

GENETICAL SOCIETY OF GREAT BRITAIN

ABSTRACTS of Papers read at the HUNDRED AND THIRTY-FIFTH MEETING of the Society held on 23rd and 24th MARCH 1961, at the SCHOOL OF AGRICULTURE, UNIVERSITY OF NOTTINGHAM

THE POPULATION GENETICS OF "SEX-RATIO" IN *DROSOPHILA PSEUDOOBSCURA*

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In *Drosophila pseudoobscura* the X-linked gene "sex ratio" causes males carrying it to produce few or no males but nearly twice as many females as are produced by normal males. In the absence of differential viability one might expect it to increase in a population until there were no males left, and yet equilibria, with gene frequencies up to 30 per cent., have been found in natural populations. Wallace (1948) conducted a series of experiments to determine the viabilities, and set up some population cages to follow the progress of the gene. In these cages the gene was either eliminated, or was at a very low frequency when the experiment was ended. Bennett (1958) put forward a mathematical model for a sex-linked locus which he applied to Wallace's findings, but examination of his model reveals an error which makes it inapplicable to this situation. Briefly, he confounded gametic and genotypic viabilities, a course which invalidates some of his findings. The present paper describes a more appropriate model, which has been used to study the polymorphism with the aid of an electronic digital computer. It is shown that Wallace's viabilities fit neither the natural nor his experimental populations, and new viabilities are suggested for each case.

THE EVOLUTION OF THE DIPLOID-LIKE MEIOSIS OF POLYPLOID WHEAT

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Previous work has shown that the diploid-like meiotic behaviour of the hexaploid wheat, *Triticum aestivum*, is due to the activity of chromosome V. In the absence of V, corresponding homœologous chromosomes from the different genomes can pair at meiosis. A series of hybrids between wheat and rye, deficient in turn for each chromosome of the wheat complement, has shown that no other chromosome has a similar activity. Other hybrids between an *Egilops* species and wheat, deficient for either the complete chromosome V or its long or short arm separately, have demonstrated that the activity is confined to the long arm.

None of the diploid species, from which the chromosome might have been derived in the evolution of polyploid wheat, produces an effect on meiotic pairing like that caused by V. In appropriate hybrids, one species removes the restriction on pairing imposed by V. The other species do not remove the restriction on homœologous pairing, nor do they prevent homœologous pairing in the absence of chromosome V. Consequently the restriction of pairing to fully homologous partners depends upon functions modified by mutation subsequent to the origin of polyploidy.

LIFETIME GROWTH AND PRODUCTIVITY OF LARGE AND SMALL STRAINS OF MICE

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The lifetime growth and reproductive performance of mice selected for high and low six-week weight were studied. The experimental material comprised six groups—two large strains, two small strains, a cross between large and small strains and an unselected strain.

Strains differing in weight at six weeks attained markedly different mature weights. But two strains with closely similar mature weights differed conspicuously in their rates of growth. Unlike the other four groups, the two large strains showed a sharp decline in weight in later life, probably through the depletion of accumulated stores of fat.

Large strains, as expected, had larger litters than the small strains, but they had a much shorter reproductive life, with the consequence that the small strains eventually weaned twice as many offspring per mouse as the large strains, over their whole lifetime.

The heterosis displayed by the crossbred mice with respect to reproductive capacity was striking. Compared with the better parental strain, this group weaned three times as many offspring over their lifetime, the total weight of which at weaning time was four times as great.

BREEDING IMPROVED MILKING COWS THROUGH ARTIFICIAL INSEMINATION

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The widespread use of artificial insemination in England and Wales (over 2 million cattle forming 60 per cent. of the National Herd are inseminated annually, some 1.5 million of these inseminations being carried out from the 23 centres owned by the Milk Marketing Board) permits the application of scientific principles to the breeding of dairy cattle. The Milk Marketing Board's plans for breeding improved milking cows through A.I. are briefly described and some of the problems encountered are discussed.

SEX DETERMINATION IN THE HOP, AND NEW BREEDING TECHNIQUES

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Cytological studies of a range of dioecious and monoecious hop plants suggest that morphological sex differences are determined by the X chromosome/autosome balance, which probably controls auxin levels. The Y chromosome, however, appears to be necessary for successful pollen development.

