chromosomes and has kindly furnished the stocks for the trisomic tests. I also wish to thank Miss Harriet Creighton for her cytological assistance and Dr. C. R. Burnham for some of the stocks used in the experiments.

6 McClintock, Barbara, Ibid., 16, 791-796 (1930).

MODIFICATION OF MENDELIAN RATIOS IN MAIZE BY MECHANICAL SEPARATION OF GERMES

By P. C. Mangelsdorf

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Communicated November 13, 1931

For a number of years the writer, in collaboration with Dr. D. F. Jones and Dr. W. R. Singleton, has been studying the inheritance of a peculiar condition in maize known as "high sugary." Plants of this stock, which are heterozygous for the well-known recessive character, sugary endosperm, produce about 66 per cent of sugary seeds when self-pollinated instead of the expected 25 per cent. When the heterozygote is backcrossed on the recessive, approximately 94 per cent of the seeds, instead of the usual 50 per cent, are sugary. The ability to produce these aberrant ratios is inherited but is transmitted through only about 15 per cent of the ovules and about one per cent of the functional pollen.

All plants which produce high sugary ratios have variable pollen. Measurements of the pollen grains show that the distribution, with respect to length, is bi-modal. Approximately half of the grains are smaller than normal, though quite sound and well packed with reserves, while the remainder are normal. The gene or other condition responsible for the production of tiny pollen is located in the third chromosome, to the left of sugary, and the crossing-over is approximately six per cent. Other characters in this linkage group, including defective endosperm de16, tunicate ear Tu, tassel seed Ts5, and a newly discovered allelomorph of sugary, are also affected.

We may assume that in "high sugary" plants, which are heterozygous for sugary, the normal pollen grains all carry the gene for sugary except six per cent of crossovers, while the tiny grains all carry starchy genes except the six per cent of crossovers. We may assume further that the tiny pollen grains do not function in competition with normal grains;
hence the percentage of starchy seeds in backcrosses is a direct measure of the crossing-over between normal pollen and sugary endosperm. These assumptions are shown to be reasonably sound by the results of separating the pollen grains according to size by passing the pollen through a series of fine-meshed sieves.

Three sieves, having specified openings of 0.088 mm., 0.074 mm., and 0.062 mm., were used. The fractions remaining in each sieve after shaking, as well as the fraction passing through the finest sieve, were used separately in making pollinations on homozygous sugary plants. Examination of the fractions under the microscope showed that no large, sound pollen grains passed through the finest sieve, though some small grains still remained in the coarsest sieve.

The results from these pollinations, compared with pollinations made with untreated pollen, are set forth in table 1. The experiment was repeated on five different days and the results were essentially the same in each case, hence only the totals and the averages are shown.

**TABLE 1**

<table>
<thead>
<tr>
<th>POLLEN USED</th>
<th>SEEDS PRODUCED</th>
<th></th>
<th>PER CENT SUGARY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Not treated</td>
<td>1170</td>
<td>1100</td>
<td>94.0</td>
</tr>
<tr>
<td>2. Fraction remaining in sieve 0.088 mm.</td>
<td>1961</td>
<td>1830</td>
<td>93.3</td>
</tr>
<tr>
<td>3. Fraction passing through sieve 0.088 mm. but remaining in sieve 0.074 mm.</td>
<td>2208</td>
<td>1915</td>
<td>86.7</td>
</tr>
<tr>
<td>4. Fraction passing through sieve 0.074 mm. but remaining in sieve 0.062 mm.</td>
<td>2566</td>
<td>1073</td>
<td>41.8</td>
</tr>
<tr>
<td>5. Fraction passing through sieve 0.062 mm</td>
<td>912</td>
<td>236</td>
<td>25.9</td>
</tr>
</tbody>
</table>

It is noted that the percentages of sugary seeds in Lots 1 and 2 are practically identical, 94.0 and 93.3 per cent, showing that the removal of most of the tiny grains had little or no effect on the gametic ratios and indicating further that only the normal grains ordinarily function.

The next three fractions, represented by the ears in Lots 3, 4, and 5, produced 86.7, 41.8, and 25.9 per cent sugary seeds, respectively. All of these values differ significantly from the percentage in the first fraction, from the untreated pollen, and from each other.

In none of the tests was the percentage of sugary seeds reduced to the six per cent expected if only tiny grains had been included in the fraction. In one of the separate experiments, however, the pollinations made with the lowest fraction averaged 15.3 per cent sugary seeds and one of the ears averaged 8.1 per cent sugary seeds.

The failure to reduce the proportion of sugary seeds to six per cent is probably due to the fact that some of the smaller grains which pass through
the finest sieve are genetically normal and not tiny. Such grains are presumably 94 per cent sugary and six per cent starchy and they would tend to raise the percentage of sugary seeds produced by the pollen fraction in which they are included.

Although the separation of the gametes has not been complete, the evidence seems to be sufficiently conclusive to show that:

1. Normal and tiny pollen grains can be partially separated by simple mechanical means.
2. Separation on the basis of size also results in separation of starchy and sugary genes, furnishing direct evidence that, in this stock, the starchy: sugary genes are genetically associated with differences in size of pollen.
3. The tiny grains, which function only rarely when in competition with normal grains, readily accomplish fertilization when competition with normal grains is reduced or eliminated.

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**A PROBABLE NEW MUTATION TO' WHITE-BELLY IN THE HOUSE MOUSE, MUS MUSCULUS**

**BY CLYDE E. KEELER**

**THE HOWE LABORATORY OF THE HARVARD MEDICAL SCHOOL AND THE BUSSEY INSTITUTION**

Communicated November 9, 1931

The so-called "agouti" series of allelomorphic genes in the house mouse, as at present understood, is shown in the first two columns of the following table.

<table>
<thead>
<tr>
<th>VARIATION</th>
<th>SYMBOLS AS ALLELOMORPHS</th>
<th>SYMBOLS AS LINKED GENES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Lethal yellow</td>
<td>$A^Y$</td>
<td>$\overline{A}^Y$</td>
</tr>
<tr>
<td>2. White-belly agouti</td>
<td>$A^W$</td>
<td>$\overline{A}^W$</td>
</tr>
<tr>
<td>3. Agouti (banded hairs)</td>
<td>$A$</td>
<td>$\overline{A}$</td>
</tr>
<tr>
<td>4. White-belly non-agouti</td>
<td>$a^W$</td>
<td>$\overline{a}^W$</td>
</tr>
<tr>
<td>5. Dark-belly non-agouti</td>
<td>$a$</td>
<td>$a$</td>
</tr>
</tbody>
</table>

Evidence indicates that the second and fourth members of this series are probably not true allelomorphs, but represent members three and five, respectively, in combination with a closely linked dominant gene ($W$) for white-belly. This interpretation is indicated in the last column of the above table.