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RESPONSE TO STRESS IN SIX LINES OF *DROSOPHILA MELANOGASTER* SELECTED FOR HIGH FERTILITY UNDER DIFFERENT ENVIRONMENTAL CONDITIONS[1]

JERZY PALEOLOG[2]

Institute of Biological Basis of Animal Production, Academy of Agriculture, Lublin

Summary. Response to selection under different environmental conditions and resistance of selected animals to a stress were examined. Six lines of *Drosophila melanogaster* selected for high fertility under optimal and restricted environmental conditions were treated with cold and heat. It was found that stress affected the fecundity of selected flies in different ways. Stress response depended on the kind of environmental conditions. It was inferred that high fertility is determined by different genotypes under different environmental conditions and that stress resistance has genetic background.

Learning of the selection mechanisms of quantitative traits has long attracted the interest of breeders and evolutionists. Geneticists establishing hereditary bases of some trait often make that on the basis of its response to selection. An important fact for such researchers is that selection for the same qualitative trait gives different results and that transportation of an individual from one environment to another involves many changes (Gebler 1978, Falconer, Latyszewski 1952, Van Vleck 1963, Ford 1967, Parker, Bhatti 1982). An interesting problem is the existence of genetically determined resistance to stresses (Fuquay 1981, Young 1981, Stott 1981). If fecundicity of animals selected under different conditions had at least partially different genetic bases (Ford 1967), it could be expected that the response of these animals to stress impulses is different too. Testing of this thesis was the purpose of the present paper.

MATERIAL AND METHODS

A laboratory population of *Drosophila melanogaster* selected for a high fertility under two different environments was used for the studies. Fertility was determined by the number of pupae on the bulb walls 10 days after placing in it of a single pregnant female. The environments differed from one another by diet, life surface and humidity, i.e. factors having a fundamental influence on fertility, one environment having optimal conditions, another — restricted. All the insects were maintained at the optimal temperature of 25° - 26° C (Ashburner 1978).

Selected (S_1O, S_2O) and unselected lines (KO) from the optimal environment, as

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[2] M. Sc. Present address: 20-934 Lublin, ul. Akademicka 13, Poland.

well as those (S_1R, S_2R and KR, respectively) from restricted environment were subjected to a cold stress (15°C) in the sixth generation and to a heat stress (33°C) in the eighth generation. The insects were stressed for 30 hours beginning with the 3rd day of egg laying. In the 16th generation, two additional groups of flies (20 insects in each group) were selected from each of the lines S_1O; S_2O and KO and one of them was exposed to a cold stress, whereas another — to a heat stress. In the 18th generation, this was analogically made in relation to the lines from restricted environment S_1R, S_2R and KR. Fourty insects from each line were subjected to fecundity control in each generation. Selection intensity was 0.25. The data obtained were treated using universally known statistical methods (Oktaba 1971).

RESULTS AND DISCUSSION

Selection in both environments appeared successful, though the response to it was somewhat different in each of them. In restricted environment, the fertility increase till the eighth generation was systematic (neglecting stress response), then during

