STERILE AND MALE-STERILE FLOWERS AND THE LINKED PIEBALD SEED OF THE JAPANESE MORNING GLORY

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(With 3 text-figures)

Some genes responsible for certain morphological characters in the Japanese morning glory exhibit sterility to various degrees (Imai 1930). Certain other genes recently determined and called sterile and male-steriles, however, exhibit, along with other less conspicuous morphological characters, sterility as the main trait of the mutants.

THE STERILE FLOWER

In 1933, a few sterile flowers sporadically appeared as the result of recessive mutation in an F_2 pedigree from a cross made between ordinary fertile parents, the other five sister pedigrees being normal as to fertility. The segregation was 58 normal and 3 sterile, with a marked low ratio for the latter. The mutant plants, which have small leaves and grow poorly, usually with only a few branches or none at all, bloom to small corollas that are scalloped at the junctions of the petals (Fig. 1). The sterile mutants, as the name indicates, produces no seeds, owing to the abortive nature of the sexual organs. The anthers are small and shrivelled, containing almost no pollen, while the pistil, although apparently normal, is completely sterile (Fig. 2E). By selfing the normal sister plants we raised the next generation in which 4 plants bred true to normal, while 2 plants segregated into 77 normal and 5 sterile individuals. The deficit in the sterile form is also remarkable. The segregates for two generations totalled 135 normal and 8 sterile, the latter being 5.6 percent of the total. The marked low ratio of recessive segregates accompanies decrease in the number of heterozygous pedigrees, namely, 4 homo-

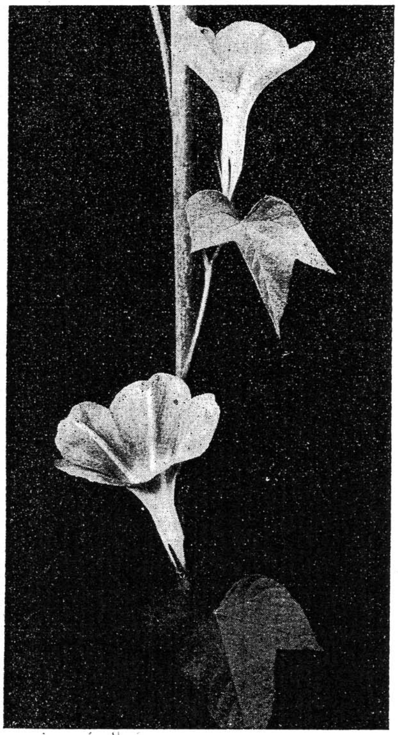

Fig. 1. Sterile specimen.

zygous and 2 heterozygous, where we should expect 1 of the former to 2 of the latter. Studying the marked deficit in the recessive rootletless ratio, Imai (1934) found it to be due to certation occurring between the normal and rootletless microspores at their tube growth. It would seem that the present case may be explained by the same cause.

THE MALE-STERILE FLOWERS

In male-sterile flowers, three cases have been reported by Imai (1933, 1935) and Yasui (1934), all being simple recessive to the normal condition. According to Imai, gene male-sterile-1 is considered to be located in the variegated chromosome. As to male-sterile-2, he has also dealt with its origination and hereditary behaviour. Yasui, however, called her form, which is closely linked with duskish, pollen sterile.

MALE-STERILE-2 :—As pointed out elsewhere (Imai 1935), the male-sterile-2 showed a deficit in its segregation. The new segregation data for the male-sterile-2 are 621 normal and 62 male-sterile-2, which when added to the previous data makes 773 normal and 99 male-sterile-2, showing 11.4 percent in the recessive segregates, the low ratio of which seems to be caused, in part at least, by the competition of the male gametophytes. Although the anthers of the male-sterile-2 are small (Fig. 2B), containing many deformed pollen, the pistil is fertile, producing seeds by natural or artificial pollination. The plants bloom flowers of small size and frequently bear them transitional to nearly normal, the increased flower size restoring the fecundity of the staminate organs.

MALE-STERILE-3 :—In 1931, the mutation to male-sterile-3 occurred in a pedigree of the yellow-inconstant-2 stock that was received from Doctor Miyazawa. The mutants appeared *en masse* as simple recessives. The

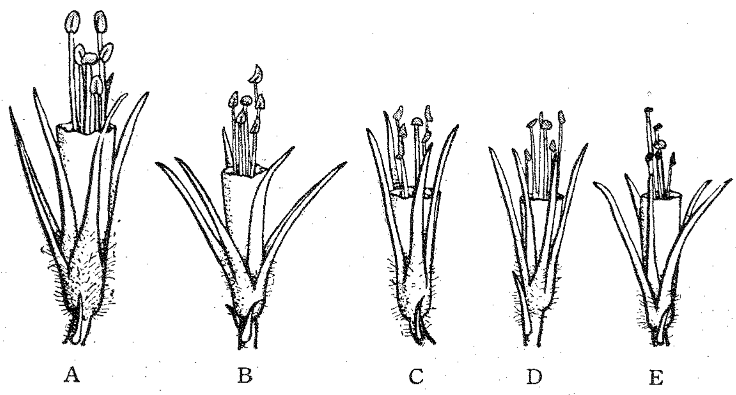

Fig. 2. The sexual organs of the flowers shown by removing their corollas from the tubes. **A**, normal; **B**, male-sterile-2; **C**, male-sterile-1; **D**, male-sterile-3; **E**, sterile.

flower size of the male-sterile-3 was also small and the anthers thin, shrivelled, and coloured brownish (Fig. 2D), the characteristics being very similar to the male-sterile-1 (Fig. 2B). The 1933 and 1934 data gave 115 normal and 29 male-sterile-3 (79.9% and 20.1% respectively), indicating a deficit in the proportion of its recessives.

