DIFFERENCE IN PHOTO-PREFERENCES AS A CAUSE OF COEXISTENCE OF *DROSOPHILA SIMULANS* AND *D. MELANOGASTER* IN NATURE¹⁾

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Since *Drosophila simulans* was found to be a colonizer in many places of the world (Sturtevant 1929) and recently in Japan (Watanabe and Kawanishi 1976), factors controlling the coexistence of this species with its sibling species, *D. melanogaster*, have been studied. Ecological and behavioral analyses of these domestic sibling species revealed that a slight difference in microniche, seasonal activity, food and temperature preference made the coexistence of these species possible in nature (Tantawy and Mallah 1961; Tantawy 1964; Dobzhansky 1965; Hoenigsberg 1968; Tantawy *et al.* 1970; Parsons and McKenzie 1972; McKenzie and Parsons 1974; Kawanishi and Watanabe 1977; Kawanishi and Lee 1978).

The absence of *D. simulans* inside houses has been reported by Okada (1971) and Watanabe and Kawanishi (1976) whereas *D. melanogaster* was found both inside and outside of houses. McKenzie and Parsons (1972) reported that *D. simulans* was not found in wine cellars but was collected outside them. They ascribed the reason to the lesser tolerance of the species to alcohol, compared with *D. melanogaster* which was more tolerant to alcohol and therefore found both inside and outside the cellars. However, other ecological factors may be involved in the different occupations of these sibling species. Spieth and Hsu (1950) and Grossfield (1972) showed differences in mating success of the sibling species under lighting conditions. *D. melanogaster* mated freely in both light and darkness, while *D. simulans* was inhibited in darkness. Relatively higher photo-preference of *D. simulans* than *D. melanogaster* has also been suggested by McDonald and Parsons (1973) and Parsons (1975). Kekic and Marinkovic (1974) selected *D. subobscura* flies for the ability to choose different light intensities.

The present paper deals with a photo-preference of the sibling species, *Drosophila simulans* and *D. melanogaster*, as a possible cause of different occurrences of these species inside or outside houses.

MATERIALS AND METHODS

Iso-female strains: Twenty strains of each of *Drosophila simulans* and *D. melanogaster* derived from single inseminated females of a 1976 collection in Mishima (Rakuju-en; site-1 of Kawanishi and Watanabe, 1977) were used for the present experiment.

Photo-preference of adult flies: Photo-preference of adult flies was measured by

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an apparatus having a gradient of light intensities as shown in Fig. 1. The apparatus was made of a small plastic box, 36 cm long, 7 cm wide, and 3 cm deep. The box was partitioned with four partition walls into five equal compartments each having a food cup. The roof of the box was of clear perspex but could be shaded by four kind of papers on the roof of section 2 to 5 to create a light gradient. The light intensity was about 100 lux at section 1 and close to 0 lux at section 5. Twenty flies were introduced into the box from the most dark section (5) and left 30 min to select a light intensity. After then four partition walls were inserted and flies in each compartment were counted. For this experiment five iso-female strains of each species were used.

Oviposition site preference: A plastic population cage was used to obtain data on lighting conditions the sibling species prefer for oviposition sites. Fig. 3 shows the population cage which is covered with a cover. Light enters only from the left side of the cage. The light intensity was about 100 lux at the left most food cups (L) and a few lux at the right most cups (D). Three cups at the light site and three cups at the dark site were placed and a total of 800 flies, 400 of each species, were admitted into the cage. These flies were derived from 10 males and 10 females of each iso-female strain. Eggs laid on the surface of the food cups were collected at the 2nd, 6th, 10th and 15th days and were placed in vials with 10 ml of standard medium so avoiding high density in the stages of larval development. Adult flies emerging from the vials were classified into species and the relative frequency of *simulans* was calculated.

Selection for photo-preference: The plastic population cage with a cover (Fig. 3) was used for the selection of the photo-preferences. Nine food cups were placed in the cage; 3 in the light site (L), 3 in the dark site (D) and 3 in the middle site (M). Eight hundred flies of both species were introduced in the cage as the same manner as the previous experiment. On the next day, 3 cups of L site were taken from the cage and placed in an empty new cage. At the 14th day, the cage was filled with many newly emerged flies. Then, these 3 old cups were discarded and 9 new cups (3 for L, 3 for D, 3 for M) were placed for egg-laying. This procedure has been repeated every 2 weeks for making L, D and M preferent population. At every generation adult flies were counted just after the egg-laying to know the frequencies of both species.

All experiments were carried out at 25°C using the standard (cornmeal, sugar, yeast and agar) medium.

