

AUSTRALIAN GENETICS SOCIETY

4TH ANNUAL GENERAL MEETING

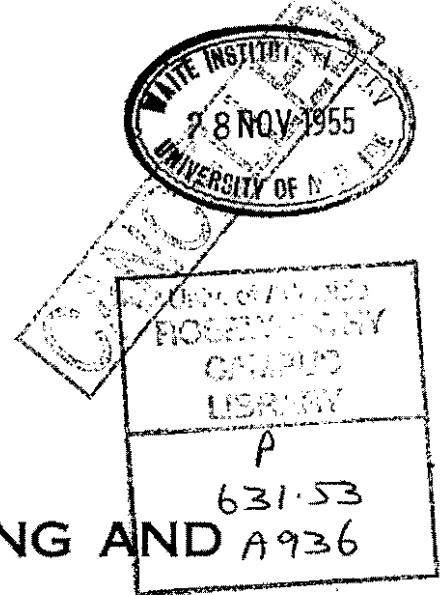
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ABSTRACTS

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ISSUED EVERY SIX MONTHS

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1. E.J. Godley: Presidential Address: "Recent investigations on breeding systems."
2. G.M. Wright: "Genetics of some Eschscholtzia populations."
3. J.B. Hair: "A cytologically irregular Agropyron."
4. R.M. Allison: "Nucleic acids."
5. J.A. Rattenbury: "Application of cytological methods to problems of plant evolution."
L.B. Anderson: "Lolium-Festuca hybrids."
S.O. Fejer: "Some new developments in quantitative inheritance."
E.J. Godley: "Cytoplasmic inheritance."
P.C. Barclay: "Recent studies bearing on the compound nature of the gene."
R.G. Robinson: "The Future of potato breeding in New Zealand."
F.W. Dry: "The variable expression of two main genes in sheep."
P.B. Hannken: "Commercial Hybrids: the stimulating effect of the new theory of co-dominance."

Discussion on genes and gene action and biochemical genetics introduced by P.C. Barclay.

C. M. Driver

AUSTRALIAN GENETICS SOCIETY. MELBOURNE MEETING

ABSTRACTS

- R. D. Brock : Natural hybridization in Danthonia.

The genus *Danthonia* (Wallaby grass) has been reported as cleistogamous and self-fertilizing (Cashmore, 1932). A study of plants collected from the field shows that within and between species there is considerable variation in floral morphology and degree of cleistogamy. Plants studied were diploid, triploid, tetraploid, pentaploid, hexaploid, and octaploid. Cytological studies thus confirm the existence of some natural hybridization. This is discussed in relation to the taxonomy of the genus.

- D. G. Catcheside. Double reduction and numerical non-disjunction in tetraploid maize.

Triple heterozygotes may produce gametes carrying only recessive genes either by double reduction or through numerical non-

disjunction, which occurs at a rate of 5 or more per cent. per chromosome. Which process has contributed in a particular instance may be determined by cytological examination of the exceptional individuals in a backcross. The results of an attempt to estimate the magnitude of the two factors for the sugary locus will be described; further experiments are under way for the yellow locus.

P. J. Claringbold. The design of experiments in Biometrical Genetics.

In order to obtain accurate estimates of genetic parameters such as heritability, Mather's D and H etc., the variances and covariances of characteristics of certain populations of individuals must be known with precision. The precision required is only obtainable with many observations. Thus most work in biometrical genetics has been carried out with plants or Drosophila, where thousands of observations are possible. With mice and other mammals the number of observations possible is much reduced. It may also be doubted if it is economically justifiable to measure thousands of mice for the sole purpose of estimating genetic parameters. In this paper methods are introduced by which genetic parameters may be estimated in the course of experiments with other primary aims.

H. Daday. Correlation between chemical and morphological character variations in wild populations of *Trifolium repens* L.

Previous work (*Heredity*, 1954) has disclosed cyanogenetic glucoside and enzyme gene clines in European natural populations of *T. repens*. The distribution of white leaf marking frequencies has now been studied in this material.

These leaf markings are governed by a series of multiple alleles (Brewbaker & Anderson, 1952).

The distribution of the allele frequencies and the occurrence of the different intensities of leaf marking have been scored in wild populations.

