had the population size doubled itself for a considerable number of genera-
tions, the probability of survival of a mutant born at the beginning of the
process would be close to the solution of

$$-\log\left(1-\pi_1\right) = 2 \cdot 2\,\pi_1,$$

namely
$$\pi_1 = 0 \cdot 8437.$$

The above remarks make it clear that the substantial determinant of
the fate of a new mutant is the absolute change in numbers of the mutant
rather than the relative changes in frequency compared to the wild type.
It is, of course, for this reason that all classical results have assumed stable
population sizes.

A final remark might be made about the fate of an unfavourable new
mutant. Taking the situation of the numerical case given above as an
example, if the fitness of the new mutant is between $0 \cdot 5$ and 1 there will be
a tendency for the mutant to increase in numbers during the generations
when the population size is doubling; however as soon as the size stabilises
such mutants will soon die out. For example, a mutant with fitness $0 \cdot 75$
born in the first generation has probability $0 \cdot 6438$ of having descendants
in the fourth generation; in a stable population the corresponding proba-
bility is only $0 \cdot 1564$. Thus while the population size increases we should
expect that a variety of new and perhaps unusual types would appear, to
disappear again fairly soon after the population size stabilises.

4. REFERENCE

HARRIS, T. E. 1963. *The Theory of Branching Processes.* Springer-Verlag, Berlin.

CHIASMA FREQUENCIES IN EUCHROMATIC AND HETEROCHROMATIC CHROMOSOMES

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1. INTRODUCTION

THE interrelationships of chiasma frequencies in euchromatic bivalents in
the presence of extra euchromatin and heterochromatin have been de-
scribed (Shah, 1964, 1965). In the normal diploid there was an indication of
negative correlation in the standard bivalents while the addition of different
numbers of supernumerary chromosomes was associated with a non-linear
change in the character studied. In the present studies, the interrelationships
between the standard chromosomes and the heterochromatic supernumerary
chromosomes in plants with 2, 3 and 4 supernumerary chromosomes and
in an asynaptic plant with two supernumeraries are presented.

2. MATERIAL AND METHODS

The plants used belong to *Dactylis glomerata* subsp. *lusitanica* ($2n = 14 + B$'s). All
the plants having 2 and 4 supernumeraries, except the asynaptic plant, are sibs
obtained from a cross of a diploid with no supernumerary and plant No. 7 (see
table 1) and the reciprocal cross.

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At meiosis standard bivalents could not be individually recognised. The supernumeraries are heterochromatic and pair among themselves. The interrelations of total chiasma frequency for the seven standard bivalents and the total chiasma frequencies in the supernumeraries were studied by inter-class correlations between these two groups. The same relations were also studied by analysis of variance. In the case of the latter method the degrees of freedom were partitioned as given below:

Source of variation	D.F.
Total	$2n-1$*
Between nuclei (inter-nuclear)	$n-1$
Between two groups of bivalents	1
Within nuclei between groups (intra-nuclear)	$n-1$

* n = number of cells studied.

The method of testing the heterogeneity of correlations and obtaining the average correlation is given in snedecor (1961, p. 178). The cytological methods are given in Shah (1963, 1965).

3. RESULTS AND DISCUSSION

Table 1 summarises the correlations between the total chiasma frequency for the standard chromosomes and the total chiasma frequency for the supernumeraries in a cell. Table 2 gives the average correlations for the

TABLE 1

Interrelationship between chiasma frequencies in supernumeraries and normal set chromosomes

No. of supernumeraries	Plant No.	No. of cells	r	Variance components		F value
				Intra-nuclear	Inter-nuclear	
2	1	121	0·227*	0·6518	0·847	1·30
	2	22	0·380	0·8443	1·377	1·63
	3	31	0·160	0·8893	0·9623	1·08
	4 sample 1	72	0·111	0·4787	0·5515	1·15
	sample 2	80	0·138	0·6487	0·7954	1·23
	5	35	0·324	0·5168	0·7335	1·42
	6	50	0·249	0·5510	0·7396	1·34
3	7 sample 1	79	—0·009	0·7500	0·6840	1·10
	sample 2	18	0·537*	0·5441	1·1453	2·10
	sample 3	188	0·051	0·6713	0·7540	1·12
4	8 sample 1	52	0·070	1·0367	1·1439	1·10
	sample 2	17	0·549*	0·5663	1·1544	2·04
	9	55	0·110	1·0344	1·1980	1·16
Asynaptic plant $(2n+2S)$	Year 1959 sample 1	41	0·113	2·2725	2·4190	1·06
	sample 2	49	0·222	1·6217	1·9277	1·19
	Year 1960 sample 1	67	0·093	1·1594	1·2888	1·11
	sample 2	50	—0·193	1·0498	0·8906	1·18

* = Significant at 5 per cent level

various groups. The correlation is negative in only 2 of the 17 samples and values are not significant (table 1). Three of the positive correlations are significant. The correlations within the four groups, namely, the plants

with 2, 3 and 4 supernumeraries and the asynaptic plant, were homogenous. Average correlation for six plants with 2 supernumeraries is $+0\cdot20$ and is highly significant. For the plant with 3 supernumeraries and plants with 4 supernumeraries the average correlations are not significant. The average correlations with respect to the plants with 2, 3 and 4 supernumeraries (table 2) are homogenous. The average r for these nine plants, *i.e.* excluding the asynaptic plant, is $+0\cdot15$ and is highly significant ($P < 0\cdot001$). In the case of asynaptic plant the average $r = 0\cdot06$ which is not significant.

