

Félix, R., J. Guzmán and A. de Garay Arellano. Genetics and Radiobiology Program. National Commission of Nuclear Energy. Mexico City, Mexico. Distribution of CO₂ sensitivity (sigma virus) in an urban population of *D. melanogaster* from Mexico City. II. Low dispersal, a factor which explains differences among locations.

Wright's (1955) model for optimum evolutionary opportunity is one of partially isolated sub-groups within which there is some opportunity for gene frequency shifts due to environmental differences between sub-populations or due to random processes (Crow, 1955). Chance gene frequency changes will be greater as populations become smaller, whereas fluctuations in selection coefficients have a similar effect

in larger populations. Kimura (1955) worked on the mathematically difficult problems of constructing the stochastic process of gene frequency change under various assumed conditions. The general conclusions of Kimura's work were anticipated by the earlier writings of Wright. The fluctuations in gene frequencies in sub-populations may be provided by random shift in small populations or by random changes in selective values in larger ones.

Wright (1951) considered a model in which the population has a homogeneous structure, but offspring travel only a certain distance from their parents. If the range of dispersal is restricted in such a way that the parents of a particular individual may be assumed to be drawn at random from a neighborhood of a certain size, the amount of local differentiation may be related to the effective size of the neighborhood.

In the study of Wallace (1966a) of the allelism, a model was applied, which predicts that for lethals collected at different times, the logarithm of the frequency of allelism due to inbreeding, should decline linearly with time. On a strictly empirical basis, Wallace (1966b) substituted the square root of the distance for time in the original model. The relationship was suggested by the dispersal of flies from a point of release: the logarithm of the numbers of recaptured flies decreases linearly with the square root of distance from the point of release.

Wallace analyzed the data of local collections of several species of *Drosophila* given by Dobzhansky and Wright (1943), by Burla et al. (1940) and by Timofeeff-Ressovsky (1941 a,b), which show that, despite its seemingly well developed powers of dispersal, (revealed by the migration of individual flies for several hundred meters in two days), more than one-quarter of the *D. pseudoobscura* captured at a given point have probably arisen within a radius of 25 meters from that point; one-eight of such collection of flies have probably arisen within a radius of ten meters. The data for *D. willistoni* reveal that this species is ever more sedentary; nearly one third of a collection of these flies have probably arisen within a radius of some ten meters from the point of capture. The data of Dobzhansky and Wright on the dispersal of *D. melanogaster*, suggest that the dispersal of this species resembles that of *D. funebris* and *D. willistoni* more closely than that of *D. pseudoobscura* (Wallace, 1966b).

When the linear relationship between the logarithm of the frequency and the square root of distance is plotted on a conventional arithmetical scale, the transformed curve clings to both the vertical and the horizontal axes. Wallace gives the following interpretation of this theoretical curve: immigrants form a small fraction of any population but, given that an individual is an immigrant, he is very nearly as likely to have come from any one distance as from another. The tall vertical portion of the curve, which hugs the Y axis means that the bulk of all individuals found at one spot has arisen initially at or very near that spot. Bateman (1947) refers to this feature of the dispersal pattern, pointing out its effect of subdividing what would otherwise appear to be a continuous population.

In this report, data are given, which suggest the low dispersal of *D. melanogaster* flies, when the percentage of sensitive flies recovered from neighboring collection sites is recorded.

Brun and Sigot (1955) pointed out the differences among stabilized and non-stabilized CO₂-sensitive strains of *Drosophila*. In stabilized strains there is a maternal effect which assures the sensitivity to all the progeny, whereas stabilized males transmit the sigma virus in his sperm to a fraction of the offspring. Non-stabilized lines, on the other hand, typically produce resistant and sensitive progeny. The role of infectious virus sigma may be clarified by future investigations of the relationship between sigma and the *Drosophila* sensitivity to CO₂ (Seecof, 1962).

L'Héritier (1958), L'Héritier and Plus (1963) made an extensive research on the variations of the genotype of the virus, as well as on the genetic factors of the host which affects his hereditary transmission. Every quantitative aspect of the relationship between virus sigma and its host seems to be more or less genotype dependent.

The CO_2 -sensitivity itself, is not a selective factor to be considered in population studies, as the concentration of the gas required to produce anoxia in *Drosophila*, is never found in natural conditions. However, the presence of sensitive, resistant, and "refractory" flies in the same population, points out that the presence of the hereditary virus is not a completely neutral character.

