

A GENETICAL PUZZLE

BY

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Two pairs of characters of maize endosperm find an extensive use for demonstrational purposes: blue versus yellow and smooth versus wrinkled. For the blue colour four independent and complementary genes are responsible: A_1 (EMERSON (1918) chromosome 3), A_2 (JENKINS (1932) chromosome 5), C (EAST and HAYES (1911) chromosome 9) and R (EAST and HAYES (1911) chromosome 10). For smooth (starchy) endosperm (versus wrinkled or sugary) three pairs of genes have been described: su_1 (CORRENS (1901) chromosome 4), su_2 (EYSTER (1934) chromosome 6) and su_4 (EYSTER, unpubl., chromosome 9).

In a collection of cobs with F_2 -seeds, used for practical students courses, segregation followed the regular dihybrid scheme 9:3:3:1; the F_1 -seeds being heterozygous for the genes C (chrom. 9) and su_1 (chrom. 4). This proved that the population of F_1 -plants produced four types of embryosacs and four types of pollen in equal numbers (CSu_1 , Csu_1 , cSu_1 and csu_1).

However in such a collection one exceptional cob was found with an obvious mosaic character (Plate I, Fig. 1). The lower part (about 2/3 of the cob) consisted of a large majority of blue smooth, and minorities of the other three gene-combinations; the upper part (about 1/3) bore a large majority of yellow-wrinkled seeds and a few seeds only of the other types. The exact numbers are given in the following table:

	blue smooth	blue wrinkled	yellow smooth	yellow wrinkled	total
lower part (2/3)					
observed	171	13	18	19	221
percentage	77.4	5.9	8.1	8.6	100
upper part (1/3)					
observed	15	2	6	77	100
percentage	15.0	2.0	6.0	77.0	100

In two respects these segregations are not conformable to expectation:

(1) Neither in the lower part of the cob, nor in the upper part the numbers agree with the 9:3:3:1-ratio. In both groups the double dominants and double recessives surpass the frequencies of the dominant-

recessive types, because of which a linkage between C and Su_1 (or c and su_1) shall be assumed.

(2) Secondly there is an essential difference between the lower part and the upper part in this respect that in the lower part the double dominants form a great majority, while in the upper part this is the reverse by a large excess of double recessives.

A case which may look analogous to the one above mentioned has been described by DOLLINGER and SINGLETON (1954). A cob (Plate I, Fig. 2) of a homozygous dominant (RR) plant was fertilized by pollen from a plant homozygous for r; the result should be that all seeds showed the blue colour of the dominant R-character. However in the upper part a few non-blue kernels appeared. No mention is made of the smooth-wrinkled ratios in both colour-groups; a decision about a possible newly originated linkage thus being excluded. No evidence of chromosome alteration was found. The explanation is given by assuming a pre-meiotic mutation in the non-blue sector of the cob. This assumption cannot be applied to the case described here, because the pollen used by D. and S. was uniformly recessive, while the pollen giving rise to the seeds on the exceptional cob mentioned here, was a mixture of CSu_1 , Csu_1 , cSu_1 and csu_1 types. Besides in the cob of D. and S. the mutation concerned one pair of alleles only ($R \rightarrow r$) while in the case described here, such a mutation should be assumed for two pairs of alleles ($C \rightarrow c$ and $Su_1 \rightarrow su_1$).

So we have to look for some other explanation. Two facts shall be accounted for: (1) the apparent linkage between C and Su_1 in this exceptional plant; the sisterplants showing independent segregation; and (2) the difference in genetical behaviour between the lower and the upper part of the cob.

Ad(1). There seems to be no doubt that a linkage exists between the factor pairs C-c and Su_1-su_1 , though thus far these have been found to be located in different chromosomes (chrom. 9 and chrom. 4 respectively). It may be supposed that in the pollenparent of the hybrid seed, from which the plant with the exceptional cob was grown, a reciprocal translocation had occurred of a part of chrom. 4 to a part of chrom. 9 and the reverse. Translocations between non-homologous chromosomes in maize are not at all uncommon, like McCLINTOCK (1931, 1933) has shown. Such a translocation in the male parent gave rise to a pollengrain in which one chromosome was built from the C-part of chrom. 9 and the Su_1 -part of chrom. 4, while the other chromosome was formed by the remaining parts, thus not possessing the C-locus nor the Su_1 -locus. The yellow-sugary motherplant produced one chromosome 9 with the gene c and one chromosome 4 with the su_1 -gene. Assuming this structure of the hybrid seed, the occurrence of a linkage and of a large majority of SCu_1 -offspring (next to equal minorities of yellow-starchy, blue-sugary and yellow-sugary) may be explained.