The frequencies of recessive allele, the distribution of dominant alleles, and the intensity of leaf markings is correlated with geographical distribution. There were significant correlations between the distribution of the genes controlling leaf markings and those controlling chemical characters in natural populations of *T. repens*.

C. Davern. Cold requirement for germination in subterranean clover.

A survey of a number of strains of subterranean clover has been undertaken to determine the strain variation in cold requirement for germination. The behaviour of this trait is to be investigated in a

number of crosses. It is proposed to use genetics methods to determine whether the site of germination inhibition is in the maternal or embryo tissue of the seed.

B. W. Holloway. Genetic recombination in *Pseudomonas aeruginosa*.

Genetic recombination has been shown to occur in *Pseudomonas aeruginosa*, in a manner similar to that occurring in *E. coli*. Crosses between 18 biochemical mutants of 4 strains have been studied and, although non-random segregation was found for non-selective markers it has not yet been possible to draw conclusions concerning gene order or linkage. The progeny obtained from crosses tend to resemble one parent more than the other. The four strains of *Pseudomonas aeruginosa* used are interfertile in certain combinations but self sterile. There is no evidence for an infectious principle affecting fertility but fertility changes may occur amongst recombinant progeny.

J. B. Langridge. Mutants of *Arabidopsis thaliana*.

A survey is being made of the frequency, as shown by mutation, of genes controlling different types of physiological activity in a flowering plant. Attention has so far been limited to mutational blocks in organic metabolism and to morphological mutants. It is proposed to select for mutations in inorganic nutrition, photosynthesis, photoperiod response, etc., by the use of selective media or environmental conditions.

G. Mayo. The use of diallel crosses.

A number of homozygous lines mated in all possible ways constitutes a diallel cross. The measurements of the F_1 progeny make up the diallel table. The algebra to describe the genetical situation of some quantitative character generating such a table, based on the assumption that inheritance is Mendelian, may be reduced to several statistics in terms of the components of variation that have been appropriately defined.

One important consequence is that the expected regression of array covariances on array variances has a slope of one. Various properties of this regression allow, inter alia, the effects due to dominance (unfixable variation) and those due to genic interaction (fixable variation) to be separated.

Data analysed so far show that heterosis and apparent overdominance can be accounted for largely by genic interaction: since this represents fixable variation, it has important implications.

The diallel analysis is a powerful tool for determining rapidly the potentiality of a number of lines in a population. Being orthogonal

in design the data are capable of diverse analysis.

The genetical terms used, such as dominance and interaction, refer to average effects of the assumed Mendelian units. They are statistical terms having no immediate relationship to the meaning of such terms used in describing the effects of genes capable of individual measurement.

G. McBride. Two oviducts in the domestic fowl.

Birds normally have a left ovary and oviduct, though a number of isolated instances have been reported of individuals with either two complete sets of genital organs, two oviducts only, or a partially developed persistent right oviduct.

All three types of abnormality have been found at a relatively high frequency in the University of Queensland flock of Australorps. Evidence will be presented on the inheritance of the character.

The frequency of double oviduct has increased rapidly in the flock since its inception in 1952. The possibility of a selective mechanism to account for this increase has been examined, and the results will be discussed.

Since flock replacements are obtained exclusively by artificial insemination and in the closed parent flock from which the University flock was obtained, natural mating is practised, the parent flock was examined to detect twin oviduct birds. One definite case was located.

Since the cloaca of twin oviduct birds differs structurally from normal birds, matings have been made to determine the relative fertility of the two types of female.

F. Morley. Genotype-environment interactions in sheep.

The progenies of a number of sires selected for high or low expression of fleece and body characters were split into two groups, one being fed on a high plane of nutrition, the other on a low plane. Heritability was generally unaffected by plane of nutrition. Some strong genotype-environment interactions were found, but there were no indications of such interactions in fleece-weight. The implications of these results are discussed in relation to selection programmes.

F.H.W. Morley, R.D. Brock & C.I. Davern. Sub-speciation in Trifolium subterraneum.

Sub-speciation in Trifolium subterraneum was indicated by the presence of reproductive and vegetative abnormalities in crosses between

some varieties.

