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VARIATION OF THE BODY WEIGHT AND FECUNDITY IN SUBSEQUENT GENERATIONS OF UNSELECTED POPULATION OF *DROSOPHILA MELANOGASTER*[1]

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Summary. Preliminary studies for the selection experiments for a large and small body weight of *Drosophila melanogaster* were carried out. The studies covered 15 generations of randomly mating flies. The specimens were individually weighed to an accuracy of 10^{-3} mg and their fertility was estimated on the basis of imago number in each generation until the 14th day of development. The experiment was performed in three replications.

Significant differences in fertility were detected between individual replications (lines), as well as between generations in each line and in all the lines together.

Significant differences were also found in the body weight of females and males between generations and between individual lines.

In order to estimate correlation between the body weight of insects and their fertility about 20 pairs of single rearings (with virgin females) were isolated from each generation.

The calculated correlation coefficients appeared to be insignificant.

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According to Hardy-Weinberg's law genetic structure should not display any changes in genetically differentiated. unselected population. Such a population should be expected to have only fluctuations caused by the action of environmental conditions. The body weight and fertility are the traits susceptible to the influence of the environment. An attempt to make environmental conditions uniform should not be the cause of natural selection.

It is difficult to determine what is the optimal population size, which would permit to retain the balance. The size of experimental and reared populations is limited and in this connection it should be expected that genetic tendency in them will increase.

The purpose of the present paper was to study variation of the body weight and fertility and their interrelation in individual generations of an unselected population of *Drosophila melanogaster*. These studies represent an introduction to selection experiments for that trait.

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MATERIAL AND METHODS

The studies were carried out on flies of a wild strain of *Drosophila melanogaster*. The flies were reared under the same conditions on a standard medium in a hot-house of CWE-2a type at the temperature of 24 - 25°C and 60% humidity. These conditions were recognized optimal on the basis of both our own studies and literature (Lopatina et al. 1977, Medvedev 1966, Piórecka 1966). It should be added that flies were reared throughout the experiments in complete darkness. The applied medium consisted of: 50 g semolina, 30 g sugar, 400 ml water and 5 g yeast.

Water and semolina were boiled with sugar until a glue consistency was achieved. Then, the medium was poured into previously sterilized vessels at 165°C for 25 min. The vessels were closed with microbiological stoppers made of gauze and cotton wool. The medium after cooling it down was injected by water suspension of yeasts. The experiments were carried out from April till November.

In order to determine natural variation of the body weight and fertility the rearing of flies was performed throughout 15 generations in three simultaneous replications in 3-litre jugs. The beginning of each generation (for individual replications) were 50 females and 50 males randomly selected from the preceding generation and individually weighed to an accuracy of 0.001 mg on electronic Sartorius micro-scales of 4431 type. When weighed the flies were ether-sleeped. 7 days after flies of the parental generation were removed from the jugs and weighed again. 14 days after laying out the succeeding generation the obtained progeny was examined and the next generation was laid out.

In view of the fact that the progeny of each rearing originated from 50 parental pairs and that it was impossible to identify the origin of each insect, rearings of single pairs were also performed. For that purpose about 75 pupae were taken from each generation and placed in individual small sterile tubes with a medium drop on their bottom. As the insects hatched they were joined in pairs in 250 erlenmayer flasks. The number of pairs resulted from the number of emerged females and males. We tried that their number was not less than 20 in each generation. The flies were weighed on a microscales before being placed in erlenmayer glass. 7 days after the insects were removed and weighed again. In 14 days after placing parents together the progeny of each pair was counted.

The results were statistically treated using the method of the analysis of variance and correlation after Ruszczyc (1981).

RESULTS AND DISCUSSION

An individual weighing of insects displayed pronounced sexual dymorphism with regard to the body weight. Females were markedly heavier than males. This was confirmed by the previous studies of De Fries and others (1961) carried out on *Drosophila affinis*.

The body weight of males and females of individual rearings and in the subsequent generations of unselected population of *Drosophila melanogaster* is presented in Figs 1 and 2. The figures were made on the basis of arithmetic means for individual rearings and generations. In addition to that, Table 1 contains parameters of this trait variation in the form of a standard deviation and variation coefficient.

