McInnis, D.O. and H.E.Schaffer. Tropical Fruit and Vegetable Research Laboratory, Honolulu, Hawaii USNA. Directional selection for field dispersal rate in Drosophila melanogaster.

Directional selection experiments in Drosophila have been used to modify various behavioral traits, at least since Hirsch & Boudreau (1958) obtained responses rapidly for both positive and negative phototaxis. Two other forms of locomotion in D.melanogaster were studied by Connolly (1966) and Grant & Mettler (1969). Connolly selected high and low activity lines of flies which moved atop a closed grid, while Grant & Mettler selected for 'escape' behavior in an I-maze. Both of these studies achieved significant differences between the high and low lines. Ewing (1963) demonstrated with D. melanogaster that attempts to select for one behavioral trait (spontaneous activity) could result instead in changes in other behavioral traits. In this study, we attempted to select for fast and slow movement in a field situation and to estimate the heritability of any resulting difference between fast and slow moving lines.

During 1977, experiments were inititated in search of a genetic component for dispersal ability in Drosophila. These experiments involved wild-raised (1st generation) then laboratory-reared flies (2nd generation onward) of D.melanogaster. Directional selection was applied over successive generations upon tested fly populations with the goal of creating a high line of fast-moving flies and a low line of slow-moving flies. Flies were maintained on standard corn meal molasses medium at 25°C except for the relatively brief periods of the experimental runs. The latter was conducted at 2½-3 week intervals with the adult flies in the same generation. The parents of each generation were removed after a week of mating and egg laying. After eclosion, new generation ♀♀ and ♂♂ (10-14 days old) were allowed to mate prior to the actual experimental run involving selection of fast and slow moving flies. Unfortunately, the control lines for the cage and field work were accidentally lost. However, the divergences between simultaneously run lines were controlled.

Heritability under a system of mass selection (i.e., selected flies mixed together (en masse) was measured by the regression of the response (R) on selection pressure (S)). If all females had mated before selection, and no mating occurred after selection, then $h^2=2$ R/S. If some remating and sperm displacement occured after selection, then R/S<h^2<2 R/S. Estimating this range is appropriate for this work since flies were allowed to mate prior to selection.

The experimental procedure for the open field was as follows. Several hundred locally collected wild ♀♀ and ♂♂ D.melanogaster provided the first release population. Later, however, experiental flies had to be marked so as to distinguish them from native D.melanogaster attracted to fermenting bait. Marking was accomplished by lightly dusting flies with a micronized fluorescent dust (Helecon Pigments, U.S. Radium Corp.). One thousand marked flies per line per generation (except only ca. 500 in gen. 1) were released at a central site during the later afternoon at a time when sufficient sunlight would induce scattering of flies to the shade and coolness of perimeter trees and shrubs. Just prior to the release, 8 traps were set evenly spaced around the periphery of the field, each one 50 meters away from the

Table 1. Directional selection for dispersal rate in an open field with D.melanogaster (1977).

	Generation number						
	1	2	3	4	5	6	7
Selected line	Average distance moved (±SE) (meters)						
HIGH		35.33±2.09 (n=118)	22.49±1.69 (n=181)	39.15±1.07 (n=330)	34.55±1.02 (n=439)	39.43±0.75 (n=342)	33.95±1.03 (n=432)
	(32.77±2.24) (n=112)						
LOW		34.27±2.21 (n=110)	19.26±1.65 (n=164)	37.41±1.29 (n=248)	27.02±1.13 (n=386)	31.58±0.98 (n=390)	27.1±0.98 (n=504)
HIGH-LOW DIVERGENCE	0	1.06	3.23	1.74	7.53	7.85	6.81
CUMULATIVE SELECTION	0	40.00	78.94	115.71	153.97	186.44	218.59

