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INTRAPOPULATIONAL VARIATION FOR DESICCATION TOLERANCE IN INDIAN *DROSOPHILA MELANOGASTER*

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ABSTRACT

Intrapopulational variation in tolerance to desiccation stress has been measured in F_1 female individuals of 10 isofemale lines from a locally collected population sample of *Drosophila melanogaster*. Differences in survival time among the individuals of each isofemale line and also among different isofemale lines are observed. The results are discussed in relation with the eco-temporal situation in India and a possible conclusion on the mechanisms involved in conferring tolerance to desiccation in Indian natural populations of *D. melanogaster* is drawn.

Key words: Desiccation tolerance, intrapopulational variation, Indian *Drosophila melanogaster*.

Water loss in nature is usually reduced by a behavioural preference for humid environment [1, 2]. Environmental temperature plays a vital role in the water balance problem. The rate of water loss depends on the saturation deficit but not on relative humidity [2, 3]. *Drosophila* species with different ecological niches have a broad range of variability in their tolerances to heat desiccation stress [4]. It has also been estimated that several species of *Drosophila* are poorly protected against desiccation [5] and the water balance is maintained by water ingestion [6, 7].

Studies on the variation in desiccation tolerance at intra- and interpopulational level in *D. melanogaster* have been undertaken in natural populations of Australia [2, 7, 8] and Congo, Tunisia and France [9]. In the Australian studies, the temperate populations were found to be more resistant to desiccation stress than the populations from subtropical regions [2, 7, 8]. However, the populations from France (temperate) and Congo (Afro-tropical) were similar for desiccation tolerance but the Tunisian population was different from the above two populations [9].

India, a tropical country, experiences a wide range of temperature fluctuations in different seasons of the year at different places. Tropical and humid environment with a narrow range of temperature fluctuation exists in the southern part, while the northern region is relatively drier and the environmental temperature fluctuates between 0–44°C in different seasons. Several *Drosophila* species exist in India, including *D. melanogaster*, which is only available for collection in nature from October to April of the year. Population genetical studies on this species have been initiated recently, but no work has been done on the mechanism of tolerance to different abiotic environmental stress in Indian *D. melanogaster*. Recently we have initiated such type of studies [11] and report results on the tolerance to desiccation in a natural population of *D. melanogaster*.

MATERIALS AND METHODS

One sample of *Drosophila melanogaster* collected in December 1992 from Kalpana area of Bhubaneswar, Orissa, was used in the present study. The flies were collected from fermented banana baits inside houses. Isofemale lines were developed by rearing individual females in separate food vials. Since no sex-dependent difference is exhibited for stress tolerance [9], only F_1 females from 10 randomly selected isofemale lines were compared. For each line, the larvae were grown on killed yeast food medium and the adults derived from individual females were divided into groups of 10 females. Each group was fed with killed yeast medium for 3 days and then transferred to 60 ml plastic experimental vials hermetically closed by a cap without any food and water. Desiccating condition of 0% relative humidity was maintained by keeping 2 g silica gel under a piece of sponge in each vial. Experiments were conducted at 25°C. After 10 h of experimental exposure, at hourly intervals dead individuals were counted.

RESULTS AND DISCUSSION

Table 1 shows the mean survival time in different isofemale lines under desiccating conditions. In spite of being descendants of a single female, there was variation in desiccation tolerance among them (detailed data not presented). The mean survival time varied from 19.40 ± 1.33 to 31.40 ± 2.84 h among the isofemale lines. Pair-wise comparison among isofemale lines was carried out by the Student's t test. Total variation was calculated by F test (Table 2). ANOVA showed the total variation among individuals of the 10 isofemale lines to be highly significant (Table 2) in majority of comparisons involving lines 6 and 10, and in some comparisons (one or two) involving lines 7, 8 and 9. The remaining lines did not exhibit statistically significant differences (Table 2).