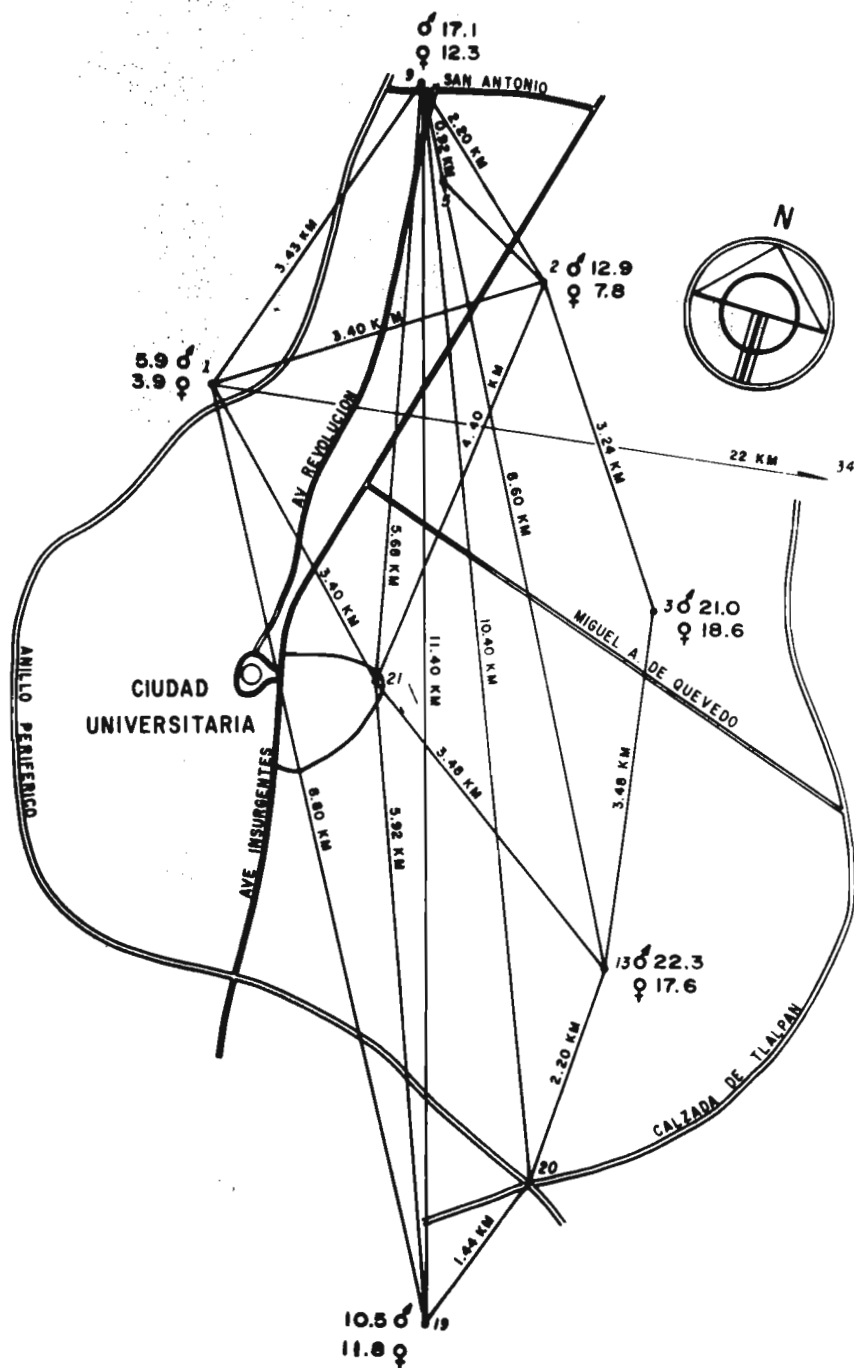


Fig. 1. Distribution of CO_2 sensitivity of *D. melanogaster*. Percentages of sensitive males and females are indicated at six locations.

Seecof (1964) investigated the deleterious effects of the sigma virus infection of *D.*

melanogaster, demonstrating a direct relationship among deaths of the infected progeny and the logarithm of the number of infectious units inherited by the progeny. Seecof tested the effect of the variation of environmental conditions, looking for a selective advantage of the flies when they are infected. As a result, the infection proved to be a handicap under all the conditions tested. The presence of the virus in wild populations of flies, in absence of any known vector, is therefore, unexplained. However, the crowding of flies did not reduce the proportion of CO₂-sensitive flies in the cultures. There is to be found, a compensating selective advantage for sigma-infected flies, in order to explain the proportion and persistence of such flies in wild populations.