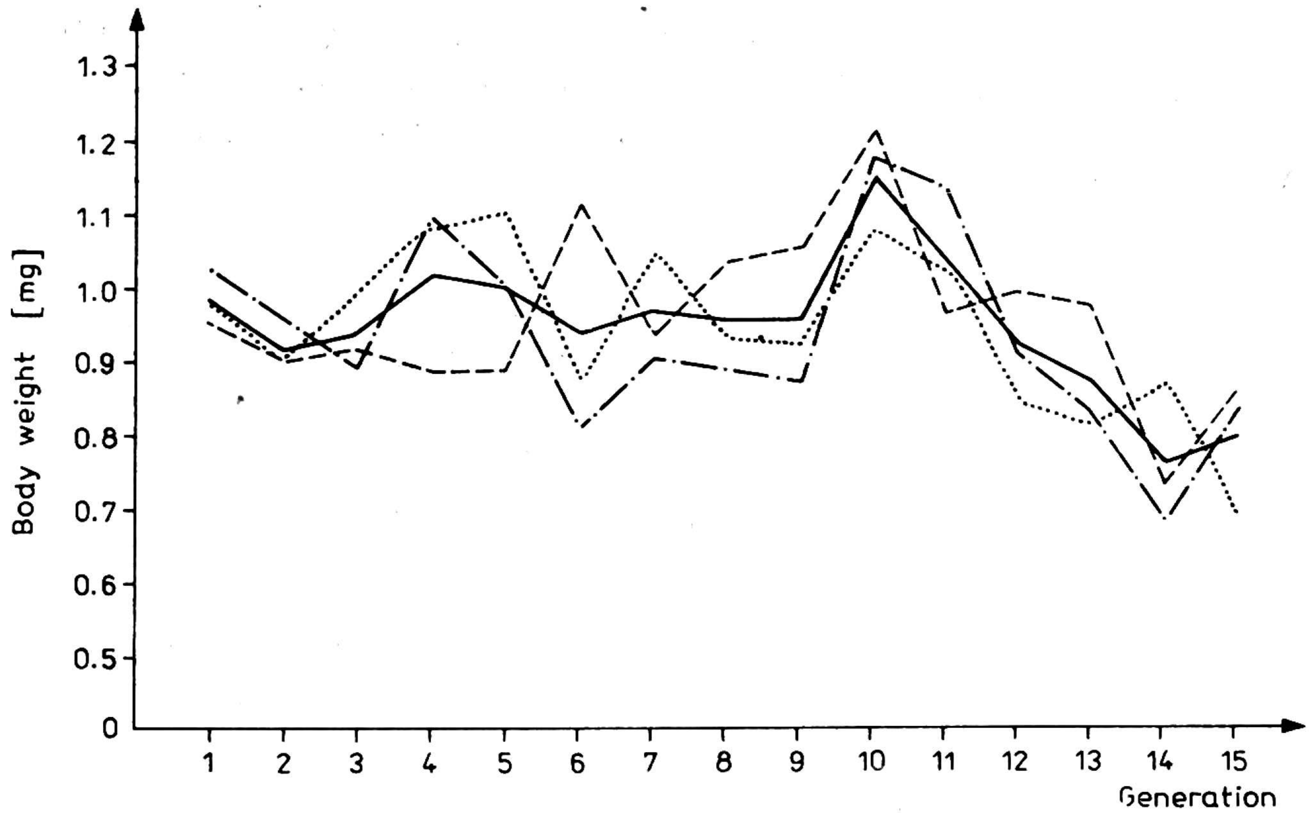

Fig. 1 Means of initial body weights of *Drosophila melanogaster* females in particular rearings and in subsequent generations

– – – – – – – – rearing 1, ... rearing 2, —·—·—·— rearing 3, ———————— general mean

With the aim to observe changes in the body weight of adult insects they were weighed when being removed from the jugs after 7-day stay there. Differences between the final and initial weight were given in Table 2.