TABLE 2

Data with respect to average correlations

Group	Average correlations
2B	$0\cdot20$*
3B	$0\cdot06$
4B	$0\cdot15$
2, 3 and 4B	$0\cdot15$*
Asynaptic plant	$0\cdot06$

* = Significant at $0\cdot1$ per cent. level.

The results obtained by analysis of variance show a similar trend. In all the samples with positive correlations the inter-nuclear component is higher (table 1).

The homogeneity of these correlations at both the intra- and inter-group level indicates that the correlations observed are of a more general nature. There is very little earlier work on this aspect. Darlington and Upcott (1941) studied the correlation of chiasma frequencies in the B chromosomes and the standard chromosomes in maize. They report that within single flowers of single plants, having various numbers of B chromosomes, no correlations were found. However, their data are limited since their sample size is from 9 to 20 cells, the total number of cells studied being 77 (table 3, p. 284). With respect to their combined data, in groups of cells with 1 to 4 chiasmata in the B chromosomes the weighted means for the chiasma frequency in A chromosomes are nearly 8 to 9 per cent. higher than in the group of cells with no chiasma in the B chromosomes (table 3, Darlington and Upcott, 1941).

The elucidation of the basic cause of these different effects of heterochromatin with respect to competition within euchromatic chromosomes (Shah, 1965) and competition between euchromatic and heterochromatic chromosomes is not possible till we have more information on the chemical nature of the euchromatin and heterochromatin and their action at the biochemical level. A significant start has already been made in these fields and it has been shown that heterochromatin differs from euchromatin in certain basic aspects, *e.g.* DNA content at low temperatures (Haque, 1963).

At the cytological and genetical level, interdependence of chiasma frequencies in various bivalents has been shown in many cases (see Mather, 1936). The change in the nature of correlation between chiasma frequencies of bivalents when some of the conditions in the cell are altered such as the extent of heterozygosity and the addition of extra euchromatin has also been studied (Lamm, 1936; Mather, 1939).

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4. SUMMARY

1. The interrelationship between the total chiasma frequency in the standard chromosomes and that in the heterochromatic supernumerary chromosomes was studied in plants with 2, 3 or 4 extra chromosomes.

2. There was a highly significant positive correlation in plants with two supernumeraries, while in plants with 3 and 4 B's the correlations were insignificant.

3. The average correlation for all the synaptic plants with B's was +0·15 and highly significant.

4. The homogeneity of correlations at both intra- and inter-group levels indicates a more general occurrence of these correlations.

5. REFERENCES

DARLINGTON, C. D., AND UPCOTT, M. B. 1941. The activity of inert chromosomes in *Zea Mays. Jour. Genet., 41*, 275-296.

HAQUE, A. 1963. Differential labelling of *Trillium* chromosomes by H³-thymidine at low temperature. *Heredity, 18*, 129-133.

LAMM, R. 1936. Cytological studies on inbred rye. *Hereditas, 22*, 217-240.

MATHER, K. 1936. Competition between bivalents during chiasma formation. *Proc. Roy. Soc. Lond. B, 120*, 208-227.

MATHER, K. 1939. Competition for chiasmata in diploid and trisomic maize. *Chromosoma, 1*, 119-129.

SHAH, S. S. 1963. Studies on supernumerary chromosomes in the genus *Dactylis. Chromosoma, 14*, 162-185.

SHAH, S. S. 1964. Interrelationship of chiasma frequency in bivalents in *Dactylis glomerata* subsp. *lusitanica. Heredity, 19* (4), 736-738.

SHAH, S. S. 1965. Interrelationships of chiasma frequencies in normal set bivalents in presence of extra heterochromatin and euchromatin in *Dactylis glomerata* subsp. *lusitanica. Heredity, 20* (3), 470-474.

SNEDECOR, G. W. 1961. *Statistical Methods.* Allied Pacific Private Ltd. Indian edition.

THE INFLUENCE OF B CHROMOSOMES ON MEIOSIS IN *LOLIUM*

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1. INTRODUCTION

REPORTS during the past few years show that supernumerary, *B* chromosomes occur in numerous species, both plant and animal. They are especially prevalent in diploid Angiosperms. While the *B* chromosomes undoubtedly influence development of the phenotype and thereby effect measurable changes in external morphology it is still not clear what adaptive role they play that would account for their widespread distribution and hence, presumed, adaptive importance. John and Hewitt (1965*a, b*) have suggested that *B*'s may serve as regulators of recombination at meiosis. In