In the present survey, the proportion of CO₂-sensitive flies from six locations in Mexico City was tested by submitting them to the treatment with pure CO₂ at 8°C during 15 minutes. Collections were made from June 1969 to May 1970, in a southwest section of Mexico City. Flies were attracted to 1/4 liter containers of decaying cantaloupe. The spatial distribution of CO₂-sensitivity, as well as the recorded averages of the monthly percentages of sensitive males and females from six locations are shown in Fig. 1. Only the data from the locations where the collections were significant, are included. The minimum and the maximum distances among locations, were respectively, 2.20 and 11.40 Km. The extreme difference of CO₂-sensitivity was found among locations 1, and 3, approximately 4.70 Km. apart.

Monthly percentages of CO₂-sensitivity in both sexes, from each location, are given in tables 1 and 2. The annual averages of the monthly percentages of sensitive males and females are shown in Table 3. These averages, are constantly larger for males than for females (ex-

Table 1. Percentage of CO₂-sensitivity of males collected at six locations from Mexico City.

Loc.	June		July		August		September		October		November	
	N/S	%S	N/S	%S	N/S	%S	N/S	%S	N/S	%S	N/S	%S
1	106/6	5.6 ±2.02	60/5	8.3 ±3.56	575/28	4.8 ±0.88	1426/139	9.7 ±0.78	261/33	12.6 ±2.05	60/1	1.8 ±1.33
2	215/32	14.8 ±2.39	198/30	15.1 ±2.54	213/28	13.1 ±2.31	43/5	11.6 ±4.88	18/4	22.2 ±9.79	-	-
3	117/9	7.6 ±2.44	339/32	9.4 ±1.69	130/25	19.2 ±3.45	149/16	10.7 ±2.53	150/0	0.0	-	-
9	-	-	75/11	14.6 ±4.07	-	-	61/3	4.9 ±2.76	26/1	3.8 ±3.74	-	-
13	60/23	38.3 ±6.27	-	-	93/14	15.0 ±3.70	18/5	27.7 ±10.54	-	-	-	-
19	-	-	70/10	14.2 ±4.17	52/4	7.6 ±2.01	158/11	6.9 ±2.01	101/6	5.9 ±2.34	46/1	2.1 ±2.11
	498/70	14.06 ±1.66	742/88	11.86 ±1.49	1063/99	0.3 ±0.99	1855/179	9.64 ±0.75	556/44	7.91 ±1.33	106/2	1.89 ±1.31

Loc.	December		January		February		March		April		May	
	N/S	%S	N/S	%S	N/S	%S	N/S	%S	N/S	%S	N/S	%S
1	126/3	2.3 ±1.75	-	-	90/3	3.3 ±1.88	73/2	2.7 ±1.87	259/21	8.1 ±1.69	658/39	5.9 ±0.91
2	68/0	0.0	-	-	-	-	71/3	4.2 ±2.38	146/12	8.2 ±2.51	-	-
3	15/2	13.3 ±8.76	-	-	-	-	-	-	45/13	28.8 ±6.75	14/8	57.1 ±13.22
9	-	-	-	-	-	-	-	-	114/26	22.8 ±3.92	38/15	39.4 ±7.92
13	21/0	0.0	-	-	-	-	-	-	14/1	7.1 ±6.34	-	-
19	-	-	-	-	-	-	-	-	19/5	26.3 ±10.10	-	-
	230/5	2.17 ±1.77			90/3	3.33 ±1.88	144/5	3.47 ±1.52	597/78	13.07 ±1.55	710/62	8.73 ±1.78

N, number of collected flies; S, number of sensitive flies; %S, percentage of CO₂-sensitive flies ± standard error.

Table 2. Percentage of CO₂-sensitivity of females collect at six locations from Mexico City.

