

SELECTION FOR MATING SPEED IN RELATION TO SOME FITNESS
COMPONENTS IN DROSOPHILA MELANOGASTER

H.M. El-Wakil* , H.A. Hamza** and A.M. Hablas**

* Faculty of Agriculture, Department of Botany, University of Helwan, Alexandria.

** Faculty of Agriculture, Department of Genetics, University of Minufiya.

الانتخاب لسرعة التزاوج وعلاقته ببعض صفات المواءمة في نياحة دروسوفيلاميلانوجستر*

- (١) حسام الدين محمد فتحى الوكيل قسم النبات - فرع الوراثة - كلية الزراعة - جامعة حلوان
- (٢) حنفى أحمد حمزة قسم الوراثة - كلية الزراعة - جامعة المنوفية
- (٣) عبد المنعم محمد حبلى قسم الوراثة - كلية الزراعة - جامعة المنوفية

ملخص البحث

أجريت تجربة انتخاب مباشر لسرعة التزاوج فى الاتجاهين السريع والبطئ لمدة (١٠) أجيال متتابعة فى نياحة دروسوفيلاميلانوجستر . ولقد وجد أن الانتخاب أنتج مباشرة خط سريع التلقيح وخط بطئ التلقيح . والتلقيح العكسى بين السلالتين المنتخبتين السريع والبطئ أوضح أن مثل هذه الصفة يعتمد أساسا على الاناث .

ولقد درست فترة الجماع للسلالتين المنتخبتين وكذا السلالة الغير منتخبة (المقارنة) وأوضحت النتائج أن السلالة المقارنة كانت أقصر فى فترة جماعها عن السلالتين المنتخبتين .

وأظهرت النتائج أيضا أن الأزواج ذات عمر ٢٥ يوما أبداً فى تزاوجها من الأزواج ذات العمر الصغير (٧ أيام) وذلك فى السلالة سريعة التلقيح فقط .

فى الجيل الأخير الانتخابى تم تقدير كل من متوسط وضع البيض اليومى للأنثى الواحدة وكذا نسبة الفقس فى البيض ، ولقد وجد أن السلالة المقارنة شوقت على كل من السلالتين المنتخبتين فى هاتين الصفتين .

ABSTRACT

A directional selection experiment for fast and slow mating speed in D. melanogaster was carried out for 10 successive generations. The response to selection rapidly produced fast and slow selected lines. The reciprocal mating between the two selected lines indicated that such trait may be female-dependent. Duration of copulation for the two selected lines and the control along the selection procedure showed that control lines were the shortest for duration of copulation. Twenty five day old flies exhibited slow speed compared with 7 days old flies for the fast line in the eighth generation. At the tenth generation of selection, the daily average egg production per female and percentage of emergence were estimated. The control line exceeded the two selected lines for both traits.

INTRODUCTION

Sexual behaviour in Drosophila species has been studied by many investigators. Parsons (1974) concluded that male mating behaviour is a very important component of fitness at least in Drosophila pseudoobscura, D. pavani and probably in D. melanogaster. Brncic and Koref Santibanez (1963, 1964) found that the frequency of heterokaryotypes for chromosomal inversions was significantly higher among males that courted and/or mated during the first few minutes of being placed with the females in D. pavani.

It is well known that sexual behaviour in Drosophila species such as mating speed and duration of copulation can be considered as quantitative traits (Manning, 1961; Mac Bean and Parsons, 1967; Ehrman and Parson, 1981 and El-Wakil and Hamza, 1988). These traits are under genetic control and can be studied by using biometrical methods and selection experiments. Manning (1961); selected for fast and slow mating speed. An approximate realized heritability of .30 was computed from the rate at which the selection lines diverged during the first few generations. In an other selection

experiment for such trait, Spiess and Stankevych (1973), concluded that it was not accurate to compute the value of realized heritability based on response to selection to cumulated selection differential.

