GENETICAL SOCIETY OF GREAT BRITAIN

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GENOTROPHIC CHANGE IN LINUM

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Heritable changes are induced in two varieties of flax when they are grown in a heated greenhouse and supplied with different nutrients. A true breeding large (L) genotroph can be induced with nitrogen and a true breeding small (S) genotroph with phosphorus but there are many other necessary factors. Crosses, and detailed morphological studies (S. C. Wanigaratne), show that L and S of both varieties have similar characteristics. L and S are stable and behave as distinct genetic types in most respects but their F_1 is unstable and gives rise to heritable variation. F_1 instability does not occur in crosses of L, or S, with other varieties.

L has 16 per cent. more nuclear DNA than S, and the original plastic variety has an intermediate amount (G. M. Evans, H. Rees). Selections were made for large and small plants from the F_1 onwards of a $S \times L$ cross and in the F_6 the large plants had more nuclear DNA than the small. D. B. Nicholas found that L and S have a major gene difference, ciliate-smooth septa. This appears to be un unstable gene which is changed by certain genotypic or genotrophic backgrounds and by some environments.

CHROMOSOME EVOLUTION IN DIPLOIDS

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Extensive polyploid series in many families of higher plants shows that increase in genetic material has played an important part in their evolution. In other, by no means rare, families we find, in contrast, a consistent diploid chromosome number throughout. It is shown, however, that between species within these diploid series the amount of genetic material, as measured by nuclear mass and nuclear DNA, is by no means constant and may vary by as much as seven fold within a genus. The nature and evolutionary significance of the increase in nuclear DNA in these diploid groups is discussed.

THE IMPLICATIONS OF DEVELOPMENT GENETICS IN FORAGE PLANT BREEDING

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The handling of yield, as such, as an objective in forage plant breeding is particularly difficult. Its measurement may be influenced by the method of

utilisation, *e.g.* mechanical harvesting compared with grazing by animals; furthermore, it is likely to show large genotype-environment interactions because of the very wide range of conditions under which a crop may be grown. For these reasons it is important to have a knowledge of the growth and development of both the individual plant and the crop as well as having a knowledge of the genetic control of various characters.

This paper reports studies of the genetics of certain aspects of development of the grass plant which are known to be associated with high growth rates and production. The implications of such studies in defining the objectives of breeding programmes are discussed.

GENETIC RELATIONSHIP OF THE ATLANTIC ISLANDS *DACTYLIS*

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The Atlantic Islands of *Dactylis* group consists, as on the Eurasian Continent and North Africa, of a basic diploid population with a more widely distributed and closely related tetraploid superstructure. The morphological relationship of these endemic populations at both chromosome levels are discussed, and the genetic relationship of the diploid with other related diploids are considered in relation to the evolution of the tetraploid superstructure.

LINKAGE STUDIES ON FACTORS CONTROLLING REACTION TO CHEMICALS IN *HORDEUM SATIVUM* JESS

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Resistance to DDT in barley is due to a single recessive gene *ddt*: F_2 and F_3 segregates from hybrids containing the key markers for each of the 7 chromosomes failed to reveal any linkage. In studies using translocation stocks as parents only progeny from the cross T3-7a × Proctor gave any evidence of linkage. Results from F_2 progeny of this cross indicated a linkage of 17 per cent. $\pm 2{\cdot}2$ of *ddt* with the breakpoint. There is no evidence of any disturbed ratios in crosses containing either T2-3d or 6-7b as a parent or any sign of linkage with a_n, *uz* or *st* located in both arms of chromosome 3 or with *r* and *lb* located in the long arm of chromosome 7. Thus the most likely location of *ddt* is in the short arm of chromosome 7.

Barban (4 chloro-2 butynyl-N-3 (chlorophenyl) carbamate) has been found to induce two forms of damage in barley, viz. chlorosis and apical inhibition. Resistance to barban chlorosis appears to be due to a single recessive gene *bc* while resistance to apical inhibition is additive, but in F_2 studies can appear to be dominant or recessive, depending on the rate of barban applied. There is no evidence of any genetic linkage of the factors controlling the reaction to these chemicals.

THE ISOLATION OF INBRED LINES FOR HYBRID KALE PRODUCTION

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The production of double-cross hybrid kale on a commercial scale appears to be possible if use is made of the sporophytically determined incompatibility system present in the species. Single-cross hybrids are already available in some

of the horticultural *Brassicæ*, but their use as agricultural crops is impossible because of the necessarily high seed costs.

