

GENETICAL SOCIETY OF GREAT BRITAIN

ABSTRACTS of Papers read at the HUNDRED AND NINETEENTH MEETING of the Society, held on 18th and 19th NOVEMBER 1955, at the GALTON LABORATORY, University College, Gower Street, London

EVIDENCE FOR AN EXCHANGE HYPOTHESIS FOR "CHROMATID" ABERRATIONS INDUCED BY X-RAYS

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A recent paper (S. H. Revell, *Proceedings of the Radiobiology Symposium*, Liege, 1954, Butterworth) suggested a new interpretation for "chromatid" changes in *Vicia faba* root tip cells: that all aberrations of this category are actually the result of chromatid exchanges, structurally similar at metaphase to meiotic exchanges. Qualitative evidence only was then given for the hypothesis.

In the present paper quantitative data from X-ray experiments with *Vicia* are offered in support of the same hypothesis. It is shown that there is no early excess of true chromatid breaks, such as would be difficult to accommodate within the new hypothesis; and that certain types of aberration are observed in the proportions which the hypothesis predicts.

Some implications of this interpretation are discussed.

DIFFERENTIATION OF CELLS WITHIN CLONES OF SALMONELLA: SPONTANEOUS PHENOTYPIC VARIATION IN RESPECT OF MOTILITY

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Morphologically, bacteria of the genus *Salmonella* consist of short rods which may be motile by means of flagella (wild type), or non-motile, lacking flagella. Mutation occurs from the motile to the non-motile condition (and vice versa). In some strains only a characteristic proportion of the individuals are motile. It has now been shown that motile cells occur at very low frequencies in some strains formerly considered non-motile (*circa* 10^{-5} in one case). These rare motile cells (isolated by micro-manipulation) are not mutant; their progeny after several generations are all or nearly all non-motile, and indistinguishable from the parent strain.

The distribution of such motile cells amongst replicate cultures (studied by a pour-plate technique in semi-solid agar) suggests that small groups of motile cells arise by division of single differentiated cells. The incidence of "differentiation events" causing the appearance of such small groups appears to be random amongst the population. It seems that each cell of a strain behaving in this manner has a genetically determined low probability of undergoing such an event. The event probably consists of a transient ability to synthesise new flagella. The "penetrance" of a character (motility) can thus be studied amongst clonal cell populations.

A METHOD FOR THE DETECTION OF AUTOSOMAL LETHALS INDUCED BY HIGH FREQUENCY RADIATION IN MICE

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A mouse from an irradiated multiple recessive stock is crossed with a multiple dominant, and lethals are detected by shortages of recessives in F_2 . An F_2 of n mice is searched for a lethal if it contains less than r recessives at any locus. r is

chosen so that the probability of suspecting a lethal which is not present is less than one in 300. The length of chromosomal map swept per locus is about $\frac{150(r+2)}{n-r-1}$ cM. With $n = 30, r = 1$, this is about 16 cM, but each such length is only searched in $\frac{1}{2}$ of the F_2 . Thus with 8 markers one could detect about 2 per cent. of autosomal lethals by scoring 30 mice. This method should detect lethals with about the same frequency, for a given dose of radiation, as Russell detected visibles by irradiating dominants at 7 loci, and crossing to recessives.

RESOLVING POWER OF GENETIC ANALYSIS IN TERMS OF DNA

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The resolving power of recombination in *Aspergillus nidulans* (total map 500 units) is now down to 10^{-6} and in *Drosophila* (total map 280 units) to 10^{-6} . The DNA per haploid nucleus is 0.044 picograms in *Aspergillus* and 0.085 in *Drosophila*, corresponding to 4×10^7 and 7.7×10^7 nucleotide pairs. The minimum recombination fraction measured in *Aspergillus*— 1×10^{-6} between two alleles of the *pro 1* region (Forbes)—corresponds to 8 nucleotide pairs or 27Å, and in *Drosophila*— 8×10^{-6} between two alleles of the *w* region (Mackendrick)—corresponds to 240 nucleotide pairs. In *Aspergillus* the chromonema—if it is DNA—could well be made up of only one Watson-Crick duplex fibre and cannot be made up of more than about 8. The ratio of the smallest recombination fraction within one region in *Aspergillus* (*ad 8*) to the total recombination for that region is 1 : 150. In the *w* region of *Drosophila* it is 1 : 62. This supports the idea that the mutational sites separable by crossing over within each region are in the order of hundreds. (By “region” we mean the series of mutational sites at which mutant alleles behave as allelic to one another.) These results agree with those of Benzer with phage T4.

