EFFECT OF TEMPERATURE ON OVIPOSITION IN FOUR SPECIES OF THE *melanogaster* GROUP OF *Drosophila*

TULIKA SRIVASTAVA and B. N. SINGH

Genetics Laboratory, Department of Zoology, Banaras Hindu University, Varanasi 221– 005, India

Correspondence to: Prof. B. N. Singh, Genetics Laboratory, Department of Zoology, Banaras Hindu University, Varanasi – 221005, India

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(With 1 figure)

ABSTRACT

Experiments were conducted to test the effect of temperature on oviposition in four species of the *melanogaster* group of *Drosophila: D. ananassae, D. bipectinata, D. malerkotliana* and *D. biarmipes.* In each species, two wild strains were used and eggs laid by females at three different temperatures (19°C, 24°C and 30°C) were counted for four days at 24 h interval. It is evident from the results that females of *D. ananassae, D. bipectinata, D. malerkotliana* and *D. biarmipes* lay low number of eggs at low temperature (19°C). Thus oviposition in these four species of *Drosophila* is significantly reduced at low temperature.

Key words: Four *Drosophila* species, *melanogaster* group, temperature, oviposition.

RESUMO

Efeito da temperatura na oviposição em quatro espécies do grupo *melanogaster* da *Drosophila*

Experimentos foram dirigidos para testar o efeito da temperatura na oviposição em quatro espécies do grupo *melanogaster* da *Drosophila: D. ananassae, D. bipectinata, D. malerkotliana* e *D. biarmipes.* Em cada espécie, duas linhagens selvagens foram usadas e os ovos depositados por fêmeas em três temperaturas (19°C, 24°C e 30°C) foram contados por quatro dias com intervalo de 24 horas. É evidente, a partir dos resultados, que as fêmeas de *D. ananassae, D. bipectinata, D. malerkotliana* e *D. biarmipes* depositam um número mais baixo de ovos em temperaturas baixas. Deste modo, a oviposição nestas quatro espécies de *Drosophila* é reduzida significativamente em baixa temperatura.

Key words: quatro espécies de *Drosophila*, grupo *melanogaster*, temperatura, oviposição.

INTRODUCTION

Oviposition is an important aspect of non-sexual behaviour of adult female *Drosophila* (Grossfield, 1978). Oviposition behaviour is an adaptive trait in the evolutionary ecology of *Drosophila* (Jaenike, 1982; Mueller, 1985). Most species are opportunistic generalists in their feeding behaviour but many species are selective in their choice of oviposition substrates (Carson, 1971).

Oviposition site preference (OSP) has been studied in different species of *Drosophila* and intra and interspecific variations with respect to OSP have been reported (Pyle, 1976; Richmond & Gerking, 1979; Takamura & Fuyama, 1980; Takamura, 1984; Moore, 1985). Choice of oviposition site is influenced by various extrinsic factors such as substrate condition, humidity, density of females, temperature, light, ethanol and other chemicals (Mainardi, 1968; Delsolar & Palomino, 1970; Markow, 1975; Takamura, 1980; Jaenike, 1982; Wogaman & Seiger, 1983).

Evidence for genetic control of oviposition behaviour has also been presented in certain cases (Delsolar, 1968; Takamura & Fuyama, 1980; Ruiz-Dubreuil & Delsolar, 1991; Ruiz-Dubreuil *et al*., 1992).

In general, behaviour of an organism is strongly influenced by environmental conditions Effect of different external factors on oviposition pattern has been investigated in various *Drosophila* species (Gruwez *et al.*, 1971; Mckenzie, 1975; Ohnishi, 1977; Rockwell & Grossfield, 1978; Seiger & Sanner, 1983; Schnebel & Grossfield, 1986). Temperature plays an important role in oviposition behaviour of *Drosophila* species. It is severely restricted at low temperature (Mckenzie, 1975; Parsons, 1978; Schnebel & Grossfield, 1986). In India, certain *Drosophila* species are very common and behavioural studies on *D. ananassae, D. bipectinata, D. malerkotliana* and *D. biarmipes* have been reported by Singh and his coworkers (Singh & Chatterjee, 1986, 1988, 1989; Singh & Pandey, 1993, 1994; Srivastava & Singh, 1993a, b; Singh & Sisodia, 1995). Oviposition site preference has been studied in these species and intraand interspecies variations have been found (Srivastava & Singh, 1993a, b). Oviposition pattern in all these four species is also affected by light and dark conditions. Light condition is favourable to oviposition in these species (Srivastava & Singh, 1996).