In F_1 's and F_2 's there was pollen sterility, reduced seed setting and embryo abortion. Dwarf and semi-dwarf plants segregated in some F_2 's. The occurrence and severity of different abnormalities were strongly correlated between F_2 's. Within F_2 's the correlation was slight or non-existent, which suggested that these abnormalities were independently determined. Chromosomal rearrangement was indicated by failure of pairing, reduced chiasma frequency, and multivalent formation at meiosis of some F_2 's. Less than forty per cent. of observed pollen sterility could be explained by such structural differences. The main cause of sterility seems to be genic.

The presence of genic and structural sterility barriers suggests that many of the varieties were reproductively isolated long before they were introduced to Australia. Major varietal differences are unlikely to have arisen from selection of locally adapted ecotypes. There is thus ample justification for a programme of hybridization and selection to improve and to extend the range of the species. Such a programme would be impeded, but not prevented, by the presence of reduced fertility in some segregates.

F. Morley & C.I. Davern. Flowering-time in Trifolium subterraneum.

The following dates of flowering of 6 varieties of Subterranean Clover have been recorded -

Location	Talla-rook	Wenigup	Mt. Barker	Bacchus Marsh	Clare	Yarloop	Dwalganup
Melbourne	22/10	-	6/10	26/9	24/9	10/9	4/8
Wagga	8/10	1/10	21/9	30/8	9/9	12/8	12/7
Canberra	12/10	7/10	29/9	22/9	27/9	17/9	10/9
" Cold G'house	16/10	10/10	20/9	5/9	28/8	15/8	10/8
Lismore	6/10	early	6/9	28/8	10/6	10/6	1/6
N. S. W.		October					

These genotype-environment interactions may be explained in terms of temperature response in addition to vernalization photoperiod effects. Vernalization experiments showed that Tallarook, Mt. Barker and Bacchus Marsh have a long cold requirement, Wenigup has a relatively low cold requirement and the other varieties flowered during summer without vernalization. The results suggest that Clare and Yarloop have relatively high temperature coefficients and may be well adapted in this respect to hot climates. Wenigup probably requires a long photoperiod or has a low temperature coefficient.

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Cold requirement may be an adaptive mechanism for ensuring that plants do not flower during winter. Experiments with coastal and montane Moroccan strains support this suggestion, since four coastal strains showed little or no cold requirement, whereas four montane strains all required some vernalization.

These findings emphasize the importance of physiological understanding in plant breeding.

D. C. Wark. Effects of temperature on resistance to tobacco mosaic.

Two types of resistance to tobacco mosaic virus now occur in N. tabacum L. The first type, governed by a single dominant gene, was introduced from N. glutinosa L. and is temperature sensitive. At low temperatures the virus is localized by the development of necrotic lesions and this resistance is effective in preventing the spread of the virus. At temperatures above 95 - 100 F the virus becomes systemic and there is a breakdown of resistance. Such plants remain a source of infection even after the temperature falls. The concentration of the virus at high temperatures is somewhat lower in the homozygote than in the heterozygote.

The other type of resistance occurs in the variety Ambalema and a group of similar varieties from Colombia, South America. The resistance is independent of temperature. Although more difficult to incorporate into a commercial type of tobacco the Ambalema type of resistance would be superior in varieties to be grown in hot areas, such as North Queensland.

M. J. D. White. Multiple sex chromosome mechanisms in Australian Morabinae grasshoppers.

The Australian grasshoppers of the subfamily Morabinae (family Eumastacidae) are an endemic group of slender wingless insects, mostly specialized in their ecological requirements. Their powers of locomotion are very restricted and there has been much differentiation of local races and species confined to small areas. About 40 species have been described taxonomically, but about 30 more are known to exist. Four genera (Moraba, Callitala, Warramunga and Keyacris) have been recognised, but their limits are somewhat arbitrary.

Forty species of Morabinae have now been studied cytologically. The chromosome numbers ($2n$ in the male) range from 15 to 21. Chromosomal evolution has been complex, with many "fusions" and pericentric rearrangements. Seven species show chromosomal polymorphism in respect of pericentric rearrangements. Chiasmata show marked proximal localization in some species, distal localization in others.