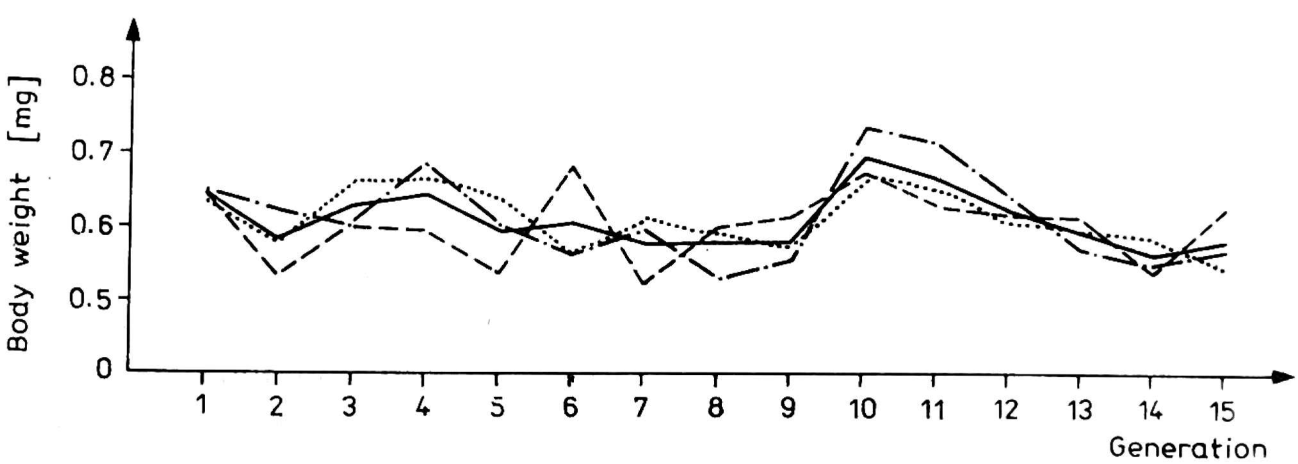

Fig. 2 Means of initial body weights of *Drosophila melanogaster* males in particular rearings and in subsequent generations

– – – – – – – – rearing 1, ... rearing 2, —·—·—·— rearing 3, ———————— general mean

It could be clearly noticed that females when being removed had a larger body weight. Changes in the body weight of males were very small. These changes resulted from complete somatic maturity and in the case of females an additional influence on the body weight increase was exerted by an intense development of ovaries associated with the reproduction period (De Fries et al. 1961).

A bifactorial analysis of variance (three simultaneous rearings and subsequent generations were taken into consideration as experimental factors) of the body weight in fruit flies separately for females and males showed highly significant differences in the insect size between generations as well as among females and males ($P<0.01$). Statistically highly significant differences ($P<0.01$) were also found between three simultaneous rearings for both females and males and an interaction of the both experimental factors.

Table 1. Body weight of females and males (mg), female fertility and variation of these traits in *Drosophila melanogaster*

Sex	Body weight			Fertility		
	$\bar{x}$	s	v	$\bar{x}$	s	v
Females	0.952	0.186	19.54	9.77	4.06	41.56
Males	0.610	0.073	11.97	—	—	—

Table 2. Differerences between final and initial body weight of females and males in *Drosophila melanogaster* (mg)

Generation	Females			Males		
	final weight	initial weight	difference	final weight	initial weight	difference
1	1.158	0.987	0.171	0.609	0.646	−0.037
2	1.139	0.919	0.220	0.617	0.589	0.028
3	1.090	0.940	0.150	0.618	0.627	−0.009
4	1.122	1.021	0.101	0.634	0.648	−0.014
5	1.092	1.003	0.089	0.616	0.597	0.019
6	1.039	0.939	0.100	0.604	0.606	−0.002
7	0.988	0.969	0.019	0.616	0.577	0.039
8	1.112	0.960	0.152	0.628	0.574	0.054
9	1.075	0.958	0.117	0.600	0.578	0.022
10	1.250	1.163	0.087	0.718	0.694	0.024
11	0.791	1.047	−0.256	0.534	0.663	−0.129
12	1.117	0.9222	0.195	0.632	0.621	0.011
13	1.181	0.880	0.301	0.651	0.592	0.059
14	1.043	0.771	0.272	0.593	0.555	0.038
15	1.137	0.806	0.331	0.605	0.578	0.027

It was proved that there exist significant differences between different generations and three simultaneous rearings. They could result from the actions of genetic tendency and variable environmental conditions. An additional influence might be exerted by inbred, though theoretically an increase of its intensity should not be large.

