

paying table; to help with the interpretation the genetic constitution of the *A* and *B* plants are included.

Two facts are evident from the first line of the table—both *A* and *B* plants are self-compatible and each plant segregates compatible and incompatible pollen in a 1:1 ratio. Hence a mutation has occurred giving self-compatibility only to the pollen carrying it, and since the original plant was S_1S_2 the new allele must have arisen from either S_1 or S_2 or a gene distinct from the S locus.

The second line of the table shows that plants in both groups, when used as male on to the original (unmutated) plant, again have compatible and incompatible pollen in a 1:1 ratio. It is not necessary, therefore, for compatibility to have the mutant allele in the style.

The reciprocal cross given in the third line of the table shows a striking difference between the two groups. When used as females, plants of group *A* are incompatible, while plants of group *B* are compatible with the original plant. Two conclusions can be drawn from this: (1) that group *A* plants are heterozygous and group *B* plants are homozygous for their S alleles; (2) that the mutant allele does not produce the new 'self-compatibility' effect in the style but produces the same effect as the original allele did before mutation.

INCOMPATIBILITY REACTIONS OF MUTANT PLANTS WITH THEIR PARENT (S_1S_2) AND WITH OTHER GENOTYPES

S_1' is the mutant allele; ++, all pollen compatible; +-, compatible and incompatible pollen in a 1:1 ratio; --, all pollen incompatible.

Group <i>A</i> S_1S_2'			Group <i>B</i> $S_1S_2S_3'$		
S_1S_2'	Selfed or intercrossed	+-	$S_1S_2S_3'$	Selfed or intercrossed	+-
S_1S_2'	×	+-	$S_1S_2S_3'$	×	+-
S_2S_2'	×	--	$S_1S_2S_3'$	×	+-
$S_1S_2S_3'$	×	--	$S_1S_2S_3'$	×	+-
$S_2S_2S_3'$	×	++	$S_1S_2S_3'$	×	+-
$S_1S_2S_3'$	×	+-	$S_1S_2S_3'$	×	+-
$S_2S_2S_3'$	×	+-	$S_1S_2S_3'$	×	+-
$S_1S_2S_3'$	×	+-	$S_1S_2S_3'$	×	+-
$S_2S_2S_3'$	×	+-	$S_1S_2S_3'$	×	+-

The reactions in the last four lines of the table show that the mutation occurred in an S_1 allele.

Since thirty-four plants arose all with the same mutant S_1' allele it is clear that a single mutation occurred at an early stage in the development of an anther and in a nucleus which had at least five mitotic divisions to complete before meiosis.

The new allele can be symbolized as S_1' , since although it fails to express its activity in the haploid pollen it has the full S_1 activity and specificity in the diploid style. This mutant allele is therefore a hypomorph to the normal allele, and since it has been produced by X-rays this is to be expected. But among spontaneous mutations which are known to occur at this locus some would be expected to be neomorphs, that is, new S alleles with a complete but new incompatibility reaction, since large numbers of different S alleles are present in natural populations.

That one and not both of the pleiotropic effects of the S gene has been affected by mutation raises problems of importance in gene structure and gene activity, and these will be discussed together with a full account of the work in a later publication.

It is now clear that self-compatible plants can be produced by X-rays in species which are normally self-incompatible. It is doubtful whether this will be an advantage in seed-reproducing crops where heterozygosity and hence vigour is maintained by cross-pollination. In such plants, under conditions unfavourable for cross-pollination, self-compatibility would have the short-term effect of increasing the immediate seed production, but the resulting loss in vigour from in-breeding during a number of generations would offset the initial advantage.

In fruit trees where heterozygosity is fixed by vegetative propagation the advantage of effective pollination under adverse conditions is not offset by loss of heterozygosity.

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¹ Emerson, S. H., *Bot. Gaz.*, **101**, 890 (1940).

² Lewis, D., *J. Genet.*, **45**, 171 (1943).

Cytological Basis of High Fertility in Autotetraploid Buckwheat

AUTOTETRAPLOIDS of buckwheat obtained in 1941 by means of colchicine treatment showed variation with regard to fertility¹. Owing to the vast amount of initial material it was possible to isolate in the variety Bolshevik individuals which were genotypically highly fertile. They differed in this respect from other experimentally produced autotetraploids the fertility of which was sharply reduced, some of them being even entirely sterile. Reduced fertility in autotetraploids depends primarily on irregular chromosome distribution in meiosis, leading to the formation of aneuploid micro- and macrospores and consequently to pollen abortion, poor seed setting and to the appearance of polysomics.