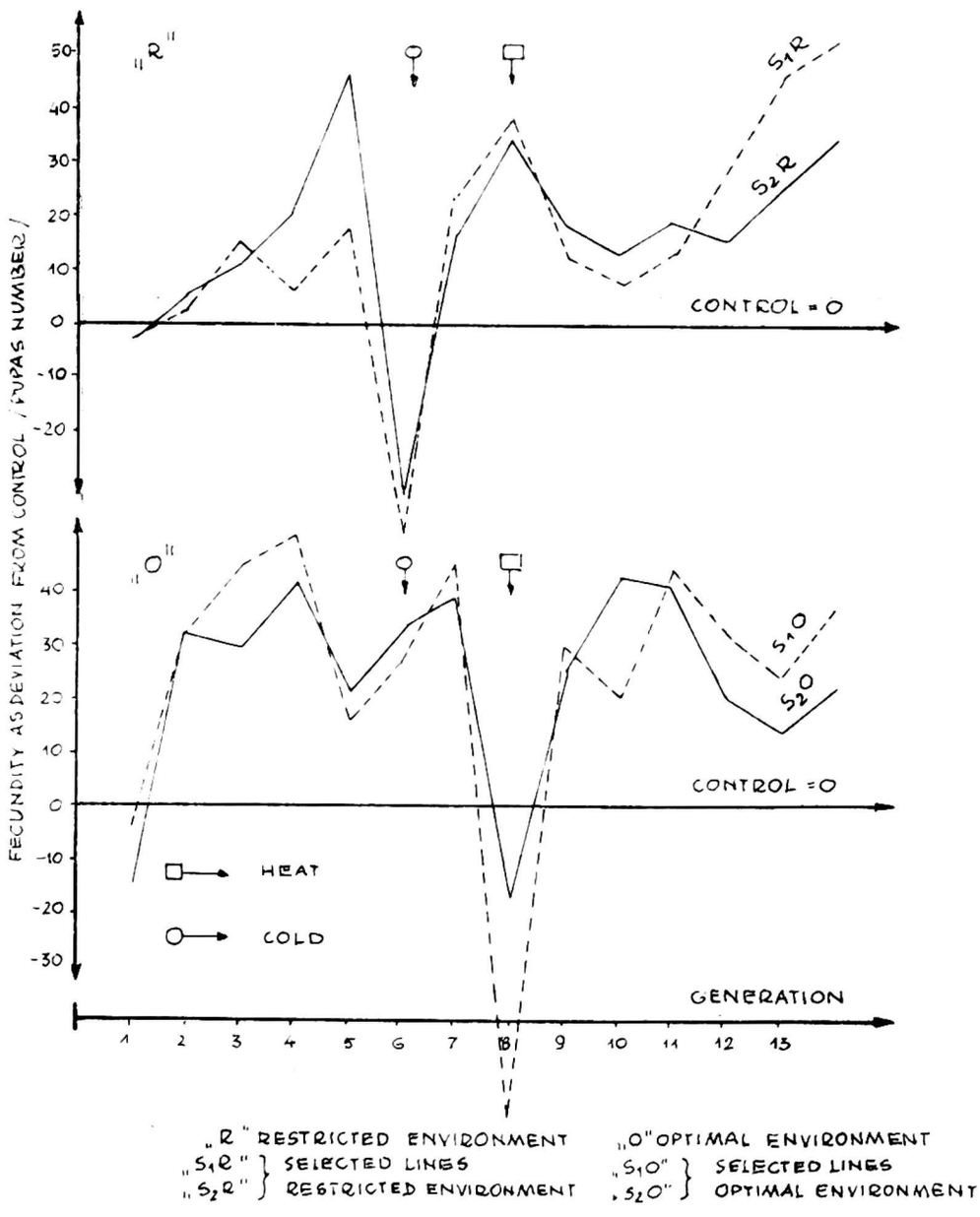

Fig. 1. Fecundity of selected lines of *Drosophila melanogaster* expressed as deviation from the control line (unselected)

the next three generations the fertility declined, after which it again displayed increase tendencies. In optimal environment, fecundity abruptly increased during four generations, after which it maintained at almost the same level (neglecting stress response) (Fig. 1). In effect of using a cold stress, the lines maintained in optimal environment (S_1O, S_2O, KO) did not decline their fertility (Figs. 1, 2), which could suggest that they have corresponding genetic reserves permitting to level the action of a stresser (Hammond et al., Orosco, Bell 1974). Lines selected under restricted conditions (S_1R, S_2R) drastically reduced their fertility showing the lack of possibi-

