

Effect of Cohabitation on Survivorship of *Drosophila melanogaster* Exposed to Varying Oxygen Atmospheric Concentrations¹

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ABSTRACT

Unisexed and bisexed cultures of vestigial wing, brown-eyed *Drosophila melanogaster* were exposed to 9, 21, 33, and 49 percent oxygen atmospheric concentrations. Flies in unisexed cultures, in almost every instance, survived longer than those in cohabitation. The lethal time to 50 percent mortality was shorter in bisexed cultures exposed to high (49%) and low (9%) oxygen mixes than among flies in the unisexed cultures similarly exposed. Atmospheric mixtures of 33 percent oxygen did not appear to affect survivorship. Mean longevities in all female cultures were significantly longer than the male cultures.

INTRODUCTION

Observations of sex differences in mortality of *Drosophila melanogaster* have been observed by many investigators including Pearl and Parker (1921) and Kloek et al. (1976a). Experimental evidence in our laboratory showed that the difference was more pronounced in our vestigial wing (vg), brown-eyed (bw) strain than in our wild type. Greiff (1940) cited Krubiegel, who in 1939 reported that cohabitation of males and females shortened the mean duration of life in both sexes. Malick and Kidwell (1966) reported that single sexed cultures of their wild strain survived about 6 days longer than mated ones. Smith (1958) reported that in *D. subobscura*, mated males lived longer than mated females. However, the longevity of females could be prolonged by keeping them virgins or by exposing mating females to a high temperature for a brief period.

This investigation, a portion of a larger research program in our laboratory, was undertaken to determine the extent of differences in longevity due to cohabitation in vgbw flies when exposed to varying oxygen concentrations. All previous studies under investigation in our laboratory had been done with flies in cohabitation.

MATERIALS AND METHOD

The flies (vgbw) used in this investigation were maintained in the Kentucky State University laboratory for more than 3 years. This strain was established from the g 519 stock originally obtained from the Bowling Green University *Drosophila* Laboratory. The flies were treated with 9, 21, 33, and 49 percent oxygen concentrations in the manner described by Kloek et al. (1976a) except the designated 60-ml bottles contained males alone, females alone, or a combination of males and females. No bottle contained more than 54 flies or fewer than 31 flies. Every 5 days, the flies were etherized, counted, sexed, and placed in fresh culture medium.

RESULTS

The survivorship curves from data obtained at 5-day intervals are shown in Figs. 1-4. The shape of each curve comparing sexually isolated cultures with flies in sexual cohabitation are quite similar for a given oxygen concentration. Flies in the 21 percent oxygen concentration showed a 5-day difference in both males and females when flies of unisexed cultures were compared with those in a mixed sexed culture. The cohabitating flies exposed to 33 percent oxygen lived equally as long as those in single sexed culture for both males and

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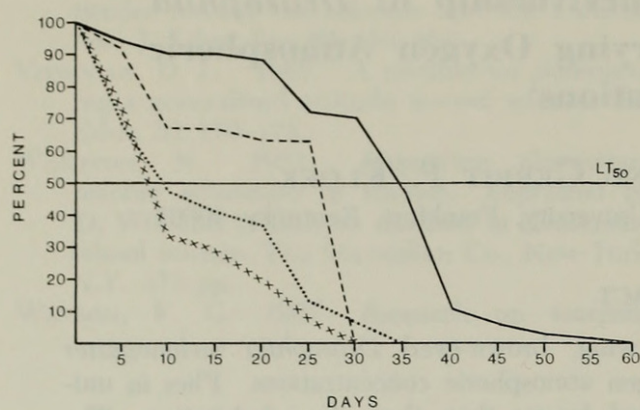


FIG. 1. Percentage of survivorship and lethal time (LT 50) of a strain of vgbw *Drosophila*, exposed to 9 percent oxygen at 5-day intervals. Solid lines represent females alone, dashed lines females in cohabitation, dotted lines males alone, and X lines males in cohabitation.

females, but at many levels during the examination periods, males living with females appeared to survive better. Unisexual male flies exposed to 49 percent oxygen had a 10-day difference in total life span compared to males in cohabitation. At the same time, the females showed a 15-day difference in life span under similar conditions. Male cultures exposed to 9 percent oxygen concentration survived 5 days longer than in bisexual cultures. Females in cohabitation survived 30 days less than those living solely with females in 9 percent oxygen (Fig. 1). However, the data for