Of the 40 species studied cytologically, 33 are XO in the male,

2 are XY and no less than 5 are X_1X_2Y . One of the latter is restricted to a small area of central N.S.W.; the other four were collected by Dr. K.H.L. Key in the Northern Territory.

The XY systems have arisen by incorporation of one autosomal pair in the sex chromosome mechanism; while the X_1X_2Y systems have resulted from the addition of a second autosome pair. Evidence will be presented suggesting that four of the five X_1X_2Y mechanisms arose independently and that the autosomes included in the sex chromosome mechanism were not the same in all cases. The detailed cytological history of some of these X_1X_2Y mechanisms has undoubtedly been complex, involving pericentric rearrangements and duplication or deletion of segments as well as the two fusions needed to produce the mechanism.

A hypothesis was put forward according to which the adaptive significance of these changes in the sex chromosome mechanism depended on fixation of heterotic mechanisms with effects limited to the heterogametic sex.

M. J. D. White. Adaptive Chromosomal Polymorphism in the Grasshopper Moraba scurra.

M. scurra is the most widespread species of the subfamily Morabinae on the southern tableland of N.S.W. and the only species over a considerable part of that area. Its distribution is highly discontinuous at the present time, but must have been less so before human settlement. Intensive grazing causes local extinction and in some areas scurra populations only survive in cemeteries fenced to exclude grazing animals.

M. scurra has only one generation a year. It is a "winter species" and adult males can be obtained from March through November. The summer months are passed in the egg stage.

In all populations there are a large number of different color-patterns. Males may be various shades of grey, brown or buff with various stripes and other markings. Females may show all these color-patterns and may, in addition, be bright green or striped with green.

Approximately 3200 male individuals from 44 different localities have been analyzed cytologically.

Most populations of M. scurra have $2n = 15$ in the male but in an area which includes Young, Murringo, Boorowa, Wallendbeen, Cootamundra, Gundegai, and Kyeamba a large metacentric chromosome which we call AB is broken into two acrocentric elements A and B, so that $2n = 17$. It is not quite clear what has happened to the centromere region. In other populations occasional individuals (approximately 0.4% of the total) have been encountered which were heterozygous for a broken AB chromosome.

All except three of the populations are cytologically polymorphic for pericentric rearrangements. One chromosome, referred to as CD, shows three sequences, Standard, Blundell and Molonglo; but the latter is only known from a single locality, where it replaces Standard, which is absent. Another chromosome, called EF, shows two sequences, Standard and Tidbinbilla; but the latter is absent from many populations. Thus almost all populations show polymorphism for the CD chromosome and many, but not all, for the EF chromosome as well. Heterozygosity for these pericentric rearrangements suppresses chiasma formation in the segment between the two centromeres.

In the case of the CD chromosome the data indicate that the hierarchy of adaptive values in most populations is:
 $St/Bl > Bl/Bl > St/St$ in most populations, but $St/Bl > St/St > Bl/Bl$ at Dalton and Murringo N.S.W.

In the case of the EF chromosome the situation in all populations containing Tidbinbilla is $St/Tid > St/St \gg Tid/Tid$ (where \gg means very much greater than). But Tidbinbilla is absent from many localities. Possibly it has been lost from these colonies because the heterotic advantage of St/Tid over St/St was too slight or non-existent; or because the adaptive value of the Tid/Tid homozygotes was too low. There is a strong tendency for Tidbinbilla to be rare or absent in populations where the frequency of the Standard CD is high.

The wide distribution of the various chromosome sequences indicates that they must be of great antiquity, in view of the feeble locomotory powers of the insect. It is therefore all the more surprising that the relative adaptive values tend to remain the same over large areas. But exceptions occur: thus the relative adaptive values of St/St and Bl/Bl homozygotes are reversed between Young and Murringo (which are only 15 miles apart) and between Royalla and Michelago.

H.N. Barber & R.H. Cruckshank. Diploid Tristylic Lythrum in Australia.