Loc.	June		July		August		September		October		November	
	N/S	%S	N/S	%S	N/S	%S	N/S	%S	N/S	%S	N/S	%S
1	75/0	0.0	41/2	4.8 ±3.34	629/33	5.2 ±0.88	1247/51	4.0 ±0.55	255/20	7.8 ±0.60	41/2	4.8 ±3.33
2	216/19	8.7 ±1.92	177/21	11.8 ±2.42	222/34	15.3 ±2.42	31/3	9.6 ±5.29	14/1	7.1 ±6.86	-	-
3	58/4	6.9 ±3.32	337/36	10.6 ±1.63	39/5	12.8 ±5.35	152/18	11.8 ±2.61	9/1	11.1 ±10.47	-	-
9	-	-	58/5	8.6 ±3.68	-	-	54/2	3.7 ±2.56	-	-	-	-
13	53/29	54.7 ±6.83	-	-	65/11	16.9 ±4.64	17/0	0.0	-	-	-	-
19	-	-	51/2	3.9 ±4.81	48/2	4.1 ±2.66	107/8	7.4 ±2.5	137/11	8.0 ±2.31	18/0	0.0
	402/52	12.99 ±2.12	664/71	10.69 ±1.15	1003/85	8.47 ±0.71	1608/116	7.21 ±0.65	415/33	7.95 ±1.37	59/2	3.39 ±2.16

Loc.	December		January		February		March		April		May	
	N/S	%S	N/S	%S	N/S	%S	N/S	%S	N/S	%S	N/S	%S
1	82/0	0.0	-	-	93/3	3.2 ±1.82	56/2	3.4 ±2.46	164/5	3.0 ±1.33	487/34	6.9 ±1.14
2	42/1	2.3 ±2.31	-	-	-	-	108/2	1.8 ±1.28	212/11	5.1 ±1.69	-	-
3	-	-	-	-	-	-	-	-	31/7	22.5 ±7.5	29/17	58.6 ±9.14
9	13/1	7.6	-	-	-	-	-	-	103/22	21.3 ±4.03	49/10	20.4 ±5.75
13	30/1	3.3 ±3.26	-	-	-	-	11/1	9.0 ±8.62	23/1	4.3 ±2.05	-	-
19	-	-	-	-	-	-	-	-	27/7	25.9 ±8.43	-	-
	167/3	1.80 ±1.58			93/3	3.23 ±1.82	175/5	2.86 ±1.60	560/53	9.46 ±1.46	565/61	10.80 ±1.90

N, number of collected flies; S, number of sensitive flies; %S, percentage of CO₂-sensitivity ± standard error.

Table 3. Total number of male and female flies collected at six locations from Mexico City and percentage of CO₂ sensitivity ± standard error.

Loc.	Males		Females	
	Totals	%S	Totals	%S
1	3,694	5.92 ±0.38	3,170	3.92 ±0.33
2	972	12.99 ±1.08	1,022	7.89 ±0.84
3	959	21.09 ±1.32	655	18.62 ±1.52
9	314	17.14 ±2.13	277	12.32 ±1.97
13	206	22.36 ±2.89	199	17.64 ±2.70
19	446	10.51 ±1.45	388	11.82 ±1.64
	6,591	14.99 ±0.44	5,711	12.04 ±0.44

cluding location 19). Such a difference suggests that Y bearing spermatozoa are more effective in transporting the virus than X bearing spermatozoa, or that there exists a differential egg-adult survival depending on sex of infected flies among the progenies.

The differences of sensitivity among adjoining trapping sites may be explained by the relative isolation of the micropopulations, resulting from the low dispersal of *Drosophila*. The dispersal rate is perhaps further diminished in these densely inhabited urban areas, as compared with the field populations previously studied.

A *Drosophila* population which has been decimated during the winter and builds up again from a few new founder individuals will have a vastly different genetic structure than a population at the height of population density. There must be a "bottleneck" in the winter months in Mexico City, as it was impos-

sible to collect any flies during January.

The variations of the percentages of CO₂-sensitivity in two localities (3 and 13), 2.48 Km. apart are shown in Fig. 2 and 3. The collections included the winter months, when the dwindling of the population took place. The pattern of variation of the proportion of sensitive flies differs considerably in the two trapping sites. Such differences may be due to a drift during the rebuilding of the populations, starting with a small population density, and to the low dispersal rate of urban *Drosophila* flies.