Digenic segregation :—Some crosses were made in order to study the combined effect of different male-sterile forms. Owing to the deficit that accompanied the recessive segregates, there was great discrepancy in the digenic ratio. By simultaneous segregation of genes male-sterile-1 and male-sterile-2, we obtained 156 normal and 67 male-sterile individuals, the latter forming 30.0 percent, where we should expect about 44 percent from the independent digenic segregation of a 9 : 7 ratio. The deficit is mainly due to the marked low ratio of the male-sterile-2 segregates. The simultaneous segregation of genes male-sterile-1 and male-sterile-3 gave 43 normal and 20 male-sterile individuals, or 31.7 percent of the latter. The digenic segregation of male-sterile-2 and male-sterile-3 showed 175 normal and 57 male-sterile individuals, the latter being 24.6 percent. The ratio of the male-sterile segregates apparently agree with that of the monogenic recessives, the remarkable low ratio being caused by the combined effect of the two male-sterile forms that are deficient in their segregating ratios.

THE PIEBALD SEED

In 1933, a new mutation occurred in the piebald seed in some pedigrees that segregated male-sterile-2. The mutants bear black seeds that are mixed with some piebald ones in black and dirty yellow, the extent of the yellowish patches however varying greatly. The yellowish patches occur at the back of the seed and then extend to the abdomen, the seed eventually becoming entirely yellowish when the extent of the remaining minute black

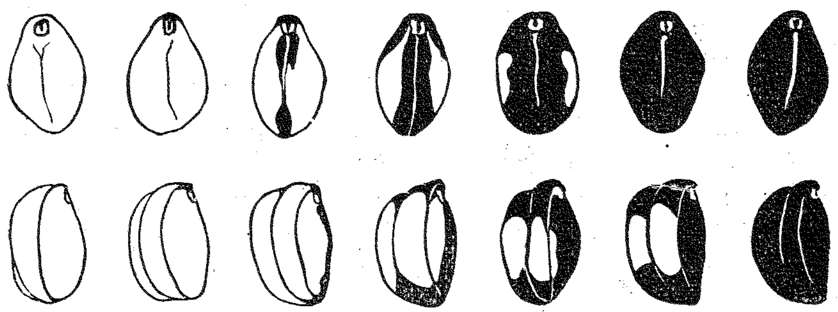

Fig. 3. Variation in piebald seeds from a single plant. The upper row gives their partly back and partly side views and the lower row their abdominal views.

part around the micropyle is diminished (Fig. 3). Thus the piebald pattern is expressed in a particular mode of variation from black to pure yellowish.

Piebald is a recessive pattern character that fluctuates considerably in its manifestation. The 1934 data for simultaneous segregation of male-sterile-2 and piebald are as follows:

Num. of pedigrees	Normal	Piebald	Male-sterile-2	Male-sterile-2 piebald	Total
6	305	8	7	33	353

The result shows linkage between the two genes, the recombination frequeney being 9.1 percent. As a consequence of the low ratio of male-sterile-2, the piebald ratio is also markedly low. Since, owing to certation, the pollen carrying the chromosome with genes male-sterile-2 and piebald seems to have small chance of fertilization, the result should be an increase in segregation of double dominant and a decrease in double recessives.

SUMMARY

1. The occurrence of sterile flowers, as recessive mutation, was observed. The recessive segregates, which show a marked deficit in their segregating proportions, seem to be caused by the certation that takes place between normal and sterile microgametophytes.

2. Male-sterile-2 shows marked deficit in segregation, and so does male-sterile-3, although not so conspicuously.

3. Digenic segregation in the male-steriles shows conspicuous deficit, the recessive male-sterile ratio being low, even to the extent of appearing to be a monogenic.

4. The piebald seed character, which appeared by a new recessive mutation, is linked with the male-sterile-2, the recombination frequency being 9.1 percent.

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摘　　要

朝顔の sterile 及び male-steriles は何れも單性的劣性であるが、一般に劣性比が低い。これは恐らく花粉管の certation にその原因を求むべきであらう。その爲め兩性雜種に於ては劣性比が低く 9:7 の期待を裏切つて一見 3:1 の分離をする樣な場合もある。新突然變異として發現した piebald (種皮に斑が現れる) は male-sterile-2 と 9.1% の linkage を保持する。