Lythrum salicaria is a variable species of plant occurring in North America, Europe, Manchuria, Japan and Australasia. The European and American populations are tetraploid ($2n = 60$), whilst the Japanese and Australian are diploid ($2n = 30$). The inheritance of style length (and incompatibility) in European and American populations depends on segregation at two unlinked loci, S and M. The S locus is always heterozygous (duplex or simplex). The S gene is epistatic to segregation at the M locus. Typical autotetraploid ratios at the M locus have been obtained by Mather and Fisher.

In Tasmanian populations a similar inheritance system is at work at the diploid level. Genotypes and phenotypes are given in the table. The data are as yet insufficient to detect linkage.

<u>Phenotype</u>	<u>PHENOTYPES</u>		<u>Equil. Frequency</u>
	<u>Frequency</u>	<u>obs. Kimberley, Tas.</u>	
Short- styled (S)	31.85	(93)	33.33
Mid- styled (M)	25.00	(73)	33.33
Long- styled (L)	43.15	(126)	33.3
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<u>Genotype</u>	<u>GENOTYPES</u>		<u>Equil. Frequency</u>
	<u>Frequency</u>	<u>Kimberley</u>	
SsMM	1.33		2.39
SsMm	10.35		13.08
Ssmm	20.17		17.86
ssMM	2.84		2.39
ssMm	22.16		30.94
ssmm	43.15		33.33
	<u>GENES</u>		
<u>Gene</u>			
S	15.92		16.67
s	84.08		83.33
M	20.42		26.79
m	79.58		73.20

The data in the table suggest that in the Kimberley population the M gene is at a selective disadvantage. It is not yet clear whether the selective disadvantage is at the gametic or zygotic stage.

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Experiments are being carried out in order to investigate the magnitude and eco-physiology of the selective action of these genes. These include determination of frequency of the M gene in S and non-S plants, determination of frequency of S, M and L plants from open-pollinated seed, establishment of two-type (S and M, S and L and M and L) populations in isolation etc.

It is also desirable to investigate the possibility of clonal variation in frequency of the three types. Any population counts or detailed localities of occurrence in Victoria and New South Wales would be welcomed.

F. E. Binet. On mixed selfing and panmixia.

A hypothetical, monoecious population is postulated in which a proportion γ of the male and female gametes produced by every zygote unit at random with those of the opposite kind produced by the same zygote, while the remainder undergo panmictic union. It is shown that with respect to each locus, such mixed selfing and panmixia lead to the same population that would be obtained by mixing, after equilibrium had been reached, purely selfing and purely panmictic populations in the proportion of $\gamma : 2(1 - \gamma)$. Both exact and limiting formulae have been derived for the case of two linked loci.

An application of the model to an ecological problem in the genus Eucalyptus leads to a brief discussion of some factors that might operate to maintain an excess of either coupled or repulsed phases. If these factors operate with sufficient intensity, then it seems that linkage can persistently contribute to correlation, even under panmixia.

G. W. Grigg. Production of macro- and micro-conidia in Neurospora.

Four genes (colonial-l, microconidial, suppressor of microconidial and temperature activated aconidiate) are described which interact with each other and the environment to determine qualitatively and quantitatively the production of vegetative spores (conidia) in Neurospora crassa.

Neurospora produces two types of conidia, microconidia and macroconidia. These differ in size and in the average number of nuclei. Strains are known which produce exclusively either macro- or microconidia.

The dominance relations of col-l, m, sm and acon^t determined by synthesising a heterokaryon between a strain carrying these genes and a wild type strain will be discussed.

It was found that there is a critical period in the ontogeny of a developing colony from a certain macroconidial-strain when ability to produce macro- or microconidia is determined. Inhibition of macroconidiophore formation during this short critical period results in the exclusive production of microconidia.

Valerie James. "Petiteness" in *Saccharomyces cerevisiae*.

There is evidence for cytoplasmic and nuclear inheritance of a respiratory deficiency in yeast. Indication that auxotrophy is associated with "petiteness" in *Saccharomyces cerevisiae* will be presented. Experiments for the restoration of a cytoplasmic "petite" to a normal yeast will be discussed.

