The compounds prepared as 0·1 M solutions of sodium salts, *p*H 7·3–7·4, were incorporated into the fluid maintenance medium. The medium contained 2 per cent horse serum and 0·5 per cent lactalbumin hydrolysate in Hanks's saline with bicarbonate and antibiotics. The ME cultures (about 2×10^5 cells/ml.) were infected with approximately 100 plaque-forming units of virus. The antiviral activity of the compounds was determined by observing the protection of tissue cultures against the cytopathogenic effect (CPE) of the virus and by measurement of the virus yield in the medium 20 and/or 48 h after infection. For the virus titration plaque assays in serological tubes with 1 per cent methylcellulose overlay were used. The details of the methods used were the same as previously described[1].

The antiviral effects of 27 compounds tested so far are summarized in Table 1.

The results presented indicate that marked antiviral activity (more than 90 per cent inhibition of virus yield and protection against CPE for at least one day) is exhibited by two types of compounds—compounds related to salicylic acid (Nos. 1–3) and certain phosphonic and carboxylic acids with benzyl groups (Nos. 4–9). To our knowledge the antiviral activity of salicylates *in vitro* has not previously been noticed. For this reason their mode of action was investigated more in detail and the results are described in a separate communication[2].

The significance of the benzyl grouping associated with different structures for virus inhibition emerges from the results of several investigators. Tamm *et al.*[15], who have examined the inhibition of virus replication by numerous derivatives of benzimidazole, suggested that hydroxybenzyl grouping at position 2 in the imidazole ring was of importance for the selective antiviral activity of 2-(α-hydroxybenzyl)-benzimidazole (HBB). O'Sullivan *et al.*[16] synthesized several substituted HBB derivatives with high inhibitory action on poliovirus multiplication and concluded that the 1-benzyl derivative of HBB is among the most active compounds. Loddo and Gessa[17] have recently reported that benthanidine and *o*-chlorobenthanidine, which are benzyl derivatives of guanidine, have a considerable inhibitory action on polio and vaccinia virus growth although presumably exerting their effects through a different mechanism from that of guanidine.

The work recorded here has revealed that certain simple compounds with the benzyl grouping attached to electronegative, electrophilic structures (carboxylic or phosphonic) also suppress the replication of EMC virus, whereas the compounds with the phenyl, β-phenylethyl and some other groups show little, if any, virus inhibitory action. Moreover, the dibenzyl structure was found to be far more active than mono-benzyl structure. It was also observed that the nitro group increased, whereas the amino group reduced, the antiviral effect of the compounds.

Even the most active of the compounds tested so far require a rather high concentration of 2×10^{-3} M/l. for activity and their effect diminishes rapidly at lower concentrations. On the other side, the increase of concentration from 2×10^{-3} to 5×10^{-3} was not followed by significant increase of percentage inhibition of virus yield. In case of phosphonic acids and of salicylic acid and its derivatives the high concentration necessary is counterbalanced, however, by low toxicity. For this reason the active doses were always several times lower than the toxic doses. Among the highly active compounds only *p*-nitrophenylacetic acid was found to be cytotoxic at a concentration of $2{\cdot}5 \times 10^{-3}$ M and slightly inhibited oxygen consumption and lactic acid production by mouse embryo tissue. It was, however, interesting to note that its phosphonic analogue, *p*-nitrobenzylphosphonic acid, conferred to cells rather high protection against virus infection although it was several times less toxic and did not significantly affect the tissue respiration.

In preliminary experiments *p*-nitrophenylacetic acid and dibenzylphosphonic acid gave distinct protection of mice infected with lethal doses of EMC virus. The *in vivo* activity of *p*-nitrobenzylphosphonic acid was described previously[1].

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GENETICS

Genetic Recombination with Ethylmethanesulphonate-induced Waxy Mutants in-Maize

Intracistron mapping in maize has been demonstrated by Nelson[1,2] with a technique based on differential staining reactions of starch in pollen of different genotypes. Those with the *waxy* (*wx*) locus stain reddish brown in iodine–potassium iodide solutions; whereas *non-waxy* (*Wx*) pollen stains dark blue. Therefore, in *waxy* plants genetic recombination or back-mutation at this locus is manifested by the appearance of dark blue staining pollen. The technique has a distinct advantage in genetic investigations with higher plants in that large populations of hundreds of thousands of genotypes (pollen grains) can be scored with ease.

As part of a programme in progress here on chemical mutagenesis in higher plants, the *wx* locus in maize is being used as experimental material and ethyl-methanesulphonate (EMS) as one of the chemical mutagens[3]. This communication is a preliminary report of results obtained with EMS on the induction of *wx* mutations at independent sites and the ordering of these sites within the locus. So far, nearly 50 *wx* mutations have been induced in the programme. Although each appeared independently, some of the sites may be identical, and this will be investigated in subsequent research. A number of mutants other than *waxy* have also been produced with EMS (ref. 3). Results with these, together with the data on *waxy* mutations, are providing preliminary evidence that EMS produces 'point' mutations in maize.

Results are reported here for four of the EMS-induced *waxy* mutants. These were obtained from seed treatments. Disinfected seeds were first soaked in deionized water at 27° C and bubbled continuously with oxygen for 24 h. They were then soaked in 0·05 M or 0·025 M aqueous solutions of EMS for either 2 or 3 days at 3° C. The rationale for this

Table 1. GENETIC RECOMBINATION BETWEEN A *waxy* TESTER AND *wx* SITES INDUCED WITH ETHYL-METHANE SULPHONATE IN MAIZE

Mutant	Seed treatment conditions: Molarity of EMS	Days at 3° C	24-h post-treatment (° C)	Recombination data: Est. No. microspores ($\times 10^3$)	$\bar{X}$ No. $Wx \times 10^{-5} \times 2$
BNL-85	0·05	2	27	85	25·6
BNL-87	0·025	3	3	376	44·2
BNL-86	0·025	3	3	409	76·2
BNL-88	0·025	3	18	603	86·0

treatment was to ensure thorough penetration without chemical disintegration of the mutagen. This was followed by post-incubation in water at different temperatures (Table 1).