release point. The traps consisted of 2-gallon wax paper buckets containing some fermenting banana to attract Drosophila. One-half hr after the release of flies 4 traps were again evenly spaced on a circle roughly 10 meters from the center. Two additional traps were placed at the center. These 6 latter traps were kept sealed outside the experimental field until needed. For 2 hr after the release, flies were collected from all 14 traps by sweeping with a net over the bait. Flies unable to fly (at the central traps only) were aspirated into a vial and kept separate from the 'flying' flies. These walking flies invariably turned out to be marked and were not included in the LOW line flies selected, since the act of handling these flies may have injured them, impairing flight ability. At the conclusion of the experimental run, all flies were returned to the laboratory where marked and unmarked flies were sorted out under ultraviolet light. Marked flies collected at the periphery became the parents of the next HIGH line generation, while viable marked flies trapped at the 2 center traps produced the following LOW line generation. A total of 7 such releases were conducted in an open grassy field on the campus of N.C.State University.

Results. The results of directional selection for 6 generations in the field are shown in Table 1. The divergence between the lines (HIGH minus LOW) and the cumulative selection pressure are also shown. Movement data in generation 1 are for the original native population prior to selection of HIGH and LOW lines. As tabulated, only between 11 and 50% of the 2,000 HIGH and LOW flies released each generation were recaptured. Six generations of selection in the field resulted again in significant divergence between HIGH and LOW selected lines (sign test, $p<.05$; t-test ($df=6:4.94$, $p<.01$)). Heritability over the 6 generations for the controlled divergence was estimated to average 0.04 (4%) with a standard error of 0.0081. The estimates of heritability for both cage and field work should be doubled if all mating took place prior to selection. Therefore, a heritability range of 4-8% is obtained.

A significant trend was associated with selection progress in the field in that the percentage of released flies recaptured increased from ca. 11% in the first 2 generations to above 40% in both HIGH and LOW lines by generation 7 (sign test, $p<0.001$).

In conclusion, the evidence indicates that a genetic component, albeit small, exists for field dispersal ability in D.melanogaster. The presence of such heritable variation in natural populations provides some flexibility to adapt should there be selection in favor of either fast or slow moving flies.

References: Connolly,K. 1966, Anim.Behav. 14:444; Ewing, A.W. 1963, Anim.Behav. 11:2; Grant, B. & W.E.Mettler 1969, Genetics 62:625; Hirsch, J. & J.C.Boudreau 1958, J.Comp. Physiol.Psycho. 51:647.

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Modification of recombination frequency by ethyl methanesulphonate and chloroquine phosphate in female D.melanogaster.

Effect of ethyl methanesulphonate (EMS) and chloroquine phosphate (CHQ) was studied on the frequency of recombination in female germ cells of D.melanogaster by dividing the 96 hr larval period (at 25°C) into three equal parts. Using LD_{50} as a criterion, optimum doses of EMS and CHQ were determined. For the 1st, 2nd and 3rd parts of D.melanogaster larvae, the LD_{50} values for EMS, respectively, were 0.90, 0.75 and 0.75%; the corresponding values for CHQ were 0.185, 0.165 and 0.180%. These concentrations of EMS and CHQ were used in the present experiments. Thirty-five to forty females of stock dumpy black cinnabar (dp b cn: 2nd chromosome markers) were mated with wild type (Oregon-K) males for 1-2 days. Inseminated females were starved for 2-3 hr and then allowed to lay eggs for 2 hr. The resultant eggs were transferred on to the food medium with or without EMS or CHQ. The F_1 larvae were thus reared in the 1st, 2nd or 3rd part of larval life on food mixed with respective optimum dose of EMS or CHQ in ratio 9:1. A two-day old F_1 female was mated with 3-4 dp b cn males. The difference in frequency of recombination obtained in the treated and untreated testcross populations was tested using z-test.

Genetic positions of the second chromosome markers in standard genetic map are: dp - 13.0; b - 48.5; cn - 57.5. In the present studies, the percentages of recombination in untreated F_1 females of D.melanogaster in regions dp-b and b-cn were very close to the values of standard genetic map (Table 1).

Decrease in the recombination frequency was observed in both the regions (dp-b and b-cn) studied when treatment with EMS or CHQ was given in the 1st, 2nd or 3rd part of larval life