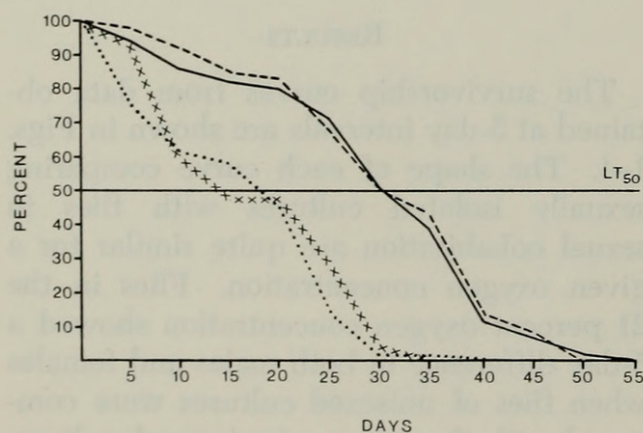


FIG. 2. Percentage survivorship and lethal time (LT 50) of a strain of vgbw *Drosophila* exposed to 21 percent oxygen at 5-day intervals. Notations are the same as in Fig. 1.

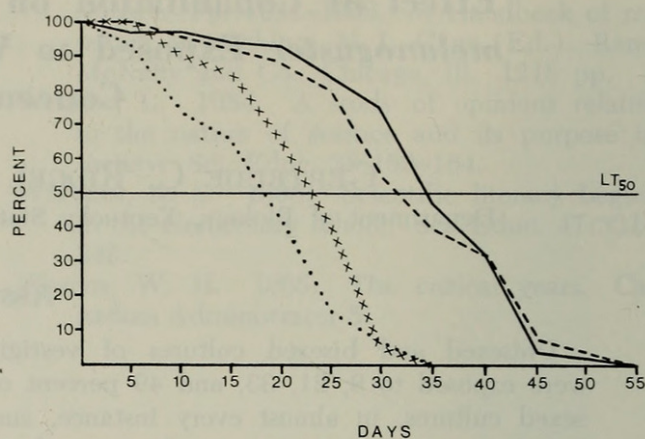


FIG. 3. Percentage survivorship and lethal time (LT 50) of a strain of vgbw *Drosophila* exposed to 33 percent oxygen at 5-day intervals. Notations are the same as in Fig. 1.

those cohabitating groups were obtained from a small sample (48 flies).

Mean longevities were determined on flies living alone and in cohabitation for each treatment. For the most part, the mean longevities were higher for flies in unisexual cultures than those in cohabitation (Table 1). The females exposed to 21 percent oxygen in cohabitation showed a slightly higher mean longevity than the single female cultures. Males in mixed sex cultures exposed to 33 percent oxygen had a higher mean longevity than those in single male cultures. When the significances of the mean were determined, the differences

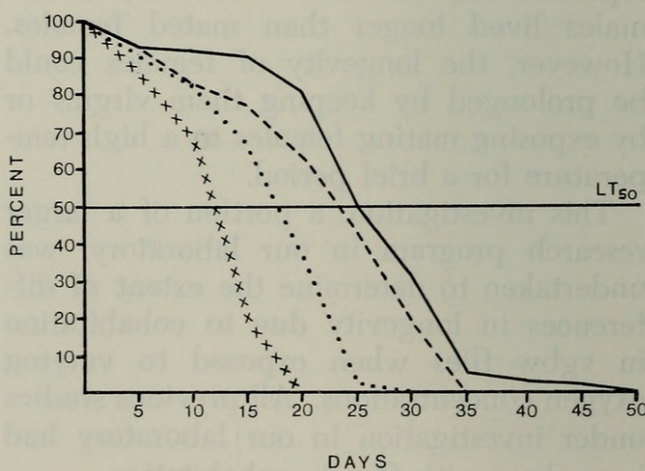


FIG. 4. Percentage survivorship and lethal time (LT 50) of a strain of vgbw *Drosophila* exposed to 49 percent at 5-day intervals. Notations are the same as in Fig. 1.

TABLE 1.—MEAN LONGEVITY (X), STANDARD DEVIATIONS (S), STANDARD ERROR, AND LETHAL TIME IN DAYS TO 50 PERCENT MORTALITY FOR VGBW FLIES EXPOSED TO 4 DIFFERENT OXYGEN ATMOSPHERES

0%	Sex	X	S	Sx	Days to 50% mortality
9	Fa ¹	33.19	11.62	1.34	39.0
	Fc ²	23.13 ³	10.24	2.09	34.2
	Ma	15.75	10.25	1.03	9.5
	Mc	13.13	8.45	1.72	7.5
21	Fa	13.10	12.61	0.87	30.0
	Fc	32.18	11.38	1.53	30.0
	Ma	19.49	8.10	0.53	18.0
	Mc	18.89	9.47	1.41	14.0
33	Fa	36.60	16.04	2.27	34.5
	Fc	34.80	10.94	2.19	31.2
	Ma	19.75	8.36	0.84	18.0
	Mc	24.25 ³	6.94	1.55	22.5
49.9	Fa	27.50	8.91	0.59	25.0
	Fc	24.00	9.32	1.70	23.0
	Ma	19.07	6.65	0.32	17.9
	Mc	13.47 ³	4.90	0.82	12.0

¹ a = unisixed culture.² c = cohabitating culture.³ Significant differences between a and c at 95% confidence limits.

were significant for females alone and in cohabitation when exposed to 9 percent oxygen and for males exposed to 33 and 49 percent.