The aim of the present investigation is to study the response to selection for mating speed as a proposed method to identify the relative importance of males and females in such traits, using reciprocal mating between selected lines. Also to study the effect of response to selection on duration of copulation and some fitness components.

MATERIALS AND METHODS

The natural population of D. melanogaster used in this experiment was collected from Alexandria Governorate. The population was maintained by mass mating under an optimum feeding conditions at 25°C.

Experimental procedure: Pairs of virgin flies aged about 7 days were put together in vials (one pair per vial) without etherization and observed for 60 minutes. Mating speed, the time until mating commences, and duration of copulation, the period between the time when the genitalia are first observed to lock until they disengage, were recorded in minutes. Both fast and slow lines in mating speed were set up by selecting ten pairs from the base population for each line. The fast line started with ten pairs mated during the shortest period of time. The slow line was set up by randomly selecting ten pairs from the group of pairs not mated during the period of observation. To insure fertility of the selected parents for the slow line, the grooves of larvae were observed in their vials. Control line was set up by choosing 20 pairs or more, at random, from the base population. In subsequent

generations not less than 70 pairs of flies per line were tested. For each generation, duration of copulation was recorded for all mated pairs. Selection was carried out for ten successive generations. In the 7th and 10th generations of selection, reciprocal matings between fast and slow lines were carried out to identify whether this trait is male- or female-dependent.

The effect of age on mating speed was estimated at the 8th generation of selection. Random samples from the two selected lines and also from the unselected control were taken up and aged for 25 days after which the aged pairs were tested. In the 10th generation daily average egg production per female, for 15 successive days, and the percentage of emergence were estimated for the two selected lines and the unselected control.

RESULTS AND DISCUSSION

Figure 1, represents the relative frequency distribution (percentage) of mating during successive 10 minute intervals, i.e. A = 1st, B = 2nd, C = 3rd, D = 4th, E = 5th and F = 6th. G represents the percentage of unmated pairs during the time of observation. Data indicated that the distribution of such frequency for the control line showed, on average, the most frequent mated pairs in two categories: The first was during the 1st 20 minutes of observation, i.e. A and B intervals, while the second was during more than one hour, i.e. G interval, for the ten generations. The total average for A and B intervals was 30.14 while it was 25.24 for the G interval. On the other hand, selection for such trait rapidly produced fast and slow lines. The response to selection for fast and slow mating speed immediately changed the frequency of different intervals of time in two different ways. Regarding the effect of selection in the generations tested, in F_1 selection it is obviously

