Body size and fitness characters in *Drosophila malerkotliana*

S. N. Hegde and M. S. Krishna

Department of Studies in Zoology, University of Mysore, Manasagangotri, Mysore 570 006, India

Body size and fitness characters have been studied in *Drosophila malerkotliana*. Large flies were fast mating and had higher fecundity, fertility and greater longevity than slow mating small flies. Further, wing length was positively correlated with number of ovarioles. These studies indicate that large flies have higher fitness characters in *D. malerkotliana*.

IN *Drosophila*, as in other insects, mating success is influenced by male body size[1]. Both laboratory and field studies have indicated advantage of larger male over small male[1,2–5] but not the largest of the two competing males[6,7]. In *Drosophila subobscura* even small males do have courtship advantage[8]. In most of these studies the role of male body size on mating success has been emphasized. However, no attempt has been made to study role of female size on mating success and fitness.

Wing is an index of body size and larger *Drosophila* flies have longer wings[9,10]. Mating success is not the only advantage of large size but it also influences fitness characters[2,11]. Furthermore, the relationship between body size and fitness characters has been established only in *D. melanogaster* and *D. buzzatii*. Different *Drosophila* species may have adopted different evolutionary strategies. Hence the present investigation was undertaken in *D. malerkotliana* belonging to the *bipectinata* complex of the *ananassae* subgroup of the *melanogaster* species group. Population and behavioural genetics studies on *bipectinata* complex have been initiated by Indian workers[12–22]. Further in *D. malerkotliana* while studying size-assortative mating[5] we have proposed a hypothesis 'bigger is better'. Size-related fitness data of this species is not available. Hence the present experiment was undertaken to study the role of male and female body size on fitness characters.

The experimental stock used in the laboratory study was established from 150 naturally inseminated females of *Drosophila malerkotliana* collected from Mysore (1997). All females were kept together in the same culture bottle (250 ml). When progeny appeared, flies were transferred to fresh culture bottles and allowed to multiply through 10 generations under constant laboratory conditions (temperature 22° ± 1°C and relative humidity of 70%). In every generation, flies from different cultures bottles were mixed together and redistributed to fresh bottles. The eggs were then collected using Delcour's[23] procedure. Eggs (100) were seeded in quarter pint milk bottles containing wheat cream–agar medium. When adults emerged, virgin females and males were isolated within 3 h of their eclosion and used for wing length measurement. Wing lengths of male and female flies were measured separately. Each fly was individually etherized, placed on transparent glass slide and then kept under binocular stereo-microscope. Left wing was spread sidewise with the help of fine needles, then the intact left wing was measured in the horizontal plane from humeral crossvein to the tip with an ocular micrometer at × 100 magnification. Wing length was measured in units of 0.1 mm. After measuring the wing length, each fly was individually placed in a vial with fresh food. After 5–6 days these flies were used to study body size-related fitness characters.

Pairs of flies of equal age were used to study relationships between wing length, mating latency, fecundity, fertility and longevity. The male fly with longest wings was paired with female having longest wings in an Elens–Wattiaux mating chamber (a circular chamber with 9 cm dia). The male fly with the next longest wings was paired with the female with the next longest wings, etc. A total of 125 pairs were analysed. Mating latency (time between introduction of male and female together into mating chamber and initiation of copulation) was recorded for each pair. Observation was made for 1 h. Flies which did not mate within an hour were considered unmated. Soon after mating, the mated pairs were placed separately into food vials containing wheat cream–agar medium to determine fecundity, fertility and longevity. Flies in the vials were transferred to fresh food vial every day (between 7 AM and 9 AM). This procedure was followed until the flies died. The number of eggs laid and the number of progeny emerging from these eggs were counted and the longevity measured in terms of days. Correlation matrices were calculated by applying partial correlation to fitness character data.

Five to six day-old females of chosen wing lengths (see Figure 1) were used to determine the number of ovarioles in them. Individual females were separately dissected out in a drop of physiological saline under binocular stereo-microscope. The ovarioles of each ovary were separated from each other with a fine needle. In total 25 females of each chosen wing size were used. Correlation was calculated between wing length and mean number of ovarioles.