During the present study, we conducted experiments to test the effect of temperature on oviposition pattern of these four species of *Drosophila* and results are reported in the present paper.

MATERIALS AND METHODS

To test the effect of temperature on oviposition pattern in *D. ananassae, D. bipectinata, D. malerkotliana* and *D. biarmipes,* two strains of each of the four species were used and experiments were conducted at three different temperatures (19°C, 24°C and 30°C). All the strains of *D. ananassae, D. bipectinata* and *D. malerkotliana* are mass culture stocks raised from females collected from different geographic localities. However, the two stocks of *D. biarmipes* are isofemale lines derived from two different localities. All these stocks have spent varying number of generations in the laboratory and are being maintained on simple culture medium in standard laboratory conditions. To study oviposition behaviour of females of these four species of *Drosophila,* simple culture medium containing agar-agar, dried yeast, maize powder, brown sugar, nipagin, propionic acid and water was used. In order to facilitate the counting of eggs a green edible dye was added to the medium and a spot of active baker's yeast was placed in the centre of culture medium

Stocks were cultured and virgin females and males were collected. These flies were aged for two days in small batches. Five females and five males were kept in a food vial for two days for mating and then transferred without etherization to a food vial (8 cm length x 3 cm diameter) containing coloured food medium. Females were allowed to oviposit for 24 h and then transferred to another food vial. Number of eggs laid in the vial was counted. This was continued for four days. In each strain ten replicates (10 x 5 = 50 females) were made. The data of that vial in which any female died during the course of observation were rejected and thus the number of replicates varies in different species. Experiments were conducted in BOD incubator at 19°C, 24°C and 30°C temperatures and 12:12h L:D cycle.

Mean number of eggs/♀/day was calculated for each strain and comparison was done between different temperatures by student's t-test.

RESULTS AND DISCUSSION

Results of experiments conducted to test the effect of temperature on oviposition in four species of *Drosophila* are shown in Table I and are depicted diagramatically in Figure 1. Females of all the four species laid low number of eggs at 19°C temperature as compared to higher temperature (24°C). All the strains showed more or less similar oviposition at 24°C and 30°C temperatures except one i.e. Ng strain of *D. biarmipes* in which number of eggs laid is higher at 24°C than that at 30°C. Comparison of mean number of eggs at three temperatures in all the four species has been done by means of student's t-test and the t values are given in Table II. The difference in the mean number of eggs between 19°C and 24°C is significant in all the species and thus oviposition is significantly reduced at lower temperature in all the four species tested. However, the difference in the mean number of eggs between 24°C and 30°C is not significant in all the four species (except Ng strain of *D. biarmipes).* Females of *D. ananassae, D. bipectinata* and *D.*

malerkotliana laid significantly less number of eggs at 19°C as compared to 30°C but the difference in the mean number of eggs between 19°C and 30°C is not significant in *D. biarmipes.*

Thus it is evident from these results that oviposition is reduced at low temperature in all these four species of *Drosophila* which occur in India. The pattern of oviposition at different temperatures is similar in *D. ananassae, D. bipectinata* and *D. malerkotliana* which belong to the *ananassae* subgroup of the *melanogaster* species group. *D. biarmipes* which belongs to the *suzakii* subgroup of the *melanogaster* species group shows some variation from the remaining three species with respect to oviposition at 30°C temperature. Females of *D. biarmipes* oviposit significantly less number of eggs at 30°C as compared to 24°C.