W. D. Jackson. Patterns of chromosome breakage after aging and X-irradiation.

An analysis of chromosome breakage in Allium cepa after treatment of the dry seed by aging and by treatment with a dose of 2.4K.r. of X-irradiation shows the following facts:-

General Effects

1. Both treatments induce a slight drop in the rate of germination and a marked incidence in post-germination death.
2. There is considerable heterogeneity in the amount of chromosomal damage between individual seeds in both treatments. This heterogeneity is most marked in aged seed.
3. The pattern of aberration types produced is the same in both treatments within the limits of scoring. Excluding minutes 98% of all aberrations are simple acentric fragments. Chromatid breakage and non-sister reunion are practically absent. The vast majority of the acentric fragments are thus terminal deletions. Cells were scored for acentric fragment length, X, and for number of acentric fragments, N.

The Distribution of damage within chromosomes.

1. In both aged and irradiated material the distribution of X, in cells containing single fragments ($N = 1$), shows marked deviations from the rectangular distributions expected on the basis of the Target Theory. Near-terminal regions of the chromosome arm are very susceptible to damage, centromere regions susceptible but less so, while mid-arm regions are resistant.
2. The distributions of X obtained with the two treatments are very similar in form.

The distribution of damage between chromosomes of the one cell.

The form of the distribution of X remains constant in both treatments when cells where N is greater than 1 are compared with cells where N = 1. The absence of correlation between X and N indicates a random or near-random distribution of damage between arms, although the distribution within arms is far from random.

The distribution of damage between cells of the one seed.

1. The Poissonian distribution for N, as expected from the Target Theory, is not realised after either treatment. Both treatments give distributions showing over-dispersion. Using the ratio of variance to mean as an index of dispersion, the aged material, gives values for this index ranging from 2 - 6. The deviations from unity range from 9 - 16 times their standard errors. In the irradiated material the values for the dispersion index range from 1.3 to 2.3 with deviations from unity ranging from 3 to 10 times their standard errors.
 2. The data for distribution of N in each treatment can be fitted with a high degree of efficiency by a Polya or contagious distribution. This efficiency cannot be attributed merely to the introduction of an additional parameter.
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Since the material shows no areas obviously rich in heterochromatin, the breakage pattern cannot be attributed to the distribution of heterochromatin. There are two possible explanations for the non-random distribution of X and N. They are (1) non-random breakage, (2) non-random restitution. It is simpler to explain these distributions in terms of non-random breakage which implies that breakage results not from independent events distributed at random, but from some collective contribution by a number of such events. The experiments thus indicate that low ion density radiation and the chemical systems involved in the process of aging produce their effects through similar mechanisms and therefore give almost identical patterns of damage; further, they show that these patterns of chromosomal damage cannot be interpreted in terms of the Target Theory. The failure of the Target Theory model can be traced to a breakdown in the fundamental requirement of independence.

It is apparent that any proposed theory on the mechanism of chromosome breakage by low ion density radiation must in general conform to a wider concept which encompasses the action of treatments such as aging and radiomimetic chemicals. The theory must assume the interaction of a number of initial sites of ionization by the production of mutagenic substances or radicals at these sites. The mutagenic substances or

radicals diffuse in time and space and have a definite and relatively prolonged half-life period within the cell. Such a mechanism would result in the final pattern of breakage showing a contagious distribution of N and readily explains the non-random distribution of breaks within the chromosomes. The Target Theory may hold as a limiting case for high ion density radiation because of the restricted spatial relations of ion centres in the particle path.

S.K. Stephenson. Some Aspects of Gene Dosage Effects in N-Type Sheep.

The dominant and recessive mimic genes, N and nr, produce increased birthcoat hairiness in New Zealand Romney lambs. There is a gradient in hairiness over the body and this gradient has been studied in lambs of different genotypes by three different methods.

It has been found (i) that all lambs show increasing hairiness of the birthcoat from the shoulder-patch to the breech, (ii) increases in hairiness with increasing dosage of the N and nr genes conform to this gradient, and (iii) with any single increase in N-gene dosage there is a differential rate of increase in hairiness on the different positions.

The results are explained on the hypothesis that the primary genetic effect is linear, but the gradient is modified by a threshold and possibly by a ceiling effect in the production of the birthcoat medullation. These effects differ with the use of different methods.

On different positions of the body the threshold and ceiling effects, combined with the gradient in hairiness, produce apparent recessiveness and dominance of the gene N.