Band, H.T. Michigan State University, East Lansing, Michigan. Environments, disruptive selection and lethals.

Disruptive selection may operate when two or more optima are favored in the population. In the South Amherst (Mass.) D. melanogaster population the frequency of second chromosome lethals and semilethals recovered in a sample has been found to be significantly negatively correlated with temperature range of the week prior to collection (Band and Ives, 1961, 1968). In agreement with hypotheses that can be deduced, from this negative relationship, heterozygotes carrying these drastic variants have been found to have significantly higher viability in narrow temperature range conditions (Band, 1963; Oshima, 1968, 1969) while heterozygotes free of drastics have the significantly higher viability in wide range conditions (Band, 1963, 1969).

Maintenance of two major classes in the population with contrasting viability properties suggests that disruptive selection is operating. Band (1969) also suggested that only a genetic system maintained by disruptive selection could track the recent environment. The numerous samples during summer and fall from the breeding site population in 1967 have provided good evidence of le + sle frequency changes in relation to the recent temperature range conditions. If disruptive selection is involved, then with respect to temperature range the environment must be sufficiently heterogeneous to promote different major classes in the population.

To investigate this possibility, the number of days of narrow, intermediate and wide ranges have been computed for the summer months. We concentrate on this season because it is a standardized period of the year (a May-Oct. interval includes months from spring and fall quarters also) and because most collections since 1938 have been made in the fall, usually September. Narrow range has been defined to include ranges from 3 to 20 degrees between daily minimum and maximum temperatures, intermediate ranges are from 21 to 25 degrees and wide temperature ranges are 26^{o} and over. Viabilities of the different heterozygous classes have not yet been investigated in the intermediate ranges. The three groups can arbitrarily be condensed into two by defining ranges 23^{o} and below as narrow and 24^{o} and above as wide. Data presented are from summers 1938 through 1946, the period when le + sle frequency was highest and rainfall averaged over 12 inches per summer. Data for summer 1967 is also given.

Most summers in this initial period of genetic investigations on the S. Amherst D. melanogaster population tend toward similar numbers of days in the various categories or toward

Table 1. Average daily temperature range per summer

1938	1939	1940	1941	1942	1943	1944	1945	1946	$\bar{X}$	1967
21.1	22.7	23.6	23.6	21.8	22.4	24.4	21.9	23.8	22.7	23.4

Table 2. No. of days with narrow (N), intermediate (I), or wide (W) temperature ranges. No. of days with ranges above or below 23^{o} also indicated.

	1938	1939	1940	1941	1942	1943	1944	1945	1946	1967
N	41	30	26	26	37	30	24	35	28	30
I	25	30	30	27	28	30	22	27	18	28
W	26	32	36	39	27	32	46*	30	46*	34
$\leq 23^{o}$	57	51	45	42	55	51	32	52	34	48
$\geq 24^{o}$	35	41	47	50	37	41	60*	40	58*	44

* means $P<.05$ that significantly more days are in the wide range category

more days with ranges 23^{o} and below, as would be expected from the average daily temperature ranges shown in Table 1. Summer 1967, during which data demonstrating the ability of le + sle frequencies to track the recent environment were obtained, is similar. Summers 1944 and 1946 have significantly more days above 25^{o} but le + sle frequency was not measured in 1944, and in 1946 June is the month with less than a third of the days with temperature range 23^{o} or below. Any reduction in le + sle frequency in June would have gone undetected by fall when le + sle frequency among second chromosomes was estimated to be 49.3% (Ives, 1954).

One consequence of the maintenance of both heterozygous classes by disruptive selection is that the level of drastics can fluctuate in relation to the recent environment while the frequency of any one lethal need not necessarily reflect either present or past environments. Indeed, if many such lethals can participate in the genotype-environmental interaction, the genetic load is minimized. In fact, one possible way to distinguish between lethals perhaps deleterious in all environments (the classical genetical load) and those conditionally heterotic (heterotic in narrow range environments) would be to compare viabilities for heterozygotes carrying different lethals in the narrow fluctuating temperature range conditions.