Due to this reason, the difference in the mean number of eggs between 19°C and 30°C in *D. biarmipes* is not significant. This species also differs from the remaining three species with respect to the effect of different environmental factors on pupation site preference (Pandey & Singh, 1993).

In certain studies, various species of *Drosophila* including *D. ananassae,* which has been utilized during the present study have been used for the study of effect of temperature on oviposition (McKenzie, 1975; Parsons, 1978; Schnebel & Grossfield, 1986). In all these species, oviposition is severely reduced at low temperature. However, oviposition increases linearly between 12-20°C in *D. melanogaster* and *D. simulans* (McKenzie, 1975; Parsons, 1978).

At 28°C, David & Clavel (1969) found less than one half of maximum daily egg production in *D. melanogaster,* Schnebel & Grossfield (1986) compared the oviposition temperature range in four *Drosophila* species triads from different ecological backgrounds and found differences in temperature range for oviposition of different species groups which reflects the group's ecological distribution.

This suggests that temperature-dependent oviposition may be important for the separation of these closely related species. Thus temperature is an important factor affecting oviposition in *Drosophila* because of limited physiological capabilities of the organism at low temperature.

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TABLE 1

Mean number of eggs/♀/day at three different temperatures in four species of *Drosophila.*

Species/Strain	Nº of ♀ tested			Nº of days eggs counted	Total nº of eggs laid			Mean nº of eggs/♀/day ($\overline{X} \pm S_{\overline{X}}$)		
	19°C	24°C	30°C		19°C	24°C	30°C	19°C	24°C	30°C
D. ananassae										
JM-87	45	40	40	4	153	1094	1046	0.85 ± 0.61	6.84 ± 1.75	6.54 ± 1.56
B-84	45	50	50	4	487	1218	1211	2.71 ± 0.54	6.09 ± 1.18	6.06 ± 1.18
D. bipectinata										
B.H.U.	50	35	50	4	760	703	895	3.80 ± 1.77	5.02 ± 1.12	4.48 ± 0.62
Kerala	35	40	50	4	376	862	9X4	2.69 ± 0.85	5.39 ± 2.34	4.92 ± 0.72
D. alerkotliana										
Brazil	40	40	45	4	267	662	820	1.67 ± 0.44	4.14 ± 1.10	4.56 ± 1.18
Baripada	50	50	50	4	153	817	850	0.76 ± 0.38	4.08 ± 1.42	4.25 ± 2.46
D. biarmipes										
Ng	50	35	50	4	414	552	433	2.07 ± 0.47	3.94 ± 0.67	2.16 ± 0.40
RC	50	35	35	4	452	485	349	2.26 ± 0.30	3.46 ± 1.53	2.49 ± 1.20

TABLE 2

Comparison of mean number of eggs/ ♀ /day at three different temperatures by t-test in four species of *Drosophila.*

Species/Strain	t-test between 19°C - 24°C			t-test between 24°C - 30°C			t-test between 19°C - 30°C		
	t-value	df	p	t-value	df	p	t-value	df	p
D. ananassae									
JM-87	12.50	15	< 0.001*	0.10	14	> 0.05	3.87	15	< 0.01*
B-84	4.10	17	< 0.001 *	0.01	18	> 0.05	2.60	17	< 0.02*
D. bipectinata									
B.H.U.	2.21	15	< 0.05*	0.30	15	> 0.05	2.65	18	< 0.02*
Kerala	2.40	13	< 0.05*	0.54	16	> 0.05	3.27	15	< 0.01*
D. malerkotliana									
Brazil	4.02	14	< 0.01 *	0.20	15	> 0.05	2.26	15	< 0.05*
Baripada	7.48	18	< 0.001 *	0.27	18	& 0.05	5.27	18	< 0.001*
D. biarmipes									
Ng	7.52	15	< 0.001 *	2.67	15	< 0.02*	0.22	18	> 0.05
RC	2.21	15	< 0.05	1.04	12	> 0.05	0.15	15	> 0.05

* Significant.