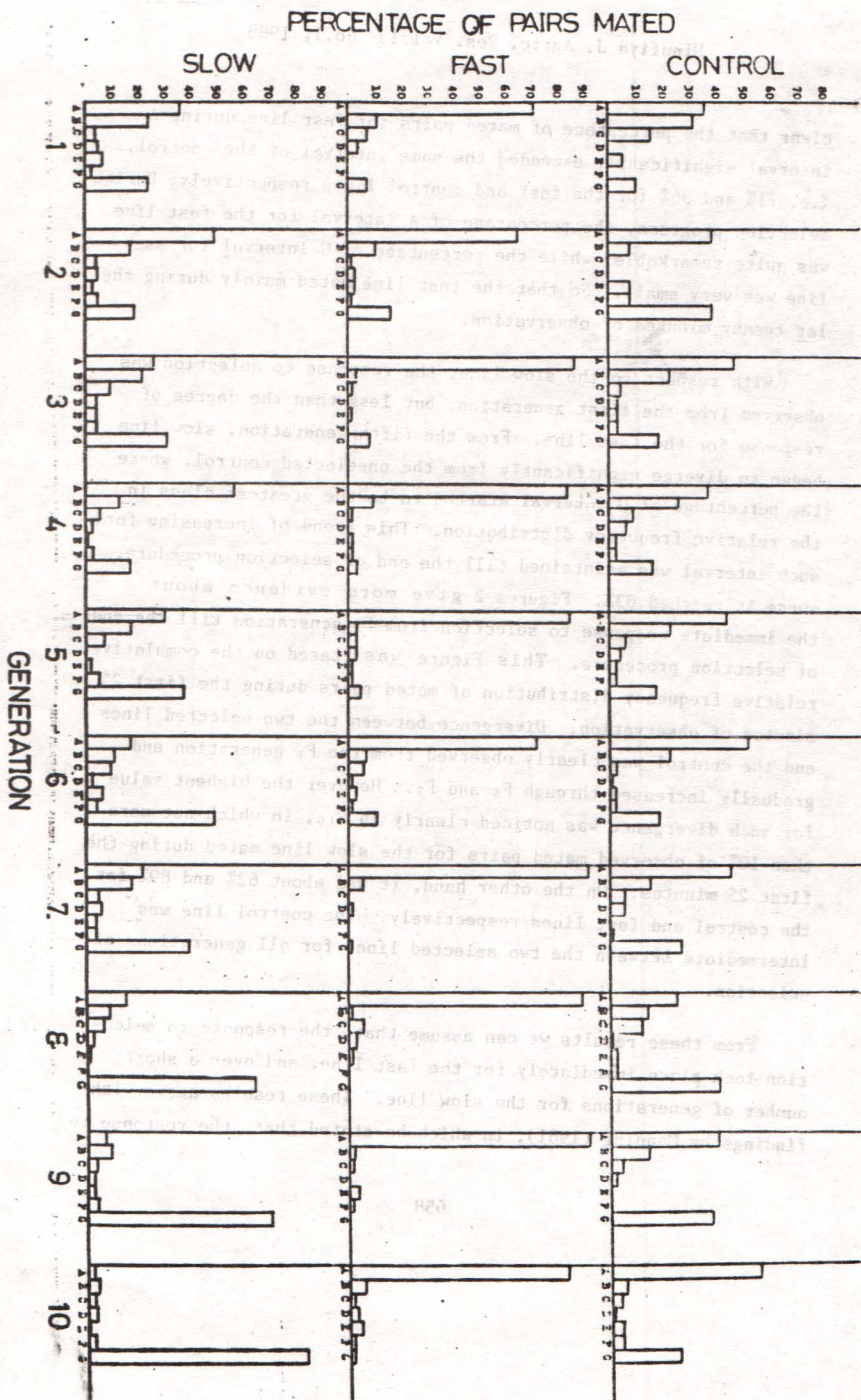


Figure 1 - Percentage of pairs mated during successive 10 minute intervals ; A = 1st., B = 2nd., C = 3rd., D = 4th., E = 5th., F = 6th. and G = unmated pairs during 60 minutes, for the two selected lines and their respective control.

clear that the percentage of mated pairs for fast line during A interval significantly exceeded the same interval of the control, i.e. 71% and 36% for the fast and control lines respectively. During selection progress, the percentage of A interval for the fast line was quite remarkable, while the percentage of G interval for such line was very small. So that the fast line mated mainly during the 1st twenty minutes of observation.

With respect to the slow line, the response to selection was observed from the first generation, but less than the degree of response for the fast line. From the fifth generation, slow line began to diverge significantly from the unselected control, where the percentage of G interval started to be the greatest class in the relative frequency distribution. This trend of increasing for such interval was maintained till the end of selection procedure, where it reached 83%. Figures 2 give more evidence about the immediate response to selection from F_1 generation till the end of selection procedure. This Figure was based on the cumulative relative frequency distribution of mated pairs during the first 25 minutes of observation. Divergence between the two selected lines and the control was clearly observed from the F_1 generation and gradually increased through F_5 and F_7 . However the highest value for such divergence was noticed clearly in F_{10} , in which not more than 10% of observed mated pairs for the slow line mated during the first 25 minutes. On the other hand, it was about 62% and 89% for the control and fast lines respectively. The control line was intermediate between the two selected lines for all generations of selection.