Hop breeding would be greatly facilitated if pollen could be obtained from plants whose quality characteristics can be directly assessed. This is possible with tetraploid monoecious plants, and attempts are also being made to produce fertile male flowers on genetically female plants by chemical treatment.

THE GENETIC CONTROL OF LEAF DEVELOPMENT IN RYEGRASS

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Total leaf area is an important factor determining yield. As the measurement of total leaf area is very laborious the genetic control of two of its main component.

characters, individual leaf size and rate of leaf production, have been studied. Estimates of heritabilities for three varieties, Italian ryegrass and Irish and Hunsballe perennial ryegrass, were obtained from parent-progeny regressions and the analysis of full sib families. These tests showed appreciable additive genetic variation for rate of leaf production in all varieties and for leaf size in Italian and Hunsballe. Small negative genetic correlations between these two characters were found in all varieties.

Selection for high and low expression of leaf size and rate of leaf production has been continued for three generations and appreciable response has occurred in all varieties. Deviations occur from the responses expected on the basis of the first generation estimates of heritabilities and genetic correlations. In most selection lines there is a marked negative correlated response between leaf size and rate of leaf production, with the result that, while there may be appreciable response in the selected character, there is no significant corresponding improvement in yield.

GENETIC ANALYSIS OF GROWTH IN TOMATO

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Genetic analysis of continuous variation has usually been carried out on characters measured at only one point of time. The results to be discussed were obtained from a diallel analysis involving five tomato varieties in which total dry weight and leaf area were determined at fortnightly intervals over ten weeks of growth. The experiment has allowed both the analysis of growth rate and of dry weight and leaf areas at varying stages of plant development. The cause of heterosis in certain crosses will also be discussed.

SOME ASPECTS OF THE INHERITANCE OF GRAIN QUALITY IN WHEAT

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For the purposes of genetic investigation, grain quality in *Triticum aestivum* must be considered as a complex of characters. Milling quality is principally determined by the cellular structure of the endosperm; test weight and grain size being less important. The quality of the flour, for bread or biscuit making, depends largely on its protein content and the capacity of the protein to give the dough the required physical properties. The inheritance of these components has been studied in a diallel series of crosses, comprising the varieties Holdfast, Yeoman, Cappelle Desprez, Hybrid 46 and Heine VII. The genetic systems involved showed a significant degree of dominance, and virtually complete absence of genic interaction.

In a further experiment, individual grains on F^1 plants were graded according to endosperm structure. The classified grains, which appeared to show a wide segregation for the character examined, were sown and grain from the resultant plants was milled experimentally. Good agreement between the two tests showed that the milling type of an individual grain on a heterozygous plant is determined by the genotype of the endosperm, rather than by that of the parent. It is suggested that other components of grain quality may be similarly determined.

MEIOTIC NON-DISJUNCTION

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Consideration is given to the several theoretically possible modes of meiotic non-disjunction and their genetic consequences.

THE MECHANISM OF FORMALDEHYDE-INDUCED
MUTAGENESIS

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It is established by means of a chemically defined and axenic treatment medium, that formaldehyde exhibits no mutagenic activity towards *Drosophila melanogaster* by the larval feeding method, unless adenylic acid is present in the treatment medium. A reaction product formed between formaldehyde and adenylic acid in the treatment medium is postulated as the metabolite concerned in the mediation of the mutagenic activity of formaldehyde. The principal metabolite is assumed to be an adenylate dimer, where two adenylic acid molecules are linked together through their amino-groups by a methylene bridge. The stereochemical properties of this metabolite and its consequent utilisation in deoxyribonucleic acid synthesis, together with mechanisms for its mutagenic activity are discussed.

An essential role is thus ascribed to the 6-amino-group of adenylate for the formation of the adenylate dimer, since the binding of formaldehyde by ribonucleic acid mono- or poly-nucleotides appears to be a specific function of the amino-groups of the purine and pyrimidine bases. Whilst adenylate is effective when present in the treatment medium as any of the forms adenosine-3'-phosphate, adenosine-5'-phosphate, adenosine-5'-phosphate, or deoxyadenosine-5'-phosphate, the simple replacement of the 6-amino-group of adenosine and adenosine-5'-phosphate (to give inosine and inosine-5'-phosphate) completely removes the ability of these compounds to mediate the mutagenic activity of formaldehyde. Although adenosine is as effective as the adenine ribonucleotides, adenine shows no ability to mediate formaldehyde-induced mutagenesis and is actually anti-mutagenic on a formaldehyde-containing yeast-glucose treatment medium. The patterns of utilisation of purine and pyrimidine derivatives by *Drosophila melanogaster* are discussed in relation to their ability or inability to mediate the mutagenic activity of formaldehyde.