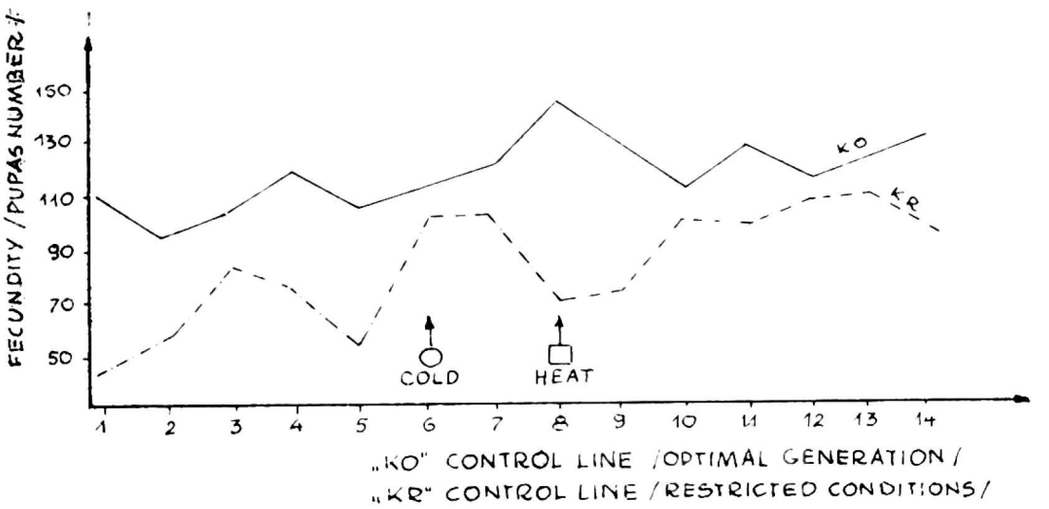

Fig. 2. Fecundity of unselected lines of *Drosophila melanogaster*

lity to counteract a cold stress. It seems interesting that the unselected line KR (Fig. 2) did not only decline, but even increased its fertility. It should, therefore, be suggested that in two different environments a high level of a given trait may be determined by different genetic systems. These systems may differ in expression or "silence" of certain genes, different frequency and in the arrangement of major and minor loci within additive genes, as well as in different systems of gene interaction in the development of phenotypes. Thus, Mackay (1981) observed changes in the size of genetic additive variance together with changes of the environment. Hammond et al. (1982) noticed that under restricted conditions, nonactive genes restore their expression. Orazco and Bell (1974) displayed a large increase of nonadditive genetic variance under conditions deviating from optimal.

The effects of using a heat stress were opposite. Lines selected in restricted environment (S_1R, S_2R) did not reduce their fertility, and the non-selected line KR reduced it slightly (Figs. 1, 2). Fecundicity of lines selected under optimal conditions (S_1O and S_2O) fell drastically while there was no response of the non-selected line KO and its fecundity even slightly increased. These results confirm the suggestion about different genetic bases of high fecundity in various environments and simultaneously suggest that genes considered favourable in one environment should not be such in another. This is in agreement with the data cited by Ford (1967). It may also be suggested that there exists interaction between a stresser and specific set of environmental conditions (Young 1981, Fuquay 1981). However, drastic changes in selected lines at nearly undisturbed performance of unselected lines, as well statistically highly significant, high value of the estimated stress × line interaction are

against the treatment of that interaction as the main cause of so different stress reactions.

In the sixtheenth and eighteenth generations the experiment was repeated again, subjecting all the lines to cold and heat stress. The results are presented in Tables 1 and 2. Like it was previously, insects selected in restricted environment (S_1R, S_2R),

Table 1. Fecundity of the studied lines of *Drosophila melanogaster* under conditions of optimal temperature and cold and heat stress in optimal and restricted environment

Restricted environment				Optimal environment			
line	cold stress	heat stress	optimal temperature	line	cold stress	heat stress	optimal temperature
Unselected KR	107.1	93.8	106.3	Unselected KO	128.7	66.5	124.7
Selected S_1R	104.5	123.8	161.9	Selected S_1O	152.9	48.9	158.7
Selected S_2R	109.0	116.3	153.6	Selected S_2O	161.9	56.8	162.4