From these results we can assume that, the response to selection took place immediately for the fast line, and over a short number of generations for the slow line. These results agree with findings by Manning (1961), in which he stated that, the response to

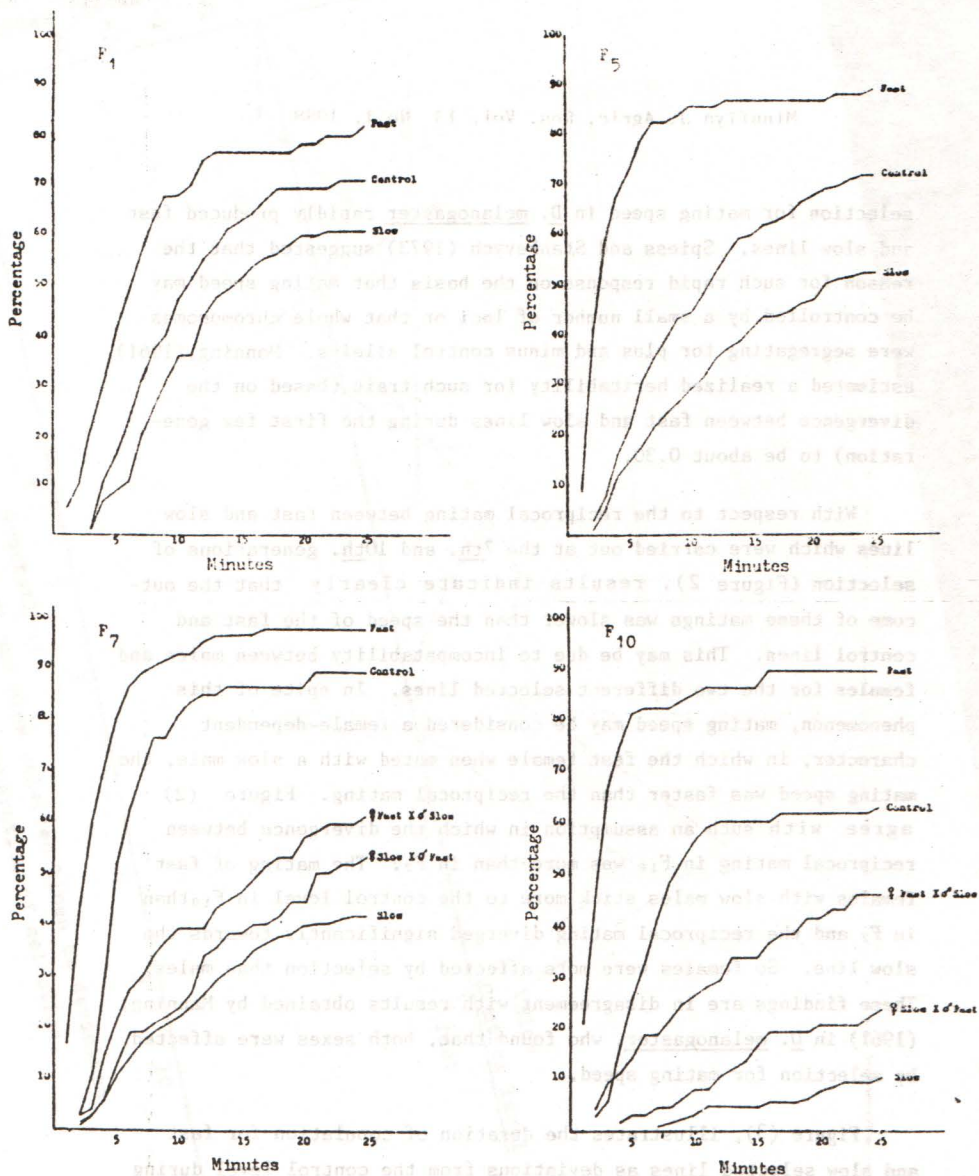


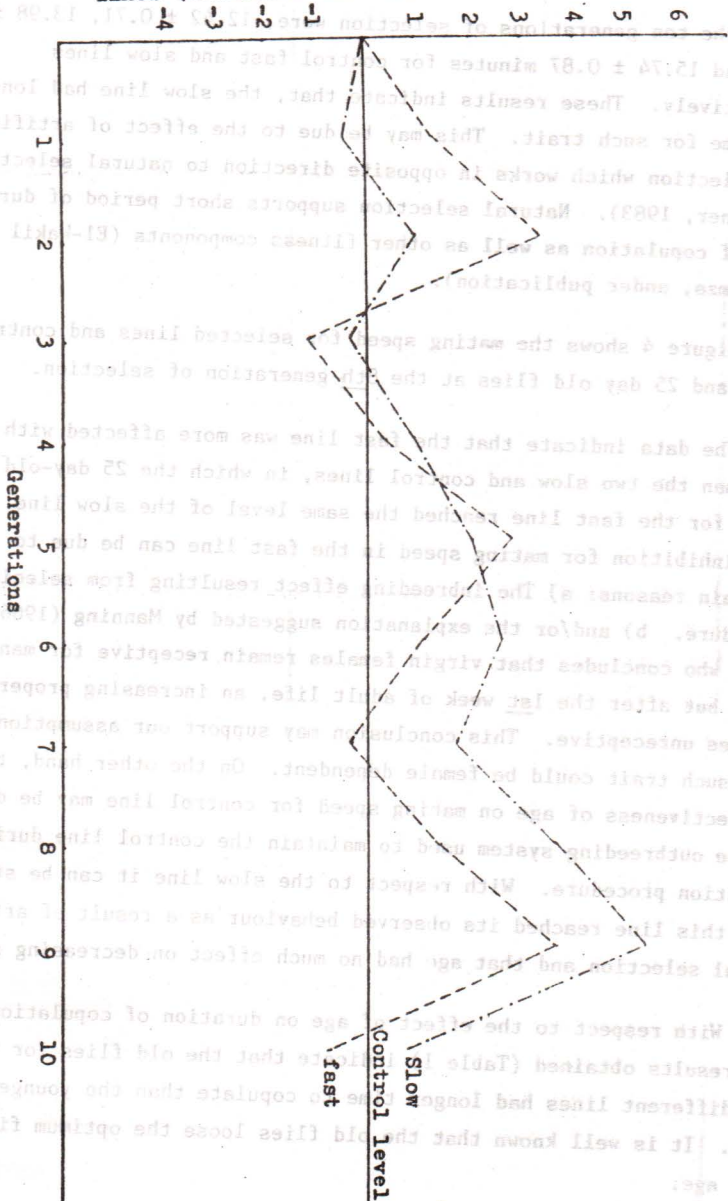
Figure 2 - Cumulative relative frequency distributions of mated pairs during the first 25 minutes of observation for the two selected lines and control at 1st, 5th, 7th and 10th generations. Reciprocal matings between the two selected lines is shown in the 7th and 10th generations.

selection for mating speed in *D. melanogaster* rapidly produced fast and slow lines. Spiess and Stankevych (1973) suggested that the reason for such rapid response on the basis that mating speed may be controlled by a small number of loci or that whole chromosomes were segregating for plus and minus control alleles. Manning, (1961) estimated a realized heritability for such trait (based on the divergence between fast and slow lines during the first few generations) to be about 0.30.

With respect to the reciprocal mating between fast and slow lines which were carried out at the 7th. and 10th. generations of selection (Figure 2), results indicate clearly that the outcome of these matings was slower than the speed of the fast and control lines. This may be due to incompatibility between males and females for the two different selected lines. In spite of this phenomenon, mating speed may be considered a female-dependent character, in which the fast female when mated with a slow male, the mating speed was faster than the reciprocal mating. Figure (2) agree with such an assumption in which the divergence between reciprocal mating in F₁₀ was more than in F₇. The mating of fast females with slow males stick more to the control level in F₁₀ than in F₇ and the reciprocal mating diverged significantly towards the slow line. So females were more affected by selection than males. These findings are in disagreement with results obtained by Manning, (1961) in *D. melanogaster*, who found that, both sexes were affected by selection for mating speed.