The selection of inbred lines for double-cross production is difficult, because of the very large numbers of hybrid combinations which can be made from relatively few inbred lines, thus severely limiting the extent of inbred testing. An outline of a system now being followed at W.P.B.S. to improve the efficiency of the breeding procedure will be presented.

Two main criteria of selection are pursued, namely (*a*) general combining abilities, and (*b*) suitability for economic production of seed on a large scale. After application of these criteria, the testing of actual hybrid combinations can be carried out with greater probability of finding desirable combinations.

THE INDUCTION AND REPRESSION OF NITRATE REDUCTASE IN THE FUNGUS *ASPERGILLUS NIDULANS*

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Experiments to study the behaviour of nitrate reductase activity in mycelium upon the addition of nitrate to the medium, and upon removal from a nitrate containing medium to media containing various other nitrogen sources, will be described. The results of these experiments suggest that the synthesis of this enzyme is induced by nitrate and repressed by ammonium. Other experiments show that no *in vitro* inhibition of nitrate reductase can be ascribed to ammonium.

The kinetics of nitrate reductase induction are different from those found commonly for bacterial enzymes, the rate of enzyme production being at no time directly proportional to mycelial mass. Models are put forward to explain these differences. One model suggests that nuclei in the mycelium are heterogeneous with respect to the control system for nitrate reductase.

THE CONTROL OF NITRATE REDUCTASE AND NITRITE REDUCTASE IN *ASPERGILLUS NIDULANS* HETEROCARYONS

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It is known that in *Aspergillus nidulans* there are at least six independently segregating loci which involve mutants unable to use nitrate as a sole nitrogen source but able to use nitrite. In addition, three loci are known where mutation results in an inability to use either nitrate or nitrite as sole nitrogen source. All of these loci have been assigned to linkage groups by the use of haploidisation and in some cases the approximate chromosomal location of the loci has been determined.

A technique has been developed for growing *Aspergillus* in still culture for the determination of enzyme activities in haploid, diploid and heterokaryotic mycelium. Using other biochemical markers to force heterokaryon formation, heterokaryons between various non-allelic non-nitrate utilising mutants were grown in the presence and absence of nitrate and replicate flasks were harvested over an extended time interval. The levels of nitrate reductase, nitrite reductase and cytochrome-c reductase have been determined in the heterokaryons and in the heterokaryon component strains. Appreciable levels of nitrate reductase have been obtained from the heterokaryons.

In the initial stages of heterokaryon development and throughout the growth period of the component strains, nitrate reductase is absent and nitrite reductase and cytochrome-c reductase are present at a high constitutive level. With the

appearance of nitrate reductase in the later stages of the development of the heterokaryon, nitrite and cytochrome-c reductase become inducible. These results support the hypothesis that the synthesis of these enzymes is governed by a control system dependent on the presence of functional nitrate reductase.

THE CONTROL OF NITRATE INDUCED ENZYMES IN *ASPERGILLUS NIDULANS*

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The enzymes nitrate reductase, nitrite reductase, hydroxylamine reductase and a number of $NADPH_2$-diaphorases of wild type *A. nidulans* are only present at high levels in mycelium grown in medium containing nitrate. Mutants at six loci which are unable to utilise nitrate, and mutants at three further loci which are unable to utilise nitrate or nitrite, have been assayed for these enzymes after growth in the presence and absence of nitrate.

The non-nitrate utilising mutants, unlike the wild type, are constitutive for nitrite reductase, hydroxylamine reductase and the $NADPH_2$-diaphorases since all these enzymes are produced at a high level after growth in the absence of nitrate. The results suggest that a single system, or a number of systems with at least one common component, are involved in the control of all the nitrate induced enzymes.

The enzyme levels in the non-nitrite utilising mutants make it unlikely that any of them are structural gene mutants for nitrite reductase or hydroxylamine reductase. One group is possibly permease or regulatory mutants, another is probably concerned with some other enzyme concerned with the nitrate utilisation pathway. The third group possess a flavin requirement which indirectly results in the inability to use nitrate or nitrite.

VARIATION IN WILD POPULATIONS OF *PAPAVER DUBIUM*

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A study of the inheritance of flowering-time in the poppy *Papaver dubium* have shown that in each of the five population samples investigated there were considerable amounts of both additive and non-additive genetic variation and that populations differed in respect of both these components of variation. Despite this evidence however there is reason to believe that individual plants are relatively homozygous for genes controlling flowering-time. It is suggested that this situation has arisen because individuals mate assortatively in respect of this character.