SIGNIFICANCE TESTS FOR HERITABILITIES AND ANALOGOUS PARAMETERS ESTIMATED FROM VARIANCE COMPONENTS

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In a standard breeding experiment, s sires are each mated to d different dams, each of whom has n offspring on whom some trait is measured. Assuming variability among the offspring is made up of three additive components, S due to sires, D from dams and W among full sibs, the analysis of variance is

	D.F.	Mean square	Expected composition of mean square
Sires	$s - 1$	G	$dnS + nD + W$
Dams within sires	$s(d - 1)$	H	$nD + W$
Full sibs	$ds(n - 1)$	K	W

Derived estimates of heritability are $4S/(S+D+W)$ from sires, $4D/(S+D+W)$ from dams and $2(S+D)/(S+D+W)$ from both parents. There is no accepted test of significance for such parameters. A simple computational routine is given for the large-sample formula of Osborne and Paterson (1952), and an easily evaluated transformation is described which stabilises the variance and should be more nearly normal in distribution. The tests can be used when d and n are not constant. The methods are quite general, being applicable to analogous parameters estimated from three or more mean squares in a “nested classification.”

HOMOSTYLY IN THE PRIMROSE—A PROGRESS REPORT

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An account will be given of some of the results which have so far been obtained from the author's research over the past ten years on homostyle populations in Somerset, Buckinghamshire, and County Durham. These will include the results of studies on incompatibility reaction, on inbreeding depression, and on the genetical structure of natural populations, together with detailed analyses of fertilisation in natural populations and of spatial variation in homostyle frequency.

THE EFFECTS OF SELECTION AND LINKAGE ON
INBREEDING PROGRESS

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Selection against homozygosis at a given locus, due to lower survival of the homozygotes, will reduce the rate of progress towards fixation during inbreeding if there is selection within lines only, or may prevent fixation altogether if selection between lines also occurs. A simple general solution will be given for the effects of selfing when the homozygous phases of the two alleles at a locus are under different selection pressures and the intensities of selection within and between lines are also different. This makes possible a comparison of the relative importance of selection within and selection between lines in holding up inbreeding progress.

Selection against homozygosis at one locus will slow down inbreeding progress at other loci which are linked to it but not directly affected by selection. A general formula for the magnitude of this linkage effect with inbreeding by selfing will be given, and some particular cases will be discussed.

When inbreeding is by sib-mating, this problem presents much greater mathematical difficulties. Some preliminary results will be briefly discussed.

GENETIC CORRELATION BETWEEN BODY SIZE AND
EGG PRODUCTION IN *DROSOPHILA MELANOGASTER*

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Progeny tests and selection experiments in wild stocks of *Drosophila melanogaster* imply a lack of genetic correlation between body size and one of the principal components of fitness, namely rate of egg production. However, there is also evidence of a phenotypic correlation between the two characters among individuals of the population, reared under favourable conditions. This cannot be attributed merely to environmental variation since there is no correlation among genetically identical flies from a cross between inbred lines, reared under similar conditions. Also the phenotypic correlation due to segregation can be greatly increased by rearing larvæ under standard sub-optimal conditions. There is again no correlation in the genetically identical flies. Estimates of environmental variance and the additive genetic variance leave a considerable fraction of the phenotypic variation of flies from the wild stock unaccounted for. It appears that such non-additive effects are responsible for the observed correlation between size and egg production and that they are particularly sensitive to nutritional variation for their joint expression. The data are considered in relation to the results of selection and methods of detecting genetic variation in fitness.

THE ABO BLOOD GROUPS AND SECRETOR STATUS IN DUODENAL ULCER

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Recent work has suggested an association between blood group O and duodenal ulcer in several areas of Europe. The finding has been obtained by comparing the blood groups of ulcer patients with a control series of unaffected people living in the same area.

Such controls can be unsatisfactory in that a population of mixed origin may contain elements with a high frequency both of group O and duodenal ulcers without the two being causally connected.