Figure (3), illustrates the duration of copulation for fast and slow selected lines as deviations from the control level during the successive generations selection. It is clear that the two selected lines had longer time for such trait than the control for most generations. The total averages for duration of copulation

Duration of copulation for fast and slow lines (deviation from control)



Figures - Duration of copulation for fast and slow selected lines as deviation from control level during the successive generation of selection.

along the ten generations of selection were, 12.42 ± 0.71 , 13.98 ± 0.63 and 15.74 ± 0.87 minutes for control fast and slow lines respectively. These results indicate that, the slow line had longest time for such trait. This may be due to the effect of artificial selection which works in opposite direction to natural selection (Falconer, 1983). Natural selection supports short period of duration of copulation as well as other fitness components (El-Wakil and Hamza, under publication).

Figure 4 shows the mating speed for selected lines and control for 7 and 25 day old flies at the 8th generation of selection.

The data indicate that the fast line was more affected with age than the two slow and control lines, in which the 25 day-old flies for the fast line reached the same level of the slow line. Such inhibition for mating speed in the fast line can be due to two main reasons: a) The inbreeding effect resulting from selection procedure. b) and/or the explanation suggested by Manning (1966, 1967) who concludes that virgin females remain receptive for many days, but after the 1st week of adult life, an increasing proportion becomes unreceptive. This conclusion may support our assumption that such trait could be female dependent. On the other hand, the ineffectiveness of age on mating speed for control line may be due to the outbreeding system used to maintain the control line during selection procedure. With respect to the slow line it can be stated that this line reached its observed behaviour as a result of artificial selection and that age had no much effect on decreasing speed.

With respect to the effect of age on duration of copulation, the results obtained (Table 1) indicate that the old flies for the two different lines had longer time to copulate than the younger ones. It is well known that the old flies lose the optimum fitness with age.

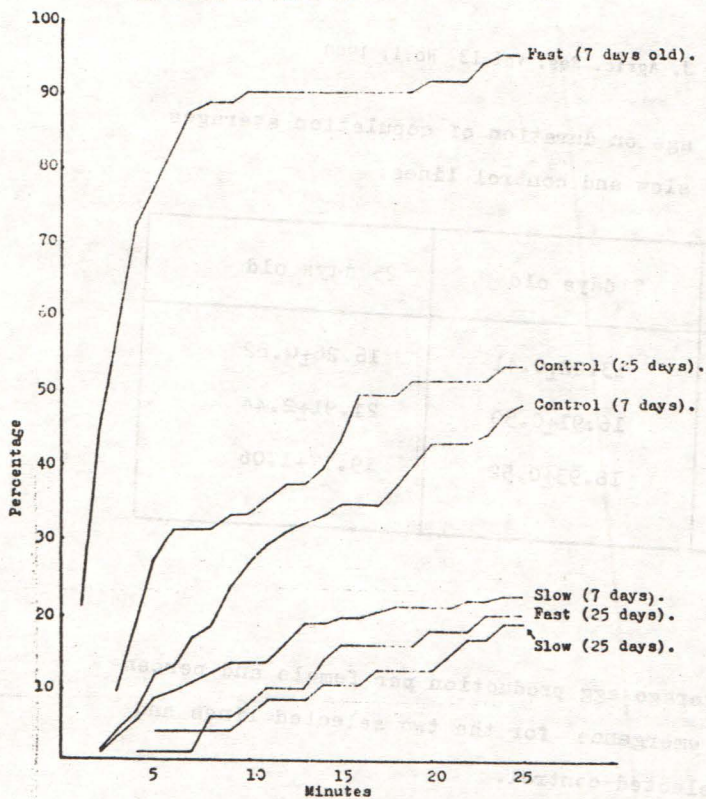


Figure 4 - Effect of age on mating speed for the two selected lines and their respective control at the 8th generation