Ad(2). More difficult seems to be the explanation of the mosaic character of the cob. Because of the large majority of yellow-sugary

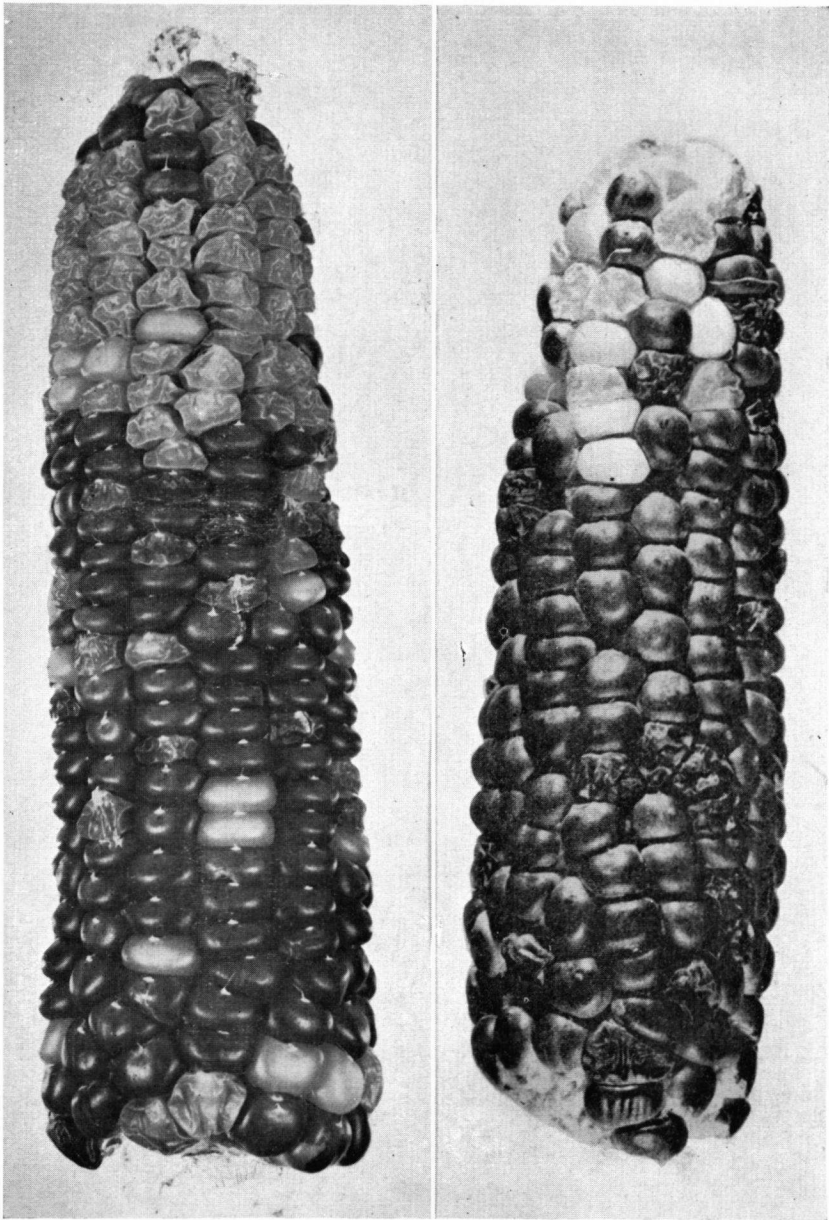


Plate I, Fig. 1.

Plate I, Fig. 2. (after DOLLINGER and SINGLETON, 1954).

seeds a preliminary view could lead to a supposition of a 'reversed dominance' but such a hypothesis looks too inconceivable and solitary so that we better refrain from discussing it. It may be that some chromosomal irregularity in somatic cells (which were discussed by JONES, 1937) has caused the genetical difference between the two parts of the cob. For instance a non-disjunction of the new C-Su₁-chromosome, like that described already by EMERSON (1921) for the genes C with Wx and C with Sh could explain the increase of yellow-sugary seeds in this part of the cob, but since the pollen produced by the sisterplants, by which the cob was fertilized, contained the four possible combinations in equal numbers, the frequency of yellow-sugary grains could not surpass a percentage of 25 %; it reached however a percentage of 77 %.

I must avow that pending a further study I cannot see thusfar a satisfactory explanation for this interesting genetical puzzle.

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