THE EFFECTS OF ASSORTATIVE MATING ON THE RESPONSE TO INDIRECT OR PEDIGREE SELECTION

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SUMMARY

The effects of assortative mating of selected individuals on response to indirect or pedigree selection were analyzed, using two experiments in Tribolium castaneum. Each consisted of a randomly (R) and assortatively (A) mated line with three replicates in each line. In experiment 1, correlated response for adult weight was evaluated using selection and assortative mating on pupal length. Experiment 2 was designed to evaluate the effectiveness of pedigree selection for adult weight when combined with assortative mating for this trait. The proportion of selection was 25% in both experiments. Phenotypic correlations between mates in the A lines were not significantly different from 1. Average selection response was similar in both lines of each experiment, although the correlated response for adult weight in experiment 1 was higher in the A line (.26 ± .08 versus .12 ± .07). Average response for the selectioon goal was statistically significant for both lines in both experiments.

INTRODUCTION

In a large population, the genetic variance and the direct response to selection may increase with phenotypic assortative mating (Bulmer, 1980). Positive assortative mating changes the magnitude of the genetic correlation between traits but not its sign (Gianola, 1982); if the sign of the genetic correlation is positive it will be increased. Therefore, correlated response to selection can be increased by positive assortative mating. Assortative mating can also increase the value of pedigree selection, since it increases the covariance between offspring-parent. Mwenya et al. (1986) investigated the effects of assortative mating on genetic parameters of unselected Tribolium castaneum; they concluded that assortative mating increased the heritability, and that the effects on the genetic covariance were not as expected. Fernando et al. (1983), in a simulation experiment, found no significant effects of assortative mating on direct and correlated responses to selection. The objective of this study was to evaluate the usefulness of positive phenotypic assortative mating to increase indirect selection for adult weight, based on selection for pupal length, or pedigree selection for adult weight in Tribolium castaneum. The mating was assortative for the trait subjected to selection, i.e. pupal length and adult weight, respectively.

MATERIALS AND METHODS

The Consejo population of Tribolium castaneum was used in the study. The traits studied were pupal length (tenths of millimeters) and adult weight (tenths of milligrams) measured at 21 days and 31 days, respectively. Three replicates were maintained through four generations of selection. Each replicate consisted of a selected line randomly mated (R) and a selected line assortatively mated (A). Animals in random lines were mated at random, avoiding sibmatings, and those in assortative lines were mated assortatively based on pupal length (experiment 1) or adult weight (experiment 2); the best male was mated to the best female, and so on. Indirect selection for increased adult weight based on individual selection for pupal length was considered in experiment 1; pedigree selection for increased adult weight was used in experiment 2. Each line was propagated by twenty single pair matings per generation. Four male and four female offspring, chosen at random, from each of twenty families per line were individually measured. Selection intensity was 25%.

The recurrence relationship of the "disequilibrium variance" ($D_n = G_n - G_o = P_n - P_o$) as a result of assortative mating and selection (line A, experiment 1) is (Tallis and Leppard, 1987):

$$D_{n+1} = .5\, D_n + .5\, c\, g_n\, G_n / (P_{11})_n$$

where G (P) is the genetic (phenotypic) matrix of variances-covariances, P_{11} is the phenotypic variance for pupal length, g is the matrix G replacing the second column by zeros, and $c = k + r(1+k)$, being r the correlation between the values of mates, k the change in variance as a result of selection ($k = -i(i-a)$), i the intensity of selection, and a the point of truncation. Expected correlated response for adult weight will be: $i\, G_{12} / P_{11}^{.5}$. Expected response to pedigree selection (line A, experiment 2) will be: $.5\, i\, (1 + r(1+k))\, G_{22} / P_{22}^{.5}$. Taking r equal to zero ($c = k$), the equations correspond to selection under random mating (lines R).

Mean response observed per generation was calculated as the regression coefficient of generation means on generation number. Standard errors of observed responses were calculated from the square root of the variance among replicate slopes divided by three. Mean responses for line A were adjusted using line R as a covariate (Muir, 1986). The realized heritability was calculated as the regression of means on cumulative realized selection differentials.

RESULTS AND DISCUSSION

Phenotypic correlations between mates in each replicate averaged over generations were .91 and .93 in experiments 1 and 2 respectively, not significantly different from 1. Mean values for adult weight in experiment 1 (correlated response) are indicated in Table 1 (replicates pooled), along with regression coefficients of response on generation number (mean responses), and expected responses. The correlated response in the assortatively mated line (A) was significant only at the 10% level, although it was twice greater than that observed in the randomly mated line (R). Mean response in the A line calculated by adjusting for change in the R line was positive (.17). The inbreeding coefficients calculated in generation 4 were similar in both lines, although line R showed slightly smaller value (.0229) than line A (.0355). Direct responses in pupal length per generation observed in both lines (.75 ± .10 and .74 ± .17, respectively) were similar and significant ($P < .05$). The same was true for the realized heritabilities (.20 ± .04 versus .17 ± .08). Average selection differentials were 2.72 and 2.57, respectively. In experiment 2, selection based on pedigree information led to a significant change ($P < .05$) for adult weight in both lines (Table 1); the A line had not higher mean response than the R line. Regression coefficient for the assortatively mated line using line R as a covariate was positive (.18). The inbreeding coefficient in generation 4 in the A line was slightly higher than that calculated in the R line (.0530 and .0346, respectively). Realized heritability was similar in both lines (.20 ± .14 versus .19 ± .04). Average selection differentials were 2.50 and 2.43, respectively.

The main conclusion of these results has been the similarity of selection response of both lines, regardless of mating system applied. In experiment 1 there was some indication of a consistent effect of the mating system, the correlated response for adult weight being higher in the A line. The proportion of realized versus expected response for adult weight in experiment 1 was 59% in line A, whereas line R did not show significant response for this trait. The proportion of expected response that was realized in experiment 2 was 72% and 54% in the R and A lines, respectively. The present results complement those previously obtained for pupal weight (Wilson et al., 1965) and larval weight (Wilson et al., 1968) in Tribolium, abdominal bristle score in Drosophila (McBride and Robertson, 1963), and 6-week body weight in mice (Sutherland et al., 1968), finding a very slight advantage for assortative mating over random mating, following direct individual selection for a trait.

Table 1. Mean values per generation and mean observed responses ± standard errors for adult weight in each experiment[a].

Experiment	Selection	Line	Generations 0	1	2	3	4	Mean response
1	Indirect	R	22.74	23.61	23.87	22.88	23.71	.12 + .07 (.42)
		A	21.66	23.05	22.84	22.63	23.16	.26 + .08 (.44)
2	Pedigree	R	23.20	22.96	24.29	24.68	24.44	.42 + .09 (.58)
		A	23.08	22.52	24.23	23.52	24.68	.42 + .10 (.79)

[a] Expected responses are in brackets.

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