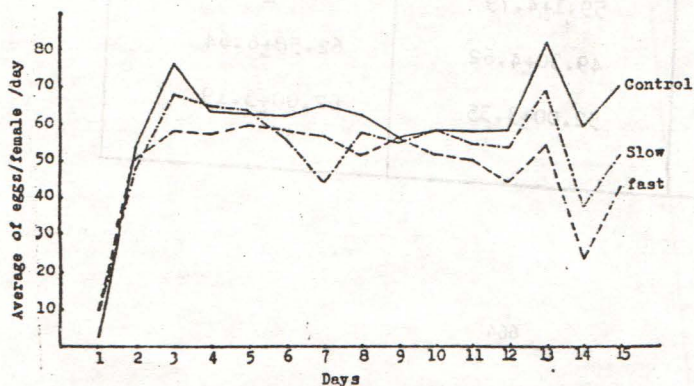


Figure 5 - Daily average egg production per female per day for fast, slow and control lines

Table 1. Effect of age on duration of copulation averages for fast, slow and control lines.

Lines	7 days old	25 days old
Control	13.22±0.41	16.26±0.82
Fast	16.91±0.50	21.91±2.44
Slow	18.93±0.52	19.77±1.06

Table 2. Daily average egg production per female and percentage of emergence for the two selected lines and the unselected control.

Lines	egg production per female per day	% of emergence
Control	59.1±4.79	80.28±3.16
Fast	49.30±4.62	62.58±6.64
Slow	52.00±3.35	62.00±3.19

Average egg production per female per day during 15 successive days after mating (7 day old females) was estimated, (Figure 5). The daily average egg production per female and the percentage of emergence are shown in Table 2. Data obtained clearly indicate that there were no significant differences between fast and slow selected lines for both estimates. The control line significantly exceeded the two selected lines. This may be due to the inbreeding effect on the selected lines.

REFERENCES

- Brncic, D., and S. Koref-Santibanez (1963). Life cycle and mating activity as criteria of heterosis in heterokaryotypes in *D. pavani*. *Genetics Today* 1: 157-158.
- Brncic, D., and S. Koref-Santibanez (1964). Mating activity of homo- and heterokaryotypes in *D. pavani*. *Genetics* 49: 585-591.
- Ehrman, L. and P.A. Parsons (1981). Behaviour genetics and evolution. McGraw Hill, New York.
- El-Wakil, H.M. and H.A. Hamza (1988). Selection for duration of copulation in relation to mating speed and sperm efficiency in *D. melanogaster*. (Under publication).
- Falconer, D.S. (1983). Introduction to Quantitative Genetics, 2nd ed. The Ronald Press Co., New York.
- Mac Bean, I.I., and P.A. Parsons (1967). Directional selection for duration of copulation in *D. melanogaster*. *Genetics*, 56: 233-239.
- Manning, A. (1961). The effects of artificial selection for mating speed in *D. melanogaster*. *Anim. Behaviour* 9: 82-92.
- Manning, A. (1966). *Corpus allatum* and sexual receptivity in female *D. melanogaster*. *Nature*, (London) 211: 1321-1322.
- Manning, A. (1967). The control of sexual receptivity in female *Drosophila*. *Anim Behaviour* 15: 239-250.
- Parsons, P.A. (1974). Male mating speed as a component of fitness in *Drosophila*. *Behav Genet.* 4: 395-404.
- Spiess, E.B., and A.J. Stankevych (1973). Mating speed selection and egg chamber correlation in *D. persimilis*. *Egypt J. Genet. Cytol.* 2: 177-194, July 1973.