RESULTS AND DISCUSSION

Photo-preference of adult flies: Twenty flies were tested per trial in the apparatus shown in Fig. 1. Sexes were tested separately when flies of a single species were admitted into the apparatus. But, five flies of each sex of each species were admitted together for the test of mixed species experiment. The results are shown in Fig. 2 being pooled over sexes and strains, since no significant differences were detected among them. *Drosophila simulans* occupied more light positions than *D. melanogaster* both

Fig. 1. Apparatus (A: top, B: side) to test the photo-preference of *Drosophila* flies.

Fig. 2. Percentages of flies at each of the five positions for the two species.

in the single and mixed species experiments. This distribution pattern was very similar to that of Parsons (1975) obtained from the materials of Australia. The average position occupied by 5 strains of each species was as follows:

	<i>simulans</i>	<i>melanogaster</i>
single	2.3 ± 0.17	2.7 ± 0.24
mixed	1.9 ± 0.17	2.5 ± 0.13

D. simulans showed significantly higher photo-preference in the mixed species experiment. This may suggest that *D. simulans* recognizes in some degree other species as well as light gradient while *D. melanogaster* tends to behave regardless to these biological and physical environments.

Oviposition site preference: The frequencies of *D. simulans* which were descended from the L or D cups of the mixed cage population are shown in Table 1. Apparently,

Table 1. Frequency of *D. simulans* descended from the eggs laid in the light (L) and dark (D) cups of the mix population

Cups		Day of eggs laid				Mean
		2nd	6th	10th	15th	
Exp-1	L	0.66	0.65	0.42	0.49	0.55 ± 0.03 — ₁
	D	0.31	0.31	0.38	0.24	0.31 ± 0.02 — ₁ **
Exp-2	L	0.57	0.57	0.65	0.39	0.55 ± 0.03 — ₁
	D	0.44	0.62	0.49	0.33	0.47 ± 0.03 — ₁ *

** 1% level significant difference.

* 5% level significant difference.

D. simulans laid relatively more eggs in the light cups than *D. melanogaster*. On the other hand, in the dark cups the situation became reversed with an exception of 6th day's sample in Exp-2. This result is very consistent with the photo-preference of adult flies. That is, the place occupied by adults is the place where eggs are laid. The decrease of relative number of *simulans* eggs at the 15th day was observed both in the light and dark cups. Ageing effect may be involved in this phenomenon.

Selection for photo-preference: A clear difference observed in the photo-preference

Fig. 3. Population cage (A: top, B: side) used in the experiments for oviposition site preference and its selection.

Fig. 4. Percentages of *simulans* in the cage populations selected toward light preference (○), dark preference (●) and dim-light preference (×).

of the sibling species, photo-positive *simulans* and photo-neutral *melanogaster*, should have occurred in the evolutionary past, since the materials from the United States and Australia responded similarly (Spieth and Hsu 1950, Parsons 1975). Artificial selections for different photo-preferences of the mixed species cage populations are shown in Fig. 4. Selection for light preference eliminated *melanogaster* in 5 generations of selection, whereas selection for dark preference almost eliminated *simulans* in 10 generations. One of the dim preferring populations eliminated *simulans*, but the other dim preferring population maintained *simulans* at about 25% at the 10th generation of selection.

This latter population was then selected for light and dark preferences. The new light preferring population soon eliminated *melanogaster*, while the new dark preferring population and the original dim preferring population still continued to reduce the frequency of *simulans*. The rapid increase of *simulans* in the new light preferring population suggests that the dim population has simply maintained normal *simulans* having its intrinsic character of light preference. Thus, selection by photo-preference can easily diversify the mixed species population into two different species populations. These may explain the absence of *Drosophila simulans* inside house which are relatively darker than outside. The dark inhibition of mating coincides with the above situation. This difference in photo-preference between the two sibling species also suggests that these siblings occupy different niches in nature where various light intensities exist. The different photo-preferences of these species could be a possible cause of coexistence of *D. simulans* and *D. melanogaster* in some environmental conditions. In future, we must consider the difference of photo-preferences of the sympatric species sharing or competing with the same food and temperature.

SUMMARY

Photo-preferences of the sibling species, *Drosophila simulans* and *D. melanogaster*, were studied using an apparatus and population cage having a gradient of light intensities. *D. simulans* preferred to stay and to lay eggs at light places whereas *D. melanogaster* did not show such a strong light preference. Selections of eggs in the light gradient cages made it possible to segregate a mixed species population into different species populations; selection for photo-positive flies soon eliminated *D. melanogaster* and selection for photo-negative or photo-neutral flies finally eliminated *D. simulans*. The difference of the photo-preference seems to be a cause of coexistence of the sibling species in nature.

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