A study involving selection for delayed senescence in *D. melanogaster* showed that long-living strains were most tolerant to various environmental challenges including

desiccation [11, 12]. It has been argued that water loss occurs mainly through respiration and tolerance to desiccation is due to the fact that adult insects have a control over the opening of spiracles [3, 6, 7]. Water content in regularly fed *D. melanogaster* adults is reported to be 71% of fresh body weight [9, 13] and the lethal threshold of water content depends on temperature [9]. Since our experiments were conducted at 25°C, the possibility of deleterious effects due to extreme cold or heat is negligible and it can be assumed that death occurred from water loss only. This assumption is supported by the fact that there is no significant compensation of water loss by metabolic water [9]. However, the observed difference in tolerance to desiccation among the isofemale lines may be attributed to the differences in their ability to store and use water in the body.

Table 1. Mean survival time in each isofemale line of *D. melanogaster* exposed to desiccating condition

Isofemale line	Total individuals examined	Mean survival time (h)
1	9	25.8 ± 1.41
2	10	27.0 ± 1.58
3	10	23.2 ± 1.96
4	10	25.0 ± 1.69
5	10	27.9 ± 3.81
6	10	19.4 ± 1.33
7	10	31.4 ± 2.84
8	10	27.5 ± 2.02
9	10	28.0 ± 3.08
10	10	20.3 ± 1.66

Although in most cases, differences in the duration of survival under desiccation were insignificant, significant differences were also obtained in some instances (Table 2). Such result indicates occurrence of genetic variations between isofemale lines of *D. melanogaster* [14] and *D. ananassae* [15]. However, the variation in tolerance to desiccation may be more due to uncontrolled common environment effects than due to from genetic differences [9].

Since the population sample of *D. melanogaster* was directly collected from nature, the results should be interpreted in relation to natural populations. In India, *D melanogaster* can be collected from nature only during winter months (September to April). At some places in India, the relative humidity is nearly zero during summer (April to mid-June) when no files of *D. melanogaster* are observed. However, flies are also not seen during rainy season (mid-June to September) when the ambient relative humidity is close to 100%. Again, the relative humidity is very low in winter. Hence, the reduction in the Indian *D. melanogaster* population is not be due to desiccation alone. However, the ecological expectations are not always vindicated in all conditions. This has been proved by the work of Da lage et al. [9], where similar tolerance to desiccation was observed in two *D. melanogaster* populations originating from completely different environmental conditions (Congo and France). On the other hand, ecological expectations were confirmed in some Australian [7] and in a Tunisian populations [9]. Thus, the problem remains unsolved and several natural

Table 2. The t values (above diagonal) and associated probabilities (below diagonal) between mean survival time of two isofemale lines of an Indian natural population of *D. melanogaster*

Isofemale lines	1	2	3	4	5	6	7	8	9	10
1	—	0.58 (17)	1.05 (17)	0.35 (17)	0.50 (17)	3.28 (17)	1.72 (17)	0.44 (17)	0.64 (17)	2.49 (17)
2	>0.20	—	1.52 (18)	0.87 (18)	0.22 (18)	3.68 (18)	1.35 (18)	0.12 (18)	0.29 (18)	2.93 (18)
3	>0.10	>0.10	—	0.70 (18)	1.10 (18)	1.62 (18)	2.38 (18)	1.06 (18)	1.32 (18)	1.13 (18)
4	>0.20	>0.10	>0.10	—	0.70 (18)	2.60 (18)	1.94 (18)	0.64 (18)	0.85 (18)	1.99 (18)
5	>0.20	>0.20	>0.10	>0.10	—	2.11 (18)	0.74 (18)	0.08 (18)	0.02 (18)	1.83 (18)
6	<0.01*	<0.01*	>0.10	<0.02*	<0.05*	—	3.82 (18)	2.14 (18)	2.57 (18)	0.42 (18)
7	>0.10	>0.10	<0.05*	>0.05	>0.10	<0.01*	—	0.86 (18)	0.81 (18)	3.37 (18)
8	>0.20	>0.20	>0.10	>0.20	>0.10	<0.01*	>0.10	—	0.11 (18)	1.84 (18)
9	>0.20	>0.20	>0.10	>0.10	>0.10	<0.02*	>0.10	>0.20	—	2.21 (18)
10	<0.05*	<0.01*	>0.10	>0.05	>0.05	>0.05	<0.01*	>0.05	<0.05*	—

*Significant. The values in parentheses indicate degree of freedom.

$F = 5.37$, $P < 0.001$, significant.

populations need to be studied in order to get a clear picture of the ecophysiological conditions affecting survival of Indian *D. melanogaster*.

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