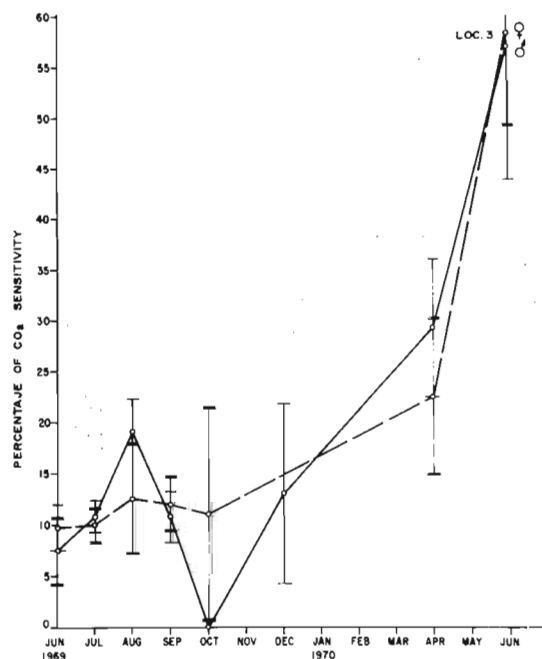


Fig. 2. Variation of CO₂-sensitivity percentage in location 3.

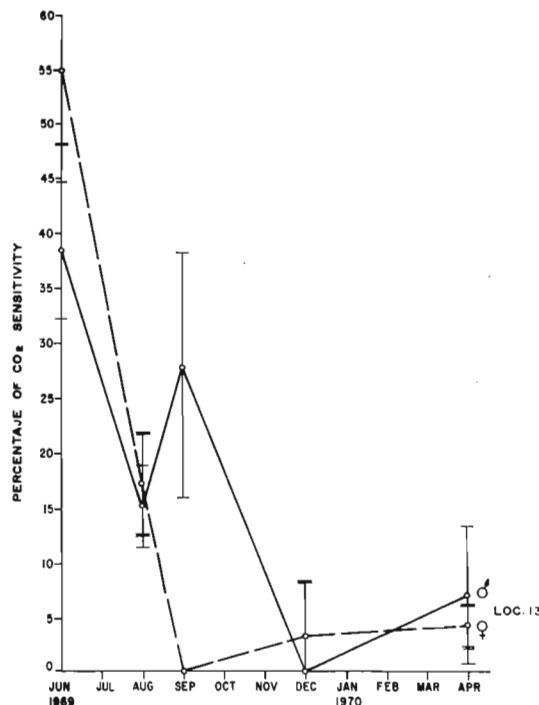


Fig. 3. Variation of CO₂-sensitivity percentage in location 13.

References: Bateman, A.J., 1947. *Heredity* 1:303-306; Brun, G., and A. Sigot, 1955. *II. Ann. Inst. Pasteur* 88:488-512; Burla, L., A.B. Dacunha, A.G.L. Cavalcanti, TH., Dobzhansky and C. Pavan, 1940. *Ecology* 31:393-404; Crow, J.F., 1955. In: Brehme, K.W. (Ed) *Cold Spring Harbor Symposia on Quantitative Biology XX. The Biological Laboratory. Cold Spring Harbor, L.I., New York: 54-59*; Dobzhansky, TH. and S. Wright, 1943. *Genetics* 28(1): 304-340; Kimura, M., 1955. In: Brehme, K.W. (Ed.) *Cold Spring Harbor Symposia on Quantitative Biology XX. The Biological Laboratory. Cold Spring Harbor, L.I., New York: 33-53*; L'Heritier, P., 1958. *Adv. Virus Res.* 5:195-245; L'Heritier, P. and N. Plus, 1963. In: Harris, R.J.C. (Ed.) *Biological Organization at the Cellular and Supercellular Level. Acad. Press. London and New York: 59-71*; Seecof, R.L., 1964. In: Brehme, K.W. (Ed.) *Cold Spring Harbor Symposia on Quantitative Biology XVII. The Biological Laboratory. Cold Spring Harbor, L.I., New York: 501-512*; Timofeeff-Ressovsky, N.W. and H.A. Timofeeff-Ressovsky, 1941a. *Z. Indukt.-Vererb.* 79:28-34; Timofeeff-Ressovsky, N.W. and H.A. Timofeeff-Ressovsky, 1941b. *Z. Indukt.-Vererb.* 79: 35-43; Wallace, B., 1966a. *Amer. Natur.* 100 (916): 565-578; Wallace, B., 1966b. *Amer. Natur.* 100(916): 551-563; Wright, S., 1951. *Genetics* 16(1): 97-159; Wright, S., 1955. In: Brehme, W.K. (Ed.) *Cold Spring Harbor Symposia on Quantitative Biology: XX. The Biological Laboratory. Cold. Spring Harbor, New York: 16-24.*