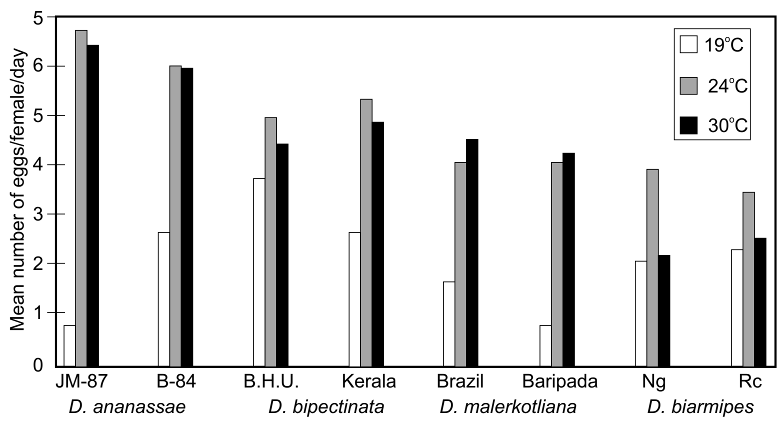

Fig. 1 — Mean number of eggs/ ♀ /day at three different temperatures in different species of *Drosophila.*

REFERENCES

CARSON, H. L., 1971, The ecology of *Drosophila* breeding sites. *In: Arboretum/ Lecture. H.L. Lyon* (ed.), University of Hawaii; Honolulu, *2*: 1-27.

DAVID, J. & CLAVEL, M. F., 1969, Influence de la temperature sur le nombre, le nombre, le pourcentage d'eclosion et la tail le des oenfs pondus Par *D. melanogaster. Ann. Soc. Entomol. Fr., 5*: 161-177.

DEL SOLAR, E., 1968, Selection for and against gregariousness in the choice of oviposition sites by *Drosophila pseudoobscura. Genetics, 58*: 275-282.

DEL SOLAR, E. & PALOMINO, H., 1970, Choice of oviposition sties by *Drosophila pseudoobscura* females among areas with different number of eggs. *Dros. Inf. Serv., 45:*132.

GROSSFIELD, J., 1978, Non sexual behaviour of *Drosophila. In: The Genetics and Biology of Drosophila,* M. Ashburner and T.R.F. Wright (ed.) Academic Press, New York, *2b*: 1-126.

GRUWEZ, G., HOSTE, C., LINTS, C. V. & LINTS, F. A., 1971, Oviposition rhythm in *Drosophila melanogaster* and its alteration by a change in photoperiodicity. *Experientia, 27*: 1414-1416.

JAENIKE, J., 1982, Environmental modification of oviposition behaviour in *Drosophila. Am. Nat., 119*: 784-802

MAINARDI, M., 1968, Gregarious oviposition and pheromones in *Drosophila melanogaster. Boll. Zool., 36*: 101-103.

MARKOW, T. A., 1975, Effect of light on egg laying rate and mating speed in phototactic strains of *Drosophila. Nature, 258*: 712-714.

McKENZIE, J. A., 1975, The influence of low temperature on survival and reproduction in populations of *Drosophila melanogaster. Aust. J. Zool., 23*: 237-247.

MOORE, J. A., 1985, Competition between *Drosophila melanogaster* and *D. simulans.* 1. Population cage experiments. *Evolution, 6*: 407-420.

MUELLER, L. D., 1985, The evolutionary ecology of *Drosophila. Evol. Biol., 19*: 37-98.

OHNISHI, S., 1977, Oviposition pattern of several *Drosophila* species under various light environment. *J. Insect. Physiol., 23*: 1157-1162.

PANDEY, M. B. & SINGH, B. N., 1993, Effect of biotic and abiotic factors on pupation height in four species of *Drosophila. Ind. J. Exp. Biol., 31*: 912-917.

PARSONS, P. A., 1978, Boundary conditions for *Drosophila* resource utilization in temperate regions, especially at low temperatures. *Am. Nat., 112*: 1063-1074.