Table 2. Fecundity of selected lines of *Drosophila melanogaster* expressed as deviation from the control line under conditions of optimal temperature and cold and heat stress in optimal and restricted environment

Restricted environment				Optimal environment			
selected line	cold stress	heat stress	optimal temperature	selected line	cold stress	heat stress	optimal temperature
S_1R	−2.6	+30	+55.6	S_1O	+24.2	−17.6	+34
S_2R	+1.9	+22.5	+47.3	S_2O	+32.3	− 9.7	+37.7

in response to a cold stress significantly reduced their fecundity, though not so drastically as in the first replication. Fecundity of non-selected lines KR did not differ significantly, thus showing the lack of phenotypic symptoms of a stress reaction (Stott 1981). Flies maintained under optimal conditions (KO, S_1O, S_2O) did not show such a reaction, since the mean fecundity of stressed and unstressed insects did not differ significantly.

Under conditions of increased temperature, flies from restricted environment (KR, S_1R, S_2R) reduced their fecundity, but selected lines S_1R and S_2R were superior to the non-selected line KR. Insects originating from the optimal environment (KO, S_1O, S_2O) as a result of heating showed a drastic stress reaction, the fecundity in selected lines being lower than that in non-selected line, which did not place in the case of KR and S_1R and S_2R.

In contrast to the first replication, the response to a heat stress also occurred in the case of the non-selected line KO. It should be added, however, that as a result of the thermostat breakdown the stressor was stronger than it was planned.

Generally it may, however, be inferred that results obtained in the first and second replications are in agreement, which suggests that stress reaction is different and depends on the kind of the environment, in which selection was previously performed. This situation is best reflected in the fact that selected lines loose their dominance over nonselected ones, which seem to be less susceptible to a stress.

CONCLUSIONS

1. Response to the same stress agent is different depending on the environment in which selection of stressed individuals is performed.

2. Factor declining productivity of selected animals in one environment should not decline it in another.

3. The expression of a stress reaction in the loss of dominance by selected lines over non-selected ones is indicative of various genetic base for a high productivity achieved by selection under different environmental conditions and of genetic determination of stress-resistance.

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REAKCJA NA STRESY SZEŚCIU LINII *DROSOPHILA MELANOGASTER* SELEKCJONOWANYCH NA PŁODNOŚĆ W RÓŻNYCH WARUNKACH ŚRODOWISKA

Streszczenie

Badano odporność na stresy zwierząt selekcjonowanych w różnych warunkach środowiskowych. Stresem zimna i gorąca potraktowano sześć linii *Drosophila melanogaster* selekcjonowanych uprzednio w optymalnych i niekorzystnych warunkach środowiskowych. Selekcja

ukierunkowana była na zwiększenie plenności. Stwierdzono, że reakcja stresowa była różna i zależała od środowiska w jakim prowadzono selekcję. Można przypuszczać, że wysoka plenność jest uwarunkowana różnymi genotypami w różnych warunkach środowiskowych, a odporność na stres ma podłoże genetyczne.

РЕАКЦИЯ НА СТРЕССЫ ШЕСТИ ЛИНИЙ *DROSOPHILA MELANOGASTER*, СЕЛЕКТИРОВАННЫХ НА ПЛОДОВИТОСТЬ В РАЗЛИЧНЫХ УСЛОВИЯХ ОКРУЖАЮЩЕЙ СРЕДЫ

Резюме

Исследовалась реакция на селекцию в различных условиях окружающей среды и сопротивляемость селектированных животных к стрессам. Шесть линий *Drosophila melanogaster*, селектированных на высокую плодовитость в оптимальных и неблагоприятных условиях окружающей среды, подвергались воздействию холода и высоких температур. Установлено, что стрессы влияют различным образом на плодовитость селектированных мух. Реакция напряжения зависила от условий окружающей среды. Проведённые исследования позволили придти к выводу, что высокая плодовитость определяется различными генами при различных условиях окружающей среды и что сопротивляемость к стрессам имеет генетическую основу.