Falconer (1974) gives a description of an idealized population (micropopulation) isolated from a single large, randomly mated population. In isolated micropopulations there occurs genetic trend. A micropopulation should fulfill the following requirements:

1. Insect mating takes place within particular lines.
2. Within the line mating is random.

3. Generations are clearly separated and do not overlap.
4. The number of individuals in all the lines and generations is the same.
5. The lack of selection and mutation.

The way of rearing of unselected population of *Drosophila melanogaster* fulfills the conditions given by Falconer. A counterpart of the lines in the performed experiment were three simultaneously isolated from one another rearings.

Sławiński et al. (1972), conducting studies on the development of the body weight in laboratory mice in F_1-F_6 generation, came to similar conclusions. Results obtained by him permit to suggest that genetic balance is disturbed by the action of genetic trend and a gradual inbred increase. Experiments of De Fries et al. (1961) dealing with variation of the body weight in *D. affinis* population, in which there occurred inbred, showed no significant differences between lines in a random generation for F_1, F_5, F_{10} of the both sexes.

Variation of the body weight depends on the influence of the environment, each change of which may cause larger or smaller differences in the body weight. It could seem that standardization of environmental conditions within the culture is a relatively simple question. However, in practice it appears that elimination of changes of the environment is impossible, e.g. alterations of climate. Distinct fluctuations of the air temperature in August caused in F_{10} generation a significant increase in the mean body weight in particular rearings in the both sexes (Figs. 1 and 2). De Fries et al. (1961) also found increase in the mean body weight of *D. affinis* during cold days despite the fact that the temperature in the thermostat was stable.

Mori et al. (1967) performing studies on *D. melanogaster* throughout 240 subsequent generations in complete darkness noticed that flies of generation 9 and 10 were smaller and in generation 12 they achieved the normal size.

An additional factor, which may have influence on the body weight in the progeny of *D. melanogaster* is the so-called maternal effect. Females laying out more eggs contribute to an increase of competition between the offspring, and that in turn may have influence on the reduction of the body size. Such a competition was displayed by De Fries et al. (1961) already at the larval stage.

In the performed studies oscillations of the body weight (Figs 1, 2) of females and males were parallel, i.e. the weight of males and females equally increased or decreased in the same generation.

Mean numbers of offspring obtained from a single female in different rearings and subsequent generations are presented in Fig. 3. An analysis of variance of fertility displayed highly significant differences ($P<0.01$) in fertility between generations and individual rearings.

It is easy to notice that in the performed rearings there occurred a marked decline in the fertility of flies from one generation to another in all the rearings. The most similar with regard to the offspring numbers in the subsequent generations were rearings 2 and 3. A possible reason of that phenomenon may be unplanned selection. The onset of each generation were hatched insects till the 14th day. It is difficult to exclude that such individuals may originate from a limited number of parental pairs, differing in fertility from the remaining ones. This suggestion requires further studies.

Łucznikova (1978) found that the cause of fertility decline may include such factors as: genetic trend and inbred, as well as medium consistency, temperature and composition and humidity. According to that author each of these factors may have influence on the increase and decrease of fertility.

Studies of 38 Brazil populations of *Drosophila sturtevanti* revealed 12-day oscillation cycles of their numbers. Each cycle had 4 pronounced phases: 1) limitation, 2) animation, 3) outbreak, 4) decrease. At the outbreak phase, the populations