The last column in Table 1 shows the days to 50 percent mortality for flies exposed to each oxygen concentration. In the 9 percent oxygen atmospheric mix, isolated females survived 39 days to 50 percent mortality, while cohabitating females lived an average of 34.2 days. In those 2 populations of female flies, the time to 50 percent mortality was actually longer than that of females exposed to 33 percent or to 21 percent oxygen mixes. Male flies in the 9 percent oxygen atmospheric mixture showed a decrease in time to 50 percent mortality of 9.5 days in isolated male cultures and 7.5 days in cohabitating cultures. Hypoxia in the males appeared more detrimental in terms of time to 50 percent mortality than hyperoxia. Males living alone that were exposed to a 49 percent oxygen atmospheric mixture had a time to 50 percent mortality of 17.9 days, while among males living with females it was 12 days.

DISCUSSION

This investigation was our initial attempt to compare the longevity of *D. melanogaster* in unisixed and bisixed cultures exposed to varying oxygen concentrations. Already reported by us (Kloeck et al. 1976a) and by many others were the observations that males cohabitating had a shorter life span than cohabitating females exposed to normal and modified atmospheres. The present investigation confirmed those observations. Furthermore, the data revealed that flies in cohabitation were less tolerant when exposed to extremes in oxygen concentrations (9 and 49%) than the flies in sex isolated cultures. This finding is more clearly demonstrated when comparisons were made at the 25th day period of exposure (Table 2). In the 9 and 49 percent oxygen concentrations, cohabitating male flies did not survive as well as those in sex isolated cultures. It may be that the greater activities assumed during courting was stressful to the cohabitating organisms in hyperoxia and

TABLE 2.—PERCENTAGE SURVIVORSHIP AFTER 25 DAYS OF EXPOSURE TO 4 DIFFERENT OXYGEN ATMOSPHERES

Sex	Oxygen Concentration (%)			
	9	21	33	50
Fa ¹	72	80	84	50
Fc ²	63	83	80	43
Ma	14	45	16	3
Mc	9	47	40	0

¹ a = unisixed culture.

² b = cohabitating culture.

hypoxia, and could lead to the reduced survivorship.

It appears that the 33 percent oxygen atmospheric mixture was not detrimental to the vgbw flies. This was also evident among a wild type strain in another study in our laboratory (Kloek et al. 1976b). As a matter of fact, in both investigations the flies exposed to 33 percent oxygen survived as well or better than those exposed to the 20 percent oxygen concentrations. This was unexpected since in a previous study Kloek et al. (1976a), the mean longevity of cohabitating vestigial wing brown-eyed flies exposed to 21 percent oxygen was 43.43 and 31.55 days for females and males, respectively, as compared with 32.18 and 18.89 days in the current investigation. The difference in longevity in those 2 sets of data may reflect a response to other environmental variations, including temperature. Kloek et al. (1976a) conducted their experiment January through March during which time the morning temperatures from day to day ranged from 18 to 27.5 C with an average temperature of 22.87 C over the entire experimental period. The present investigation was undertaken June through August when temperatures from day to day ranged between 24 and 27 C with an average temperature over the experimental period of 25.74 C. Siddiqui and Barlow (1972), in their research on population growth with a strain of vestigial wing flies, found that time to 50 percent mortality decreased with rising temperatures at both constant and alternating temperatures.

Comparing Siddiqui and Barlow's data with ours, they found that at a constant temperature of 22.5 C the time to 50 percent mortality was 36 days and at 25 C the time was 23 days. Our data from a previous experiment (Kloek et al. 1976a) showed that with the average temperature of 22.87 C, the flies exposed to 21 percent oxygen had a time to 50 percent mortality of greater than 45 days, while in our experiment with an average of 25.74 C, the time was 30 days. Those data confirm other evidences that show that temperature differences may greatly influence experimental results in the life activities and must be considered when analyzing data on longevity of *Drosophila*.

Data presented above demonstrate clearly that males have a lethal time of 50 percent mortality far below females exposed to high (49%) and low (9%) oxygen atmospheres, and that cohabitating organisms are more affected by those exposures than sex isolated cultures. From the mean longevities and total life spans, we draw similar conclusions.

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