy. Five slightly different lines have been sterilized by T cytoplasm and restored to full fertility. Hy has been a difficult line to sterilize and to restore. After 5 generations of backcrossing both S and T sterile lines produce some partially fertile plants. When restored by Ky21 and C236 (an inbred out of the same Chester Leaming variety from which Hy was derived) the backcrossed lines give 108 fertile to 39 sterile plants, which is close to a 3:1 gametic ratio. These same backcrossed lines self-fertilized give 109 fertile and 7 sterile plants, which is remarkably close to a 15:1 $F_2$ ratio. Both results indicate two genes of which either one alone or both together can restore fertility. WF9 therefore seems to be recessive for at least two complementary genes and Hy recessive for at least two duplicate genes for pollen restoration, and the dominant alleles of all these genes are present in the restorers used.