It has been shown that I153 and W22 can also be used to differentiate S and T cytoplasm. When I153 was crossed on to five other sources of cytoplasmic sterility, differing from the S and T sources, but all converted by backcrossing to the same inbred genotype, all of the progenies were either completely sterile or showed only a few anthers with little or no normal pollen. When crossed by W22 more pollen was produced but none were completely restored. This would indicate that none of these new sources of sterile cytoplasm are the T type. Some of them may be of the S type but the evidence is not conclusive. These five sources and several additional new sources are being put into the same genotypes by backcrossing and will be tested further.

2. Inhibitors of pollen restoring genes.

Previously all crosses of I153 and related lines (W153R, A344, A293) on T sterile inbreds have given completely normal pollen production on all plants in the $F_1$ hybrids. Last year a few combinations on HyT and W22T were either completely sterile or segregated into fertile and sterile plants. Pollen from the same I153 line on other T sterile lines produced all normally fertile plants. This is an indication that there may be pollen inhibitors that operate only in T sterile cytoplasm but not in normal cytoplasm to prevent the action of T restoring genes. This may account for some of the variable results with pollen restoring inbreds.

3. Universal seed parents.

These inhibitors of pollen restoration may also make possible sterile seed parents that can be used with non-restoring pollinators to give adequate pollen production in the final hybrids. This will be brought about by the normal segregation of restoring genes and inhibitors brought in solely from the seed parent. Such sterile universal seed parents could be produced and maintained with little more difficulty than present sterile seed parents and would be available for use with any pollinator, not carrying inhibitors, without incorporating pollen restoring genes.

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4. Non-segregation in restoration of cytoplasmic male sterility.

A number of cases have been found where cytoplasmic male sterile (S type) plants crossed by plants carrying sterile cytoplasm and heterozygous for fertility restoring genes have given all-fertile progenies (S x SF → all SF). (The nomenclature is that proposed by the Northeastern Corn Conference /Maize News Letter 31: 2_/). All of

the cases which shall be discussed here have occurred in pedigrees which received the fertility restorer genes in 1949 from a line of Ky21.

Most of the progenies consisted of 12 to 18 plants; however, as few as five and as many as eighty plants were observed in other progenies.

Pedigrees with M14 as the residual genotype: M14S4 (4 backcrosses with M14 after the first cross on to S) when pollinated by a hybrid of Ky21 and M14 gave rise to plants all of which were fertile. Since M14 will not restore S, the restorer(s) from Ky21 should have been segregating, and the progeny composed of both steriles and fertiles. Plants from this non-segregating progeny were crossed with M14S4 and M14S5. Both of these crosses yielded non-segregating progenies. This backcrossing was continued for 4 more generations; the last cross was M14S9 x M14SF5 (5 backcrosses after being restored to fertility) yielding M14SF6. A total of ten crosses of the type M14S x M14SF have been made; each gave rise to only fertile plants.

When these restored steriles were used as females in crosses with the inbred (M14) segregation resulted. Two such crosses were made; in each case an equal number of steriles and fertiles were produced.

Selfing plants heterozygous for the restorers presents a similar picture to that of a cross of the type S x SF. Four such selfs have been made. They were made in different years and with different progenies. Three of these produced only fertile plants; the fourth produced a progeny in which half the plants were sterile and half were only slightly fertile.

Pedigrees with A158 or P39 as the residual genotype: A158S4 was pollinated by (Ky21 x A158); this gave rise to seven fertile and five sterile plants. When one of these fertiles was put on A158S5 all the resulting plants were fertile. Plants from this non-segregating progeny were then crossed on to A158S6 and P39S6; both of these produced fertile non-segregating progenies. In each of these cases backcrossing to the respective steriles was continued for several generations. Many crosses of the types S x SF, SF selfed, and SF x inbred were made. The breeding behavior in all these crosses was similar to that exhibited with the M14 genotype.

The following is a summary of the results from all crosses involving the above pedigrees: Of 26 crosses of the type S x SF, 25 gave rise to non-segregating progenies; the other produced only one sterile plant in the entire progeny. Seven crosses of the type SF x inbred were made; each of these progenies exhibited normal segregation. From nine self-fertilizations of plants heterozygous for the restoring gene(s), seven did not segregate. One of the two which segregated was mentioned above; the other gave 17 fertile and 3 sterile plants. Since one of the three sterile plants was definitely off type, these three may have been outcrosses.

These data suggest the operation of a type of male gametophytic selection which insures fertilization by pollen grains carrying the restoring allele. At present it is not possible to determine whether this selection is a function of the S restoring gene(s), another gene closely linked to an S restorer, an interaction of an S restorer and a non-linked factor, or an interaction between any of these and the female; however, all these possibilities shall be investigated. Apparently no similar selection (at least not to such a degree) exists in the female, for in crosses of the SF x inbred type segregation appears to be normal.

In all of the above cases where no segregation occurred the male parent had S type sterile cytoplasm. It is of interest to know if this selection mechanism manifests its effect when the restorer gene(s) is not in S type cytoplasm. Two cases exist which suggest that it can. The crosses M14S4 x (Ky21 x M14) and M14S5 x ((Ky21 x M14) x M14) both yielded all-fertile progenies. This would be expected only if selection pressure were being exerted in the male (or male gametophyte) which had no sterile cytoplasm. If this is indeed the case, the result of the cross A158S4 x (Ky21 x A158) mentioned above cannot be resolved unless the selection factor(s) did not exist as such until the following generation.

This selection mechanism does not appear to function in T type sterile cytoplasm. A158T was crossed by A158SF4, and two of the progeny were selfed (the male parent also carried a T restorer). A few of the offspring from each of the two selfs were then crossed on to several S steriles. Since in both cases some of the S sterile lines were not restored, the S restoring gene(s) must have segregated while in T type cytoplasm.

No definite conclusions will be drawn until this phenomenon has been investigated further.

5. <u>The application of non-segregating restorers to seed production</u>.

If inbreds carrying restorers are to be utilized in the production of hybrid pollen parents, in most cases it will be necessary to convert the inbred by incorporating the restoring gene(s) into the inbred genotype by the cross-and-backcross method. Converting an inbred to the restorer version theoretically cannot be accomplished as quickly as conversion to the sterile counterpart. One reason for this is that crossing over must take place close to each gene involved in restoration so that only this genetic material is changed in the inbred. Another is that the converted inbred must be homozygous for the restorer(s) so that all the $F_1$ plants (hybrid pollen parent) will be fertile. To get the plants homozygous for the restoring genes several generations are required for selfing, testing progeny and multiplying the seed. Because of the first reason mentioned, slight combining ability