THE MANIFOLD EFFECTS OF A GENE AFFECTING FRUIT SIZE AND VEGETATIVE GROWTH IN THE RASPBERRY

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A mutation found in the raspberry variety Malling Jewel had bigger fruiting branches, flowers, fruits and seeds than the parent stock. The results of breeding experiments were consistent with the hypothesis that the change was caused by mutation of a single gene from the homozygous to the heterozygous state, and that the gene concerned has functions whose effects are seen at each stage of development.

These effects are to depress slightly the amount of vegetative or first year's growth and to increase the amount of reproductive or second year's growth. The nature of the physiological changes induced will be discussed. It is suggested that genes of similar function may account for differences which distinguish the raspberry from certain related species. The mutant is useful for plant breeding purposes.

THE GENETICAL CONTROL OF FLOWERING AND RUNNERING IN VARIETIES OF *FRAGARIA VESCA*

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In the annual cycle of development wild type *Fragaria vesca* has a phase of flowering and fruit production, followed by a period of vegetative development during which runners are produced. The Alpine varieties, Baron Solemacher and Bush White, have no such vegetative phase and produce no runners but continue to produce flower and fruit throughout the growing season. Crosses between wild type *F. vesca* and the two Alpine varieties showed that in both cases the everbearing habit and non-runnering character are inherited independently of each other and each is controlled by a single major gene, wild type being dominant. Crosses between the two Alpine varieties showed that whereas the everbearing habit appears to be controlled by the same gene in both cases, the control of the non-runnering habit is more complex. Both Baron Solemacher and Bush White breed true for the recessive character, non-runnering, on being selfed for several generations, but F_1 progeny of crosses between the two all produce runners. The results of selfing and back-crossing the hybrid plants as far as an F_3 and corresponding back-cross generations showed that the inheritance of the non-runnering character could not be controlled by a relatively simple system of complementary genes but must involve a more complex polygenic system.

GENETICAL CHANGE IN AN ISLAND MOUSE POPULATION

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The incidences of all-or-none variants in the skeleton of house mice are remarkably constant over the whole of the southern half of England, but significant differences from the mainland are found in the mainly cliff-living population on the virtually uninhabited island of Skokholm (two miles off Pembrokeshire). The Isle of May in the Firth of Forth has a population of mice living under ecologically similar conditions, and these mice are as distinct from their mainland neighbours as are those on the Welsh island. Although the mice on both islands have the large size characteristic of island races of rodents, their distinctiveness from their mainland neighbours cannot be regarded as entirely adaptive since they are almost as distinct from each other as the sum of their distinctiveness from their respective neighbours, and they both have certain features in common with their nearest neighbours. Their oddities can best be ascribed to the persistence of the chance characteristics of the presumed few founders of each population. However, genetical change in the Skokholm population (indicated by change in skeletal variant incidences) equivalent to differences between populations 150 miles apart on the mainland, took place between 1957 and 1960, and again between 1960 and 1961. The changes apparently occurred during, and not after, heavy (up go 95 per cent.) winter mortalities, *i.e.* they are selective.

THE CAUSES OF DEAFNESS AND BLINDNESS IN CHILDREN

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Not less than 1 in 500 of the population of the United Kingdom suffer educational social and economic difficulties because of deafness or blindness in childhood. Studies of these conditions, based mainly on a clinical and family investigation of 2355 deaf and 776 blind children in special schools have revealed considerable biological heterogeneity. In the case of both handicaps genetical factors play a considerable role in causation both directly and by interaction with environmental influences. The spectrum of causation is defined as far as possible in the case of both deafness and blindness. Estimates are made of the relative numerical importance of the causes involved and an ætiological comparison and contrast between the two entities is discussed.

TWO NEW CYTOPLASMIC MUTAGENS FOR *ASPERGILLUS NIDULANS*

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Gamma radiation and DL-p-fluorophenylalanine have been shown to exhibit mutagenic activity for the cytoplasm of *A. nidulans*. While the radiation gives a number of different phenotypes the amino acid analogue appears to induce two phenotypes in those lines described. On the basis of a comparison of the mutagenic efficiency of these two non-specific mutagens with other observations with the nucleic acid specific ultra-violet irradiation it is suggested that cytoplasmic mutation is not necessarily restricted to a nucleic acid target.