A further point to emerge from the data is that temperature ranges appear not to be the exclusive environmental variable influencing the frequency of lethals and semilethals in the population; the average frequency of these genetic variants in samples collected during the 1938-1946 period is 48.8% while the average in summer 1967 samples is 24.2%. But this is not unexpected from the significantly positive relationship also between le + sle frequency and summer rainfall (Band and Ives, 1968) and the finding of parallel environmental changes in rainfall and temperature range in the area from 1930 through 1969.

References: Band, H.T., 1963 Evolution 17: 307-319; ____, 1969a Japan. J. Genet. 44, Suppl. 1: 200-208; ____, 1969b, unpublished manuscript; ____ and P.T. Ives, 1961 P.N.A.S. 47: 180-185; ____ and ____, 1968 Evolution 22: 633-641; Ives, P.T., 1954 P.N.A.S. 40: 87-92; Oshima, C., 1968 Proc. XIIth Intern. Cong. Genetics 2: 170-171; ____, 1969 Japan. J. Genetics 44, Suppl. 1: 209-216.

Mazar Barnett, B. Comisión Nacional de Energía Atómica, Buesos Aires, Argentina. Lack of effect of DMSO on the fertility of irradiated males exposed to low temperature.

We have previously reported (1970) some data on the viability of sperm in inseminated females exposed to 0°C during different periods of time.

While working on the action of radioprotectors at the genetic level, some experiments were done to study the combined effect of X-radiation and dimethyl sulfoxide at a low temperature, on sperm treated in adult males. Six day old Canton S males, pre-treated with a 10% solution of DMSO, were irradiated with 1000 R and submitted to 0°C during the irradiation and before and/or after the irradiation in three different treatments. Immediately after treatment the males were allowed to mate for 3.30 hours and then provided with new virgins until completion of 24 hours (a procedure followed to study the effect on immotile and on fully mature sperm). The Basc females were transferred twice, every 4 days, so the broods covered a period of 12 days. Although the proportion of F_1 males and females seemed to be normal, there was a sharp decrease in the number of offspring. It was hoped that the problem of diminished progeny, which is known to be the joint effect of radiation and low temperature, would be overcome by the presence of DMSO, a cryoprotective agent, Ashwood-Smith (1967). However, this was not the case, the number of offspring of the so-treated males did not differ from the ones submitted to irradiation and low temperature only. Males exposed to 0°C for 10 to 20 minutes produced a normal number of offspring. Only the F_1 females, which were collected for standard sex-linked recessive lethal tests are shown in the tables.

From the results shown in Table I, it is interesting to note that the males submitted to 0°C for a total period of 20 minutes, of which 10 minutes were previous to the irradiation, produced more offspring than those submitted to 0°C for a total period of 10 minutes during and after irradiation only.

In another experiment the mating procedure was changed. Of 270 males, irradiated and kept for a total period of 10 minutes at 0°C, half were mated immediately and for 24 hours, then provided with new virgins for another day. The other half were witheld from mating for one day, after which the same procedure was repeated. The two groups yielded a similar number of F_1 females, all from the first mating period (See Table II). No progeny was obtained from the second mating period. The amount of F_1 females per treated male was higher than in the previous series of experiments.

The results obtained with the second group of treated males could perhaps be explained by a process of recovery of the damaged sperm or a higher resistance of spermatids, plus a higher sensitivity of less mature germinal cells. To account for the similar results obtained with the first group of males is rather difficult; a test in dominant lethality is in progress.

References: Ashwood-Smith, M.J., 1967 Radioprotective and cryoprotective properties of DMSO in cellular systems. Ann. N.Y. Acad. Sci. 141: 45 Mazar Barnett, B. and E.R. Muñoz, 1970 Effect of low temperature on inseminated females. DIS 45: 123.