1. REFERENCES

BEARDMORE, J. A., DOBZHANSKY, TH., AND PAVLOVSKY, O. A. 1960. An attempt to compare the fitness of polymorphic and monomorphic experimental populations of *Drosophila pseudoobscura*. *Heredity*, *14*, 19-33.

DOBZHANSKY, TH. 1948. Genetics of natural populations. XVIII. Experiments on chromosomes of *Drosophila pseudoobscura* from different geographic regions. *Genetics*, *33*, 588-602.

LEVINE, L. 1955. Genotypic background and heterosis in *Drosophila pseudoobscura*. *Genetics*, *40*, 832-849.

MOURAD, A. M. 1962. Effects of irradiation in genetically coadapted systems. *Genetics*, *47*, 1647-1662.

STRICKBERGER, M. W. 1963. Evolution of fitness in experimental populations of *Drosophila pseudoobscura*. *Evolution*, *17*, 40-55.

VAN VALEN, L., LEVINE, L., AND BEARDMORE, J. A. 1962. Temperature sensitivity of chromosomal polymorphism in *Drosophila pseudoobscura*. *Genetica*, *33*, 113-127.

INTERRELATIONSHIP OF CHIASMA FREQUENCY IN BIVALENTS IN *DACTYLIS GLOMERATA* subsp. *LUSITANICA*

S. S. SHAH

Botany Division, I.A.R.I., New Delhi 12, India

Received 10.vi.64

THE chiasma frequency in one bivalent is in many cases not independent of chiasma frequency in other bivalents and often the bivalents compete with each other (Darlington, 1933; Mather and Lamm, 1935; Morgan *et al.*, 1933; Jain and Maherchandani, 1961). Mather (1936) examined this relation in 27 species and hybrids in both plants and animals belonging to diverse groups and he observed that while a positive correlation of chiasma frequency in various bivalents occurs in some cases, a negative correlation occurs more often. He generalises from the data that after a certain level of chiasma formation bivalents must compete and this will result in a negative correlation.

Some plants with supernumeraries were obtained in *Dactylis glomerata* subsp. *lusitanica*. These supernumeraries are heteropycnotic and they pair among themselves (Shah, 1963). The normal complement in this subspecies consist of 14 chromosomes. The seven pairs of homologues have no obvious size differences at meiosis. A study of " competition " in plants having supernumeraries could give information with respect to the effect of the presence of heterochromatin in the cell on competition. Also such material allows one to study the effect of the chiasma frequency in the supernumeraries on the chiasma frequency in the normal set. The author has not come across any similar studies in the literature, though extensive work has been done on supernumeraries both in plants and animals (see reviews by Müntzing, 1958 and by White, 1954). In the present paper data are presented on the interrelationships of chiasma frequency in the bivalents of the normal set in plants with 2 supernumeraries. Data for the same relation with respect to plants with 0, 1, 3 and 4 supernumeraries and the interrelationships of chiasma frequency in supernumeraries and the normal set chromosomes will be published elsewhere.

Data with respect to the " between nuclei " and " within nuclei " variance components and the probability levels for the variance ratios are presented in table 1 (see Mather, 1936, for the method of partitioning the variance and testing their significance). A higher intra-nuclear component indicates a negative correlation with respect to the chiasma frequency in various bivalents. A higher internuclear component will indicate a positive correlation. Data were collected at diakinesis and metaphase-I.

In plants no. 2, 5 and 6 the inter-nuclear component is significantly higher, while in plant no. 4 it is significant in one sample (table 1). In plant no. 3 the inter-nuclear component is higher but not significantly so ($0.1 > P > 0{\cdot}05$). In plant no. 1, the intra-nuclear component is slightly higher.

