Whitten, M. J. CSIRO, Canberra, Australia.

Quantitative measurement of the effect of temperature on the penetrance of the eye mutant, witty, in D. melanogaster.

Penetrance of the witty character is dependent on background genotype and a number of environmental conditions (Whitten, 1966 and in press). In characters of this type penetrance has been measured in several ways. One can simply measure the proportion of abnormal flies or abnormal eyes (Hansen and Gardner, 1962). Sang et al. (1963) have quantified the measurement of penetrance by reference to an underlying scale and two thresholds separating the three phenotypic classes. An alternative method requiring only one threshold was outlined in Whitten (loc cit). This method assumes that the abnormal phenotype is produced when some morphogenetic substance (m.s.) surpasses a threshold. In the witty case, it was argued from the presence of asymmetrical flies and the frequency of their occurrence in certain inbred strains that the amount of m.s. is independently determined for each eye. Since each fly has two values of m.s., each in part determined by developmental noise, a new penetrance parameter was introduced which is wholly determined by genotype and environment and has one value for each combination of genotype and environment. By measuring Z_1, Z_2 and Z_3 where Z_1 is the proportion of flies with both eyes normal ((++) in Table 1), Z_2 the proportion of asymmetrical flies ((L+) and (+R)) and Z_3 the proportion of flies with both eyes abnormal (LR), it is possible to calculate the mean (x) and SD (y) of the penetrance parameter for any population. Table 1 and figure 1 show the response to temperature using this method.

The mean, x, increases with temperature but the SD shows no consistent change. Similar results have been obtained with replica experiments. It can be shown that the mean change in m.s. for a population is equal to the change in x which is thus a direct measure of the response of the morphogenetic substance to temperature changes.

These results support the reasonableness of the penetrance parameter model described by Whitten (1966). The sigmoid response probably indicates a degree of developmental stability for the production of morphogenetic substances over the temperature range normally encountered by Drosophila.

References: Hansen, A. and E. J. Gardner, 1962, Genetics, 47:587-598; Sang, J. H., 1963, J. Hered., 154:143-151; Whitten, M. J., 1966, Genetics, 54:465-483.

Table 1: Effect of temperature on mean, X, and standard deviation, Y, of the penetrance parameter for the inbred line, SH, homozygous for witty.

Temperature	Sex	(++)*	(L+)	(+R)	(LR)	Sample Size	mean (X) males	mean (X) females	S.D. (Y) males	S.D. (Y) females
20°C	m	296	8	11	0	315	-2.2	-1.11	0.40	0.61
	f	237	43	39	16	335				
23°C	m	178	26	29	11	244	-1.2	0.0	0.67	0.37
	f	91	84	73	92	340				
24°C	m	102	27	16	11	156	-0.96	+0.15	0.64	0.58
	f	40	36	33	57	166				
27°C	m	167	105	86	64	422	-0.33	+0.96	0.22	0.19
	f	14	77	59	329	479				
29°C	m	2	13	8	200	233	+1.5	+2.3	0.28	0.40
	f	0	4	3	211	218				

* (++) indicates flies with both eyes normal, (L+) with right eye only normal, etc.

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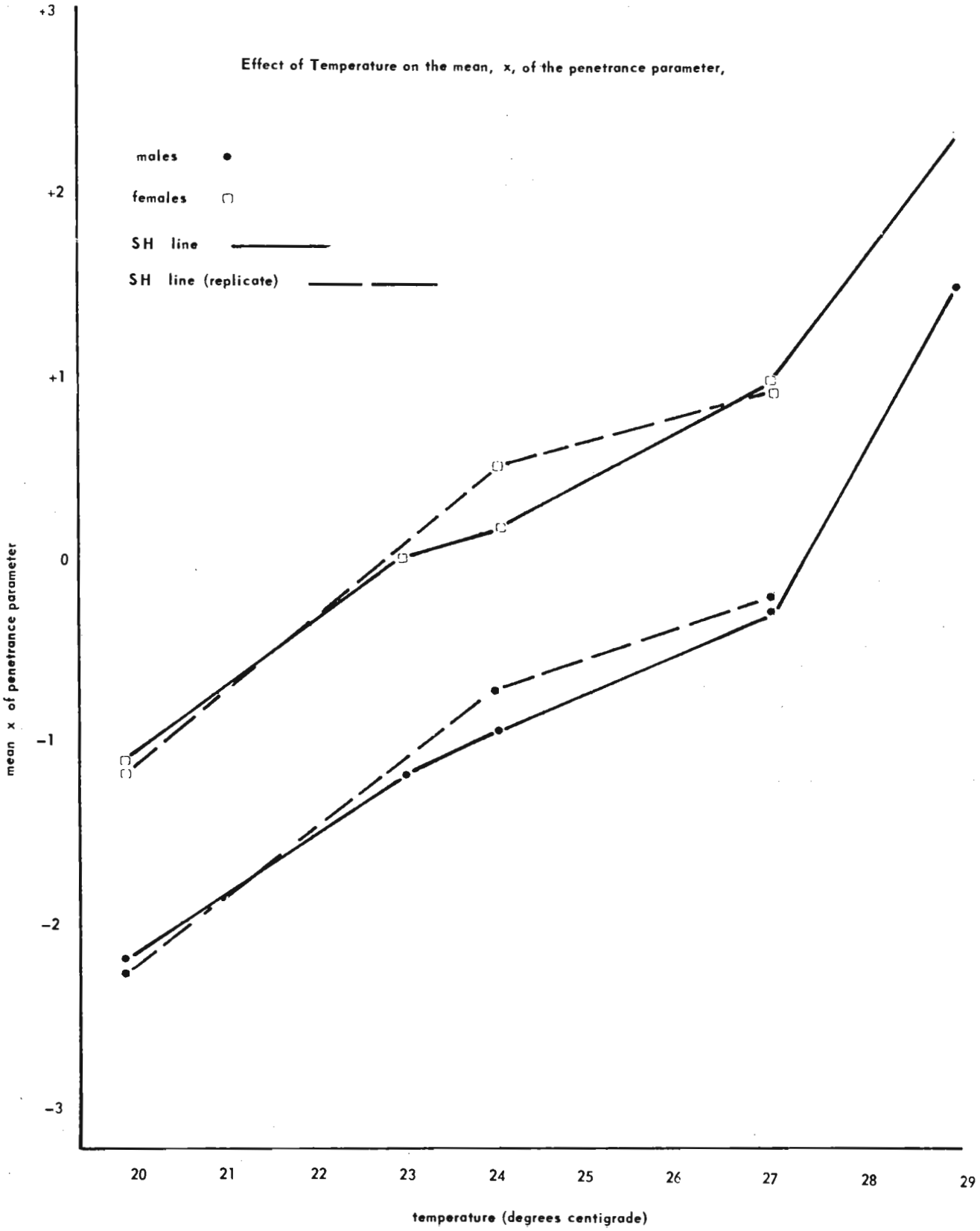
Effect of Temperature on the mean, x, of the penetrance parameter,
males
females
SH line
SH line (replicate)
+3
+2
+1
0
−1
−2
−3
mean x of penetrance parameter
20
21
22
23
24
25
26
27
28
29
temperature (degrees centigrade)