The plants grown from treated seeds were crossed to a tester stock that was recessive at the *waxy* locus. The occurrence of *waxy* kernels in the F_1 indicated a mutation. The presence of *Wx* pollen in the F_1 plants, in excess of back-mutation frequency, was evidence of recombination between the tester and mutant *wx* site.

Recombination results on the four sites are shown in Table 1. These were selected for reporting in this preliminary article because closely comparable results were obtained by two observers (R. B. and E. A.), working completely independently of each other. The figures shown in Table 1 are averages computed from the two sources of data. The number of *Wx* grains has been multiplied by two to be comparable with other recombination maps. The mutant sites are arranged in Table 1 in order of increasing amount of recombination with the tester.

In so far as the *Wx* pollen in F_1 plants heterocallelic for tester and mutant *wx* sites arises from genetic recombination, this result, in itself, is an indication that the mutant sites are positioned differently from the tester site in the *wx* locus. The results in Table 1 have not been corrected for the spontaneous back-mutation rate. Evidence from other research[4] with standard *waxy* sites shows that back-mutation rates range from 0·60 to 2·42 $\times$ 10^{-5}, which is about equivalent to a map distance of 0·0012–0·0048. The range of recombination of the mutants reported was from 0·0256 to 0·086. Therefore, the recombination figures shown in Table 1 are considerably in excess of a back-mutation rate from other work. Furthermore, the results presented here indicate a back-mutation frequency of zero for the homoallelic tester used in this research.

Mapping by the described procedures gives the relative recombination distances from one site. However, if a map is constructed by this method it may not give the true spatial relationships since at present all mutants are mapped to one side of the tester site.

Future mapping will be done by first obtaining stocks which are homoallelic for the induced site. These will then be intercrossed in all possible combinations so that the actual recombination distances among induced sites can be determined, rather than only the distance from the tester site. This conventional mapping method should show whether induced sites are distal or proximal to the tester site and, hence, their true spatial relationships. Furthermore, by following such a procedure insight should be gained on whether EMS-induced sites are 'point' mutations or minor deletions. The *ad hoc* mapping procedure used here is not capable of distinguishing small deletions from 'point' mutations since recombination would be expected in both. However, by the conventional mapping procedure, minor deletions should be distinguishable by non-additivity of recombination distances when all the combinations of a diallel system of crosses are tested. In the course of the analysis evidence for major chromosomal damage should also be detectable.

In summary, the evidence for intracistron recombination reported here indicates that EMS induces independent mutations at sites within the *waxy* locus in maize. The occurrence of recombination between mutant and tester *wx* sites is further indication that 'point' mutations, or at least minor deletions, have been induced by this mutagen.

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PSYCHOLOGY

Inappropriate Constancy Explanation of Spatial Distortions

THE perception of two- and three-dimensional space has for long been one of the central issues in the experimental study of sensory and perceptual processes. An aspect of this problem is the apparent distortions of shape, size and direction which occur when the elements of a stimulus pattern (lines, angles, forms, etc.) are juxtaposed in certain spatial relationships. Such spatial illusions, which can be defined as discrepancies between the judged and true physical properties of the stimulus, have not yet been explained satisfactorily. It is clear, however, that their explanation would constitute a considerable advance in our understanding of the perceptual processes involved in space perception.

Interest in illusory patterns has been revived recently by a further attempt at their explanation by Gregory[1–3], who has extended and tested a theory originally proposed by Tausch[4]. Although this theory has the virtue of simplicity in addition to that of interpreting illusory phenomena in the context of the established principle of perceptual constancy, it can be seriously questioned on several grounds. Some criticism has already been raised by Brown and Houssiadas[5].

Gregory argues that the classical spatial illusions are two-dimensional projections of three-dimensional objects such that those elements normally further away in three-dimensional space appear larger. The principle of 'misapplied'[6] or 'inappropriate'[1] constancy can be illustrated in Hering's illusion shown in Fig. 1. The two vertical lines in this pattern are parallel. The radiating lines give a perspective effect; the centre of the pattern represents a point more distant than points around the margin. Since the distance between the two vertical lines is constant throughout, the visual sub-tense is also constant. But the central region of the pattern contains information for greater distance than the margin. In order to subtend the same visual angle, therefore, the separation between the parallels in the centre must be perceived as greater than at the ends, hence the outward bowing effect of the parallels. The principle of inappropriate constancy is also illustrated in the variants of Ponzo's illusion from Teuber[6] also shown in Fig. 1. In summary, information or cues for greater or less distance contained in the background pattern will determine the apparent size of elements in a two-dimensional display.

The principle involved is precisely that invoked by Ptolemy to explain the Moon illusion, that is, the greater apparent size of the Moon at the horizon as compared with its size at zenith. In each location the Moon subtends much the same visual angle, but the horizon is judged further than the vertical distance. Thus the Moon must be judged larger at the horizon. This apparent distance theory of the Moon illusion has been strongly supported by data from a series of recent experiments[7].

A first point of criticism which has already been raised[6] concerns the occurrence of spatial illusions in the tactile modality. It has for long been known that spatial illusions similar to those in vision occur when the same