TABLE 1

Diploid plants with two supernumeraries

Plant No.	No. of cells	Variance components		P value
		Intra-nuclear	Inter-nuclear	
1	121	0·1928	0·1870	—
2	22	0·1472	0·2910	$0{\cdot}05 > P > 0{\cdot}01$
3	31	0·1628	0·2363	$0{\cdot}1 > P > 0{\cdot}05$
4 {Sample 1	72	0·0860	0·1245	$0{\cdot}05 > P > 0{\cdot}01$
4 {Sample 2	80	0·1696	0·1794	$P > 0{\cdot}25$
5	50	0·1114	0·1669	$0{\cdot}05 > P > 0{\cdot}01$
6	35	0·0690	0·1638	$P < 0{\cdot}005$
Pooled estimate		0·1362	0·1792	$0{\cdot}05 > P > 0{\cdot}01$ ($V_1 = 120$; $V_2 = 726$)

Heterogeneity of variances was tested with Bartlet's test. The seven inter-nuclear variances are homogenous ($0{\cdot}25 > P > 0{\cdot}10$), while the intra-nuclear variances are heterogenous ($P < 0{\cdot}005$). It is of some interest to pool the data for all the six plants and examine if there is a difference in the magnitude of inter- and intra-nuclear variances for the group as a whole. However, the intra-nuclear variances are heterogenous and, so the use of the pooled estimate in the F test has certain limitations. In the case of a similar situation with respect to combining the data for Latin square designs, Cochran and Cox (1950) observe that the calculated F value is an overestimate of the true F value, the latter will lie between the calculated F value and the F value with respect to the degrees of freedom for a single experiment with highest error variance. This could be used as a basis of preliminary conclusions. With respect to the present data similar approach is followed, however, the experimental set up is of hierarchal nature here. The pooled inter-nuclear variance, is significantly higher than the pooled intra-nuclear variance ($0{\cdot}05 > P > 0{\cdot}01$; the degrees of freedom for the tabular F used are the ones for the sample with the highest intra-nuclear component; see table 1). The data suggest that in the case of plants with two supernumeraries there is a positive correlation with respect to chiasma frequency in the normal A-chromosome set. In the case of plants belonging to the same subspecies and having no supernumeraries there is an indication of a negative correlation of chiasma frequency (Shah, unpublished).

Heterochromatin is no longer considered inert. The role of heterochromatin in V-type of position effect (see review in Lewis, 1950), the effect of heterochromatic supernumeraries on morphology and fertility in *Secale* and some other plants (Müntzing, 1958), the synthesis of DNA in euchromatin and heterochromatin at different times (Lima-de-Faria, 1959), and the effect of the Y chromosome in *Drosophila* on synthesis of nucleic acid bases, the purine compounds in the extracts of XXY eggs being more than double than in XX type eggs (Travaglini *et al.*, 1958), all suggest a specific role of heterochromatin. The present data, though only limited, suggest an additional role of heterochromatin.

Acknowledgments.—I am grateful to Dr G. L. Stebbins, Dr B. P. Pal and Dr M. S. Swaminathan for providing facilities to carry out this work. I am also thankful to Dr P. N. Saxena for reading the manuscript.

REFERENCES

COCHRAN, W. G., AND COX, G. M. 1950. *Experimental Designs.* John Wiley & Sons, Inc.

DARLINGTON, C. D. 1933. The origin and behaviour of chiasmata. VIII. *Secale cereale* (n, 8). *Cytologia*, *4*, 444-452.

JAIN, H. K., AND MAHERCHANDANI, N. 1961. The control of intranuclear distribution of chiasmata in *Delphinium. Heredity*, *16*, 383-392.

LEWIS, E. B. 1950. The phenomena of position effect. *Advance Genet.*, *3*, 73-115.

LIMA-DE-FARIA, A. 1959. Differential uptake of tritiated thymidine into hetero- and euchromatin in *Melanoplus* and *Secale. J. Biophysic & Biochem. Cytol.*, *6*, 457-466.

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

MATHER, K., AND LAMM, R. 1935. The negative correlation of chiasma frequencies. *Hereditas*, *20*, 65-70.

MORGAN, T. H., BRIDGES, C. B., AND SCHULTZ, J. 1933. Constitution of the germinal material in relation to heredity. *Carnegie Inst. Washington Year Book*, *32*, 298-302.

MUNTZING, A. 1958. Accessory chromosomes. *Trans. Bose Res. Inst.*, *22*, 1-15.

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

TRAVAGLINI, E. C., LEVENBOOK, L., AND SCHULTZ, J. 1958. Nucleic acids and their components as affected by the Y chromosome of *Drosophila melanogaster.* II. Nucleosides and related compounds in the acid soluble fraction of the unfertilized egg. *Exp. Cell. Research*, *15*, 62-79.

WHITE, M. J. D. 1954. *Animal Cytology and Evolution.* 2nd edit. Cambridge University Press.