POLARISED REPLICATION AS A POSSIBLE CONDITION
FOR RECOMBINATION

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Localised negative interference in *Aspergillus nidulans* and other microorganisms shows that recombination in one zygote is confined to small regions of the chromosome. These regions called, by Pritchard, effective pairing segments, are discontinuously distributed over the chromosomes.

Among crosses involving fourteen *paba* mutants, two by two, the distribution of recombination events in this region has been studied. The strength of negative interference on either side of the interval within which a cross-over between two *paba* mutants is selected, is asymmetrical. With increasing length of the selected interval "negative interference" on the proximal side falls rapidly while on the distal side it remains unaffected.

If, as generally believed, replication is an essential condition for recombination, the results suggest that replication is polarised. This imposes a time sequence on the occurrence of recombination events within the effectively paired region. The results are consistent with those of Rizet, though in our case the distribution of outside markers permits identification of single and multiple cross-overs.

SOME STUDIES OF THE EFFECTS OF ULTRAVIOLET LIGHT ON RECOMBINATION IN *NEUROSPORA*

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Preliminary studies suggest that ultraviolet light may increase both crossing-over and non-reciprocal recombination in *Neurospora*.

Recombination, as detected by random spore and tetrad analyses, was studied in crosses involving a pair of multi-marked stocks of *Neurospora crassa*, with markers in Linkage Groups I and VI. Conidia were irradiated with small doses of ultraviolet light prior to use in a cross. When compared with untreated crosses, two of three treated crosses showed highly significant increases in crossing-over in the region between *cr* (*crisp*) and *arg-3* (30300) in Linkage Group I.

Seventy-seven tetrads were analysed from treated crosses, and three were found to show atypical segregations; in each a single locus was involved. The three loci were *hist-2* (C94), *ylo* (Y30539Y), and *tryp-2* (75001). Eighty-nine tetrads isolated from similar crosses not treated with ultraviolet light, showed no atypical segregations.

RECOMBINATION AND COMPLEMENTATION BETWEEN SUPPRESSOR GENES IN *COPRINUS LAGOPUS*

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Monocaryons of *C. lagopus* carrying a gene *pur*, which affects the synthesis of aromatic compounds and gives rise to purple pigmentation, display instability due to suppression of *pur* by recessive mutations at other genes. Suppressed cultures are thus white, although not always of wild phenotype.

When matings are made between suppressed monocaryons homozygous for *pur* but carrying suppressors of independent origin, complementation between suppressors may occur—restoring the purple phenotype. Some 40 suppressors have been tested for complementation with each other and can be arranged on a single linear complementation map. Preliminary recombination analysis on the other hand indicates that more than one suppressor locus is involved in this group. Crosses between suppressed cultures and wild type reveal recombination between *pur* and suppressor loci varying from 0 per cent. to 19 per cent. These findings support those of Lewis (1960), working with suppressors of methionine requirement, that non-complementarity may obtain between widely separated genes. It may well be significant that this phenomenon has so far only been encountered in suppressor systems. The results are of interest with respect to

- (1) the concept of dominance
- (2) the distinction between non-complementarity at the phenotypic level and functional identity at the genic level.

S ALLELE MUTATIONS AND COMPONENTS OF THE S GENE

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Two components of the *S* gene complex, one controlling *S* allele specificity and having two, pollen and stylar, mutable units, and the other, determining a growth substance in the pollen, are already known. Evidence will be presented from different species of *Nicotiana* and *Solanum*, for the occurrence of (1) another growth substance unit controlling production in the style and (2) a third component, determining a general primary specificity and having pollen and stylar mutable units.

On the above basis of *S* gene structure, eight kinds of *S* allele mutants are possible, six of which have already been identified. In the light of these observations, the reason for the failure to recover spontaneous or induced mutations of the normal *S* allele in certain solanaceous species will also be briefly discussed.