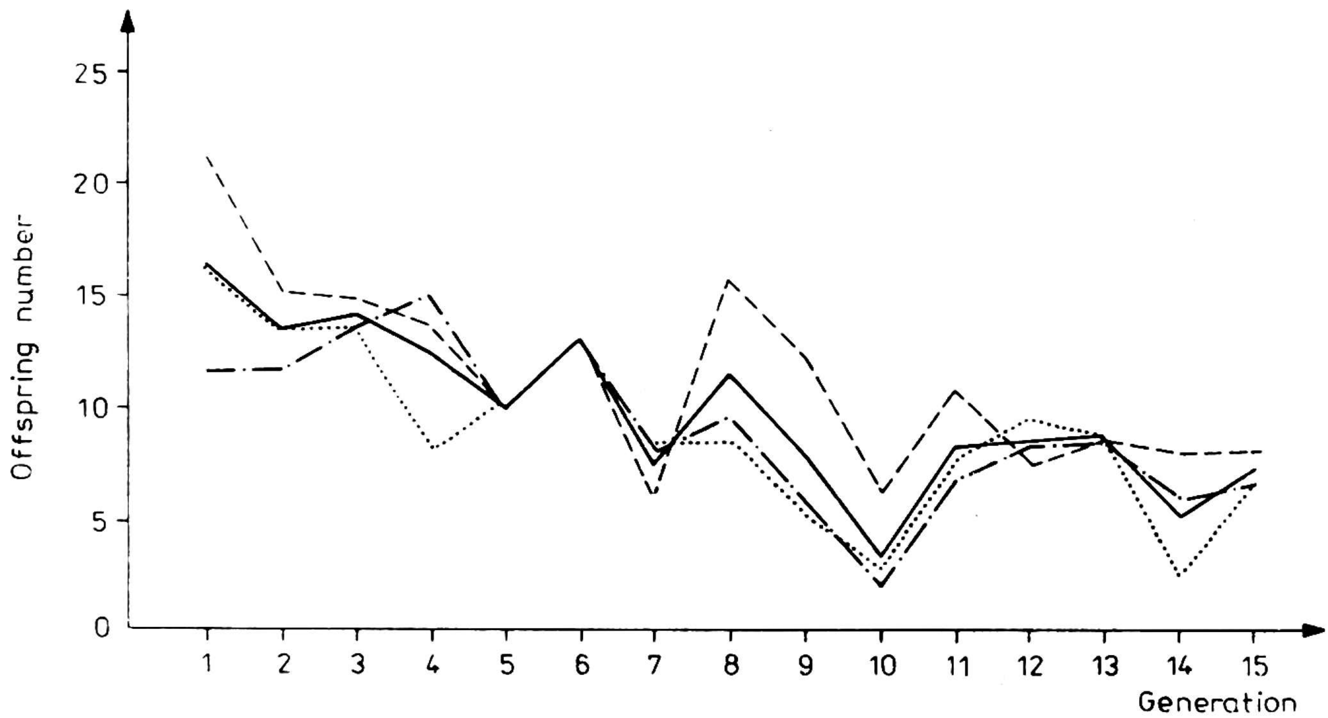

Fig. 3 Mean numbers of offspring obtained from a single female in particular rearings and in subsequent generations

– – – – – – – – – – – rearing 1, ... rearing 2, —·—·—·—·— rearing 3, ———————— general mean

consisted of 300 - 400 flies, which is ten-fold more than at the limitation phase (Joao et al. 1981). Results of other authors (Sławiński, Writh-Dzięciołowska 1972) indicate that in randomly mating population of a limited size the equilibrium may be disturbed by inbred increase and by the occurrence of genetic trend. Inbred in *D. melanogaster* causes the appearance of lethal genes, which induce mortality increase during the development (Biemont 1978).

Significant differences in the fertility of individual rearings and between generations may indicate that this kind of phenomenon is influenced by the environment. For instance, generations 9 and 10 fell at the time, when the indoor temperature ranged between 13 - 16°C. Though the flies were maintained in hothouse, where the temperature was 25°C, all manipulations with them were made indoors, but outside the hothouse.

In order to determine interrelationships between the two studied traits, correlation coefficients (r) were calculated on the basis of data obtained from individual rearing. The calculated correlation coefficients were: a) between the initial female weight and the number of the obtained offspring: $r=-0.026$, b) between the final female weight and the number of obtained offspring: $r=0.003$, c) between the male body weight and the number of the obtained offspring: $r=-0.083$.

Many authors have been dealt with the problem of interrelationship of the body weight of parents and the number of obtained offspring. Studies were conducted on various animals. Results of the studies were differentiated. Some authors obtained negative correlation (Cholewa 1980, Maciejewska 1980) or positive (Curll et al. 1975), whereas others found no correlation at all (Gibes et al. 1977, Nowara et al. 1980, Śliwa et al. 1980).

Nowara et al. (1980), when studying relationship between the number of lambkins per sows and its weight obtained a low and insignificant correlation coefficient $r=0.09$. Gibes et al. (1977) studying relationship between the body weight of pheasants and their egg productivity in the first year of studies found no such a relationship ($r=0.02$) and the next year they revealed a rather large negative relationship ($r=-0.498$). Żuk (1969) and Wężyk (1970) performed studies in a flock of hens and found no significant correlation between the body weight of hens and their egg productivity. According to Wężyk (1970) with the lapse of years of observations there occurs a tendency towards correlation coefficient increase, though he failed to find its significance.