Data are presented using family studies which are not subject to this criticism. Up to the present (176 sibships) there is no significant increase in the frequency of O in the propositi compared with their unaffected sibs.

The secretor status has also been investigated in these sibships. Here there is a significant increase in non-secretors among the duodenal ulcer patients compared with controls. The implications of this finding are discussed.

FATHERLESS FAMILIES OF *LEBISTES RETICULATUS*

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Sixteen related *Lebistes reticulatus* between the ages of 184 and 769 days of age have produced fatherless litters totalling more than 270 babies and embryos. With two exceptions (1 male and 1 hermaphrodite) the individuals (about 100) surviving to be sexed have been females, and 3 : 1 segregation ratios of three domestic mutants have been observed among them. Fatherless females can themselves produce fatherless litters. With two exceptions the sired offspring both from fatherless females, and from the mothers of fatherless females, occur with a normal sex ratio. Females which are the offspring of crosses between two stocks produce larger fatherless litters than do females from the original stock, but these large litters contain many miscarriages. The one fatherless male was sterile. The hermaphrodite produced 9 fatherless litters, several of which were entirely still-born. "She" performed male-courtship behaviour to females but these did not produce offspring. After death, well developed testis-tissue was found in "her." All other 15 mothers were morphologically perfect females and no testicular tissue or sperm were found in the two examined histologically.

PRIMARY SEX RATIOS OF THE SEA-WEED FLY *COELOPA FRIGIDA* (F.) AND THE HOUSE MOUSE

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Zygotic ratios, unmodified by mortality subsequent to fertilisation, are rarely preserved in crosses. It is therefore of interest to analyse these ratios statistically when they are encountered. The sex ratio of the sea-weed fly *Coelopa frigida* was found, in an extensive experiment, to show hardly any variability between the families with low mortality. The chance of getting a more homogeneous sample is less than 5×10^{-4} , clearly not in agreement with the binomial distribution. An analysis of the data by McDowell and Lord on the house mouse also shows an unexpected homogeneity though not as strikingly as in *Coelopa*.

EFFECT OF GAMMA IRRADIATION ON THE AFFINITIES
OF *LOLIUM PERENNE* AND *FESTUCA PRATENSIS*

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Attempts to increase the crossability of *Lolium perenne* and *Festuca pratensis* by irradiating the gametes with gamma rays from a Co⁶⁰ source gave some unexpected results, which, however, have been consistent for two consecutive years.

Using *Lolium perenne* as female and crossing with pollen from irradiated *Festuca pratensis*, the percentages of seedset and germination were determined in relation to irradiation dose.

The results showed that up to about 500 r there was a decrease in seedset and germination. This was followed by a sharp rise to about 1500 r with a gradual decrease towards 3000 r.

The possible significance of these results will be discussed.

EXPERIMENTAL EVIDENCE CONCERNING "AFFINITY"

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In 1953 Dr Donald Michie and the writer presented the concept of, and observations supporting, a new phenomenon involving non-random assortment of independent markers, found in the House Mouse; this concept was termed "affinity" (*Nature*, 171, 26). An association of a chromosome III marker with three chromosome V markers, reported by the writer at that time, has been thoroughly investigated in order to test whether it can be explained on the hypothesis of "affinity." The results are significant and are given with a tentative map of linkage group V the position of the point in V responsible for the association. The possibility that this is the centromere is briefly discussed.

NOTICE OF CONGRESS

FIRST INTERNATIONAL CONGRESS OF HUMAN GENETICS

This congress will be held in Copenhagen, 1st to 6th August 1956.

Provisional programme and information are sent on request.
Address: The Secretariat of the Congress, University Institute for Human Genetics, 14, Tagensvej, Copenhagen, N., Denmark.

PROFESSOR ØJVIND WINGE

Professor Winge's 70th birthday is due on May 19th, 1956. At the same time he completes his long service to the Carlsberg Laboratory. Geneticists all over the world will wish to offer their tribute of congratulations on this occasion to one whom we have admired for the immense versatility and fruitfulness of his successive researches. To no other living man do we owe the elucidation of so many unforeseen novelties, from his early work on polyploidy, sex chromosomes and sex-linkage, to his later pregnant researches in the *Saccharomycetes*. Each topic to which he has given his mind has turned out to be of importance for the development of our science.

C. D. D., R. A. F.