

SELECTION FOR SINGLE AND MULTIPLE TRAITS IN MICE

Sélection pour simples et multiples caractères chez la souris

Selección para caracteres simples y múltiples en el ratón

J. NAGAI *
C. G. HICKMAN *
G. R. BARR *

INTRODUCTION

Quantitative geneticists are interested in the difference between the expected and realized responses from selection. Many experiments have been performed to test theories of selection for a single trait (FALCONER, 1960). Very little experimental examination of selection index theory has occurred. Thus, the present study was initiated to examine responses to selection for two traits: body weight at preweaning age (12 days) and body weight at maturity (42 days). The results from this experiment were intended to elucidate correlated responses from single- and multiple-trait selection.

MATERIALS AND METHODS

Four lines (*M*, *W*, *B* and *C*) were established by random selection in each of two mouse populations (*P* and *Q*) of different origin. In each line 92 males and females were selected for mating every generation. Litter size was standardized at birth to 8 and crossfostering (YOUNG, LEGATES and FARTHING, 1965) using 4 