Curll et al. (1975) performing studies on 3-year old sheep noticed that the percentage of litters was larger when the body weight of mothers during mating was larger.

Maciejowski and Jeżewska (1976) studying minks displayed that the largest litters were obtained from females with an average body weight. Females with a smaller body weight gave smaller litters, whereas litters of heavy females were markedly smaller. Similar conclusions were made by Cholewa (1980) who noticed that the largest numbers of foxes were born by females with intermediate body weight.

It is difficult to compare the attached results with our own since they concern economic animals where selection is performed for the both traits. This may disturb genetic equilibrium in comparison with unselected populations.

In the population of *Drosophila melanogaster*, which was an object of studies, no correlation was found between the studied traits.

Results of the experiments show that in the case of planned selection experiments, the results cannot be compared between selected lines, but should be referred to the control line repeated several times.

CONCLUSIONS

On the basis of the performed studies it was found:

1. Pronounced sexual dymorphism in the studied insects manifesting itself in larger size of the female body (larger weight) in comparison with males.

2. Highly significant differences in the body weight of both females and males between three simultaneous rearings and generations.

3. Highly significant differences in the offspring number between individual replications and generations.

4. While removing flies from different rearings it was found that the latter have larger final weight (particularly in females) in comparison with the initial body weight.

5. General decline in fecundity throughout 15 generations.

6. The values of the obtained correlation coefficients between: a) the initial female weight and the number of their offspring, b) the final female weight and the number of their offspring, c) the initial male weight and the number of obtained offspring were close to 0 and statistically insignificant.

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ZMIENNOŚĆ MASY CIAŁA I PLENNOŚCI W KOLEJNYCH POKOLENIACH NIESELEKCJONOWANEJ POPULACJI *DROSOPHILA MELANOGASTER*

Streszczenie

Przeprowadzono badania stanowiące wstęp do doświadczeń selekcyjnych na wysoką i niską masę ciała *Drosophila melanogaster*. Badaniami objęto 15 pokoleń losowo rozmnażającej się muszki owocowej. Muszki ważono indywidualnie z dokładnością 10^{-3} mg, natomiast plenność szacowano na podstawie liczby imago w każdym pokoleniu do 14 dnia rozwoju. Doświadczenie przeprowadzono w trzech powtórzeniach.

Stwierdzono istotne różnice w plenności zarówno pomiędzy poszczególnymi powtórzeniami (liniami), jak również pomiędzy pokoleniami w każdej linii i we wszystkich liniach łącznie.

Wykazano również istotne różnice w masie ciała samic i samców pomiędzy pokoleniami i pomiędzy poszczególnymi liniami.

W celu oszacowania korelacji między masą ciała owadów i ich plennością z każdego pokolenia izolowano około 20 par hodowli pojedynczych (z samicami dziewiczymi).

Obliczone współczynniki korelacji okazały się nieistotne.

ИЗМЕНЧИВОСТЬ ПРИЗНАКОВ МАССЫ ТЕЛА И ПЛОДОВИТОСТИ В ПОСЛЕДУЮЩИХ ПОКОЛЕНИЯХ НЕСЕЛЕКЦИОНИРОВАННОЙ ПОПУЛЯЦИИ *DROSOPHILA MELANOGASTER*

Резюме

Проведены предварительные исследования для дальнейшей экспериментальной селекции на большую и небольшую массу тела у *Drosophila melanogaster*. Исследования охватывали 15 поколений произвольно спариваемых мух. Особи были взвешены индивидуально с точностью до 10^{-3} мг, а их плодовитость оценивалась на основании числа имаго в каждом поколению до 14-го дня развития. Эксперимент проводился в трёх повторениях.

Существенные различия в плодовитости были обнаружены между отдельными повторениями (линиями), а также между поколениями в каждой линии и во всех линиях вместе взятых. Существенные различия были также обнаружены в массе тела самок и самцов между поколениями и между отдельными линиями.

Для того, чтобы установить корреляцию между массой тела насекомых и их плодовитостью, изолировалось около 20 пар одинарных разведений (с девственными самками) из каждого поколения.

Вычисленные коэффициенты корреляции оказались несущественны.