The present procedure enabled us to study the relationship between body size and fitness characters in *Drosophila malerkotliana*. Mating latency was negatively correlated with wing length, fecundity, fertility and longevity (Table 1). Therefore fast mating larger flies had higher fitness than slow mating small flies. This is because mating latency is an important component of fitness as shown by Prakash[24], who found a positive correlation between fast mating, repeated mating and fertility in *D. robusta*. Monclus and Prevosti[25] reported that in *D. subobscura* fast mating flies had wings longer than slow mating flies. Naseerulla and Hegde[16] while

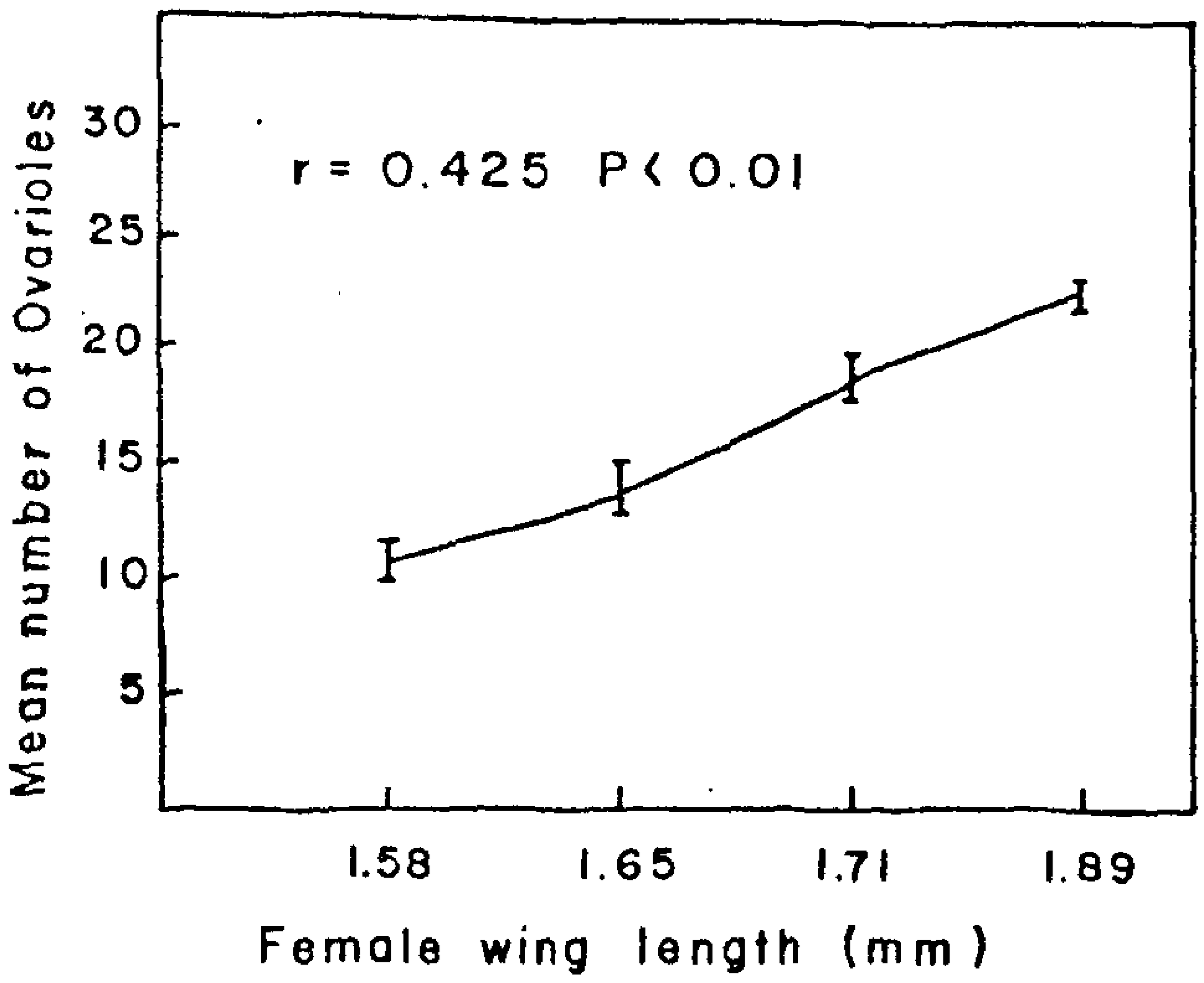

Figure 1.

Table 1. Partial correlation between different parameters

Parameters	Mating latency	Female wing length	Male wing length
Female wing length	– 0.467**	—	—
Male wing length	– 0.560**	—	—
Fecundity	– 0.512**	0.243*	—
Fertility	– 0.497**	0.323**	—
Male longevity	– 0.241*	—	0.272*
Female longevity	– 0.310**	0.210*	—

$N = 121$, df = 119, $^{**}P < 0.01$; $^{*}P < 0.05$.