PYLE, D. W., 1976, Oviposition site differences in strains of *Drosophila melanogaster* selected for divergent geotactic maze behavior. *Am. Nat., 110*: 181-184.

RICHMOND, R. C. & GERKING., J. L., 1979, Oviposition site preference in *Drosophila. Behav. Genet., 9*: 233-241

ROCKWELL, R. F. & CROSSFIELD, J., 1978, *Drosophila* behavioural cues for oviposition. *Am. Midl. Nat., 99*: 361-368.

RUIZ-DUBREUIL, D. G. & DEL SOLAR, E., 1991, Genetics influences on gregarious oviposition in *Drosophila melanogaster*. *Evol. Biol., 5*: 161-171.

RUIZ-DUBREUIL, D. G., CARDENAS, H. & HOENIGSBERG, H. F., 1992, Genetic correlation under selection for high and low egg aggregation in components of fitness with the multiple pleiotropy in *Drosophila melanogaster. Evol. Biol., 6*: 135-174.

SCHNEBEL, E. M. & GROSSFIELD, J., 1986, Oviposition temperature range in four *Drosophila* species triads from different ecological backgrounds. *Am. Midl. Nat., 16*: 25-35.

SEIGER, M. B. & SANNER, A. B., 1983, Selection for light preference during oviposition in *D. pseudoobscura. Can. J. Genet. Cytol., 25*: 446449.

SINGH, B. N. & CHATTERJEE, S., 1986, Mating ability of homo and heterokaryotypes of *Drosophila ananassae,* from natural populations. *Heredity, 57*: 75-78.

SINGH, B. N. & CHATTERJEE, S., 1988, Selection for high and low mating propensity in *Drosophila ananassae, Behav. Genet., 18*: 357-369.

SINGH, B. N. & CHATTERJEE, S., 1989, Rare male mating advantage in *Drosophila ananassae. Gen. Sell Evol., 21*: 447-455.

SINGH, B. N. & PANDEY, M., 1993, Selection for high and low pupation height in *Drosophila ananassae. Behav. Genet., 23*: 239-243.

SINGH, B. N. & PANDEY, M., 1994, Sex ratio and mating propensity in *Drosophila biarmipes. Ind. J. Expt. Biol., 32*: 482-485.

SINGH, B. N. & SISODIA, S, 1995, Variation in mating propensity in laboratory strains of *Drosophila bipectinafa. Biol. Zent.* bl., *114*: 95-101.

SRIVASTAVA, T. & SINGH, B. N., 1993a, Oviposition site preference in four species of *Drosophila. Ind. J. Exp. Biol., 31*: 460-462.

SRIVASTAVA, T. & SINGH, B. N., 1993b, Intra species variation with respect to oviposition site preference in certain Indian species of *Drosophila. Evol. Biol., 7*: 193-203.

SRIVASTAVA, T. & SINGH, B. N., 1996, Rhythmicity in oviposition pattern in four Indian species of *Drosophila. Biol. Res., 29*: 355-360.

TAKAMURA, T., 1980, Behaviour genetics of choice of oviposition site in *Drosophila melanogaster.* II. Analysis of natural populations. *Jpn. J. Genet., 55*: 91-97.

TAKAMURA, T., 1984, Behaviour genetics of choice of oviposition sites in *Drosophila melanogaster. IV.* Differentiation of oviposition force in *melanogaster* species subgroup. *Jpn. J. Genet., 59*: 71-81.

TAKAMURA, T. & FUYAMA, Y., 1980, Behaviour genetics of choice of oviposition sites in *Drosophila melanogaster. I.* Genetic variability and analysis of behaviour. *Behav. Genet., 10*: 105-120.

WOGAMAN, D. J. & SEIGER, M. B., 1983, Light intensity as a factor in the choice of oviposition site by *Drosophila pseudoobscura* and *Drosophila persimilis. Can. J. Genet. Cytol., 25*: 370-377.