EVIDENCE THAT HERPES SIMPLEX VIRUS CODES FOR TRANSFER RNA LIKE S-RNA

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Herpes virus contains double-stranded DNA of 68 per cent. G+C content. Virus replication takes place in the nuclei of mammalian cells, whose DNA has 40 to 44 per cent. G+C. If the population of transfer RNA molecules normally present in a mammalian cell is optimally adjusted to the translation requirements of messenger RNA transcribed from its 40 to 44 per cent. G+C DNA, then this population cannot be similarly adjusted to the requirements of herpes virus specified messenger RNA. Calculations indicate that 24 transfer RNAs would be poorly represented at the time of extensive synthesis of virus proteins, which suggests that the virus may contain genetic information for certain transfer RNAs (and their activating enzymes).

DNA-RNA hybridisation experiments were carried out using labelled S-RNA fractionated from infected and uninfected hamster cells, and DNA extracted from herpes virus and from hamster cells. On several criteria these S-RNAs behave like transfer RNA. The experiments show that (*a*) virus DNA hybridises with infected cell S-RNA but not with uninfected cell S-RNA and (*b*) cell DNA hybridises with both infected and uninfected cell S-RNA. 1·2 per cent. of the virus DNA specifically hybridises with the cell S-RNA which represents sufficient DNA to code for 10 to 20 molecular species of transfer RNA.

POSSIBLE EFECTS OF MITOTIC RECOMBINATION ON GENE CONVERSION, NEGATIVE INTERFERENCE AND THE ORIGIN OF VARIATION IN ASEXUALLY PROPAGATED PLANTS

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It has become recognised that segregation of gene loci may occur in ratios deviating from the 1 : 1. The usual explanations put forward to account for such ratios have been based on copy-choice although 7 : 1 and 8 : 0 ratios are difficult to explain on this basis. It will be suggested that all such ratios can be explained by the occurrence of mitotic recombination involving only part of a 4-stranded chromatid. Separation of the chromatids after such recombination could result in further breakage of the same strand. This would result in gene conversion for a limited number of closely position loci while the remainder would segregate normally. This is the generally observed result. When the sites of recombination are closely positioned the exchange postulated can also account for the phenomenon of negative interference. Evidence will be presented for and against the suggested hypothesis and conclusions will also be drawn about the relationship of mitotic recombination to negative interference and to the origin of variation in asexually propagated plant material.

THE INFLUENCE OF METABOLIC INHIBITORS ON RECOMBINATION IN *CHLAMYDOMONAS REINHARDI*

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Inhibitors of DNA, RNA, or protein synthesis have been applied during specific meiotic stages, and changes in recombination frequency assessed. Different DNA inhibitors influence recombination in varying ways. As a group, however, they differ from the other two in affecting recombination only during two specific stages. When effective, inhibitors of RNA and protein synthesis change recombination frequencies during all stages up to pachytene. These observations are compatible with models in which the terminal events of crossing-over, occurring in pachytene, result in the exchange of material between DNA molecules, and in which new material is incorporated into DNA during this process.

A COMPARISON OF CYTOLOGICAL AND GENETICAL OBSERVATIONS ON THE YIELD OF MAJOR CHROMOSOME REARRANGEMENTS FOLLOWING IRRADIATION OF MOUSE SPERMATOGONIA

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It is now known that reciprocal translocations and dominant lethals are induced by the irradiation of pre-meiotic as well as post-meiotic germ-cell stages in male mice. The rate of induction of such translocations is usually calculated from the incidence of heritable semi-sterility in the offspring of those exposed, with cytological confirmation of translocation heterozygosity where possible. When translocations arise in pre-meiotic stages, however, it should also be possible to deduce their rate of induction by cytological examination of the treated gonads themselves, especially by estimation of the frequency of multivalent configurations in germ-cells at first meiotic metaphase.

The recent development of an air-drying method of treating suspensions of testicular germ-cells for cytological examination has made this second more direct approach a practical proposition in males, since the primary spermatocytes (in

which the chromosome rearrangements are actually scored) should be randomly distributed in such preparations.

Results from these two methods have been compared, using irradiated hybrid male mice. A marked discrepancy was found, the frequency of multivalent associations in spermatocytes being much higher than expected from genetic results. All the evidence suggests that this does not result from a failure of translocation heterozygotes to show semi-sterility, but rather from a selective process between meiotic metaphase and fertilisation.