In the microsporogenesis of buckwheat autotetraploids during the first metaphase of meiosis only very rarely were exclusively quadrivalents observed; in the majority of cases there were seven quadrivalents and two bivalents. At times the number of bivalents was considerably greater as a result of a decrease in the number of quadrivalents. Trivalents and univalents were observed only in plants with reduced fertility. The shape and orientation of quadrivalents on the spindle in autotetraploid buckwheat ensured regular chromosome separation. However, a small amount of irregular distribution was observed in all plants. The most common irregularity was the lagging of one or two chromosomes at the spindle equator, followed by the formation of dwarfed nuclei. Far less common was irregular chromosome distribution: 15 and 17 or 14 and 18. The proportion of abortive pollen varied between 2 and 6 per cent; it was higher only in plants with reduced fertility.

In highly fertile plants there were observed extremely small abortive pollen grains containing one or two lagging chromosomes, all the large pollen being good. Consequently, pollen grains with aneuploid chromosome numbers $2n - 1$ or $2n - 2$ are viable. Hence the possibility of an appearance of polysomics. Indeed, polysomics have been discovered, although so far in the progeny of plants with reduced fertility only. They are distinguished by their reduced viability and, with rare exceptions, by complete or nearly complete sterility; a great proportion of their seeds are incapable of germination. A hundred per cent germination of the seeds of highly fertile plants is evidence of the absence of polysomics in their progeny.

The main source of polysomics is in the progeny of triploids. Autotetraploids of buckwheat do practically not cross with diploids. Among 986 seeds collected in 1941 from chimeral plants there were found six triploid ones, three of which proved inviable; the remainder were nearly completely sterile. Experiments on artificial pollination (658 crosses) furnished negative results. The rarity and, possibly, a complete absence of triploids, along with inviability of the majority of aneuploid combinations, make it improbable that a considerable number of polysomics may ever occur in the fields of autotetraploid buckwheat. The reduced fertility and nearly complete sterility of the latter would ensure a constant high fertility in autotetraploid buckwheat, and correct breeding work opens wide prospects of a further improvement.

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¹ Sacharov, Frolova, Mansurova, *Nature*, **154**, 613 (1944).

Homostyly of the Flowers of Buckwheat as a Morphological Manifestation of Sterility

BUCKWHEAT is a heterostyly plant, but as early as 1872, Müller described the occurrence in buckwheat, as in other heterostyly plants, of isolated homostyly flowers. In *Primula* and in flax, homostyly flowers were said to be morphologically aberrant but functional with increased self-fertility.

Our observations have shown that flowers of buckwheat appear to be homostyly in short-styled individuals when stamens are shortened, and in long-styled plants, when the pistil is reduced in size. The anthers of shortened stamens are reduced in size and filled with oval abortive pollen with a thin exine, or contain no pollen whatever.

The study of microsporogenesis showed that pollen degeneration was connected with precocious degeneration of the tapetum cells. The earlier degeneration of the tapetum begins the stronger is the reduction of stamens. The earliest degenerative phenomena were observed immediately after the completion of meiosis in pollen-mother cells; the meiotic divisions themselves proceeded always normally. In these cells there occurs gradual dying of nuclei and of cytoplasm. Rudimentary stamens with completely empty rudimentary anthers are formed. When degenerative phenomena set in after the walls begin to be formed around the newly arisen pollen grains, there may be seen within the anther a cellulose plate consisting of adhering pollen-grain walls. When stronger walls have already been formed prior to the beginning of degeneration, a somewhat compressed empty pollen is formed. Such pollen is not shed from the anthers. Stamens are somewhat shortened in such cases so as to make short-styled flowers appear to be homostyly. It has since been found that such a sterility is more or less frequent in all the diploid varieties of buckwheat.

In many flowers reduction in pistils was also found, not only in the style but also in the ovary. This phenomenon was observed both in short-styled and in long-styled plants; it is, however, easier to notice it in the latter. When the pistil is shortened to such an extent that the style lies at the level of the stamens or even below, the flowers give an impression of homostyly. It has been proved by experiments arranged in the summer of 1945 with diploids of the variety Bolshevik that these presumably homostyly flowers were never fertilized.

Microscopic examination of such pistils has revealed complete degeneration of the embryo sac, of the epithelial cell layer, and also of the cells of the integument. When only the style was shortened the embryo sac was developed normally and fertilization could take place. Indeed in such flowers where the stigma is somewhat raised above the level of stamens there was noticed after pollination a slight growth of the ovary, which ceased after a few days. Formation of normal seeds was never observed in these flowers. In the case of the presence of rudimentary stamens in short-styled flowers there were observed cases of the formation of normal seeds. There were cases of simultaneous reduction of both pistils and stamens.

It is clear that homostyly in buckwheat is actually due to sterility based upon genetic factors, while its manifestation may depend upon environment.

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The Coefficient of Variation

TEXT-BOOKS of statistics generally cite the coefficient of variation (or variability) as a measure of relative variability. While the coefficient (abbreviated to *CV*) is usually defined by the equation $CV = 100AM$ (which is the form to which these notes refer), the more general definition is of a specified measure of dispersion expressed as a percentage of some appropriate measure of central location. Simpson