studying the relationship between wing size and mating speed in *D. malerkotliana* using random multiple choice experiments involving 50 males and 25 females, have found that fast-mating flies were larger than low mating flies. In the present studies the correlation has been made by pairing males and females on the basis of wing length. Thus female size is automatically correlated with the size of her mate, while male size is correlated with his partner. In view of the present results similar to that of Naseerulla and Hegde[16] and in view of the positive correlation between female/male wing length (Table 1) with fecundity, fertility and longevity indicate higher fitness of large flies than smaller ones. Singh and Mathew[26,27] who, while studying sternopleural bristles in *D. ananassae*, have also found that flies possessing a larger number of sternopleural bristles are larger in size and more successful in mating and also show greater fertility than the flies with fewer sternopleural bristles. In the present study female wing length was positively correlated with fecundity and fertility, indicating large females had higher fitness than small females. This agrees with the work of Santos *et al.*[3] who while studying positive phenotypic covariance between field adults fitness components of body size have found positive correlation between thorax length and fitness. According to Gruwez *et al.*[28] higher fecundity in females is correlated with the number of ovarioles. In the present study also (Figure 1), significant positive correlation ($r - 0.423$, $P < 0.01$) was noticed between female wing length and mean number of ovarioles. Therefore a number of ovarioles increased with increasing wing length in *D. malerkotliana*. This agrees with the work of Montague[29] and Santos *et al.*[3] who also showed positive correlation between thorax length and ovarioles number.

In the present study both male and female winglength was positively correlated with longevity (Table 1). Therefore longevity increases with increasing wing length indicating that larger flies live longer than the smaller flies. Partridge and Farquhar[30] also pointed out that larger males have greater longevity. Thus these findings suggest that fitness increases with increasing body size in *D. malerkotliana*.

1. Partridge, L., Ewing, A. and Chandler, A., *Anim. Behav.*, 1987, **35**, 555–562.
2. Santos, M., Ruiz, A., Barbadilla, A., Quezada-Diaz, J. E., Hasson, E. and Fontdevila, A., *Heredity*, 1988, **61**, 255–262.
3. Santos, M., Ruiz, A., Quezada-Diaz, J. E., Barbadilla, A. and Fontdevilla, A., *J. Evol. Biol.*, 1992, **5**, 403–422.
4. Aspi and Hoikkala, A., *J. Insect Behav.*, 1995, **8**, 87.
5. Hegde, S. N. and Krishna, M. S., *Anim. Behav.*, 1997, **54**, 419–426.
6. Krebs, R. A. and Barker, J. S. F., *Aust. J. Zool.*, 1991, **39**, 579.
7. Dow, M. A. and Von Schilcher, F., *Nature*, 1975, **254**, 511.
8. Steel, R. H. and Partridge, L., *Anim. Behav.*, **36**, 1190–1197.
9. Sokoloff, A., *Evolution*, 1966, **20**, 49–71.
10. Norry, M., and Vilardi, J. C., *J. Insect Behav.*, 1996, **9**, 329–338.
11. Ruiz, A., Santos, M., Barbadilla, A., Quezada-Diaz, J. K., Hasson, E. and Fontdevila, A., *Genetics*, 1991, **128**, 739–750.
12. Hegde, S. N. and Krishnamurthy, N. B., *Aust. J. Zool.*, 1979, **27**, 421–431.
13. Gupta, J. P. and Panigrhy, K. K., *Genetica*, 1990, **82**, 45–49.
14. Singh, B. N. and Chatterjee, S., *Evol. Biol.*, 1991, **5**, 105–113.
15. Singh, B. N. and Das, A., *Biol. Zentbl.*, 1991, **110**, 151–157.
16. Naseerulla, M. K. and Hegde, S. N., *Boll. Zool.*, 1992, **59**, 367–370.
17. Singh, B. N. and Banerjee, R., *Cytobios*, 1995, **82**, 213–227.
18. Krishna, M. S. and Hegde, S. N., *Cell Chromosome*, 1996, **19**, 1–8.
19. Hegde, S. N. and Krishna, M. S., *Indian J. Exp. Biol.*, 1996, **34**, 440–443.
20. Krishna, M. S. and Hegde, S. N., *Indian J. Exp. Biol.*, 1997, **35**, 1341–1347.
21. Krishna, M. S. and Hegde, S. N., *Curr. Sci.*, 1997, **72**, 747–750.
22. Singh, B. N. and Sisodia, S., *Curr. Sci.*, 1999, **76**, 222–225.
23. Delcour, J., *Drosoph. Inf. Serv.*, 1969, **44**, 133–134.
24. Prakash, S., *Genetics*, 1967, **57**, 655–663.
25. Monclus, M. and Prevosti, A., *Evolution*, 1971, **25**, 214–217.
26. Singh, B. N. and Mathew, S., *Curr. Sci.*, 1996, **70**, 1088–1089.
27. Singh, B. N. and Mathew, S., *Curr. Sci.*, 1997, **72**, 112–114.
28. Gruwez, G., Hoste, C., Lints, C. V. and Lints, F. A., *Experientia*, 1971, **27**, 1414–1416.
29. Montague, J. R., *Drosoph. Inf. Serv.*, 1985, **61**, 123–125.
30. Partridge, L. and Farquhar, M., *Anim. Behav.*, 1983, **31**, 871–877.

Received 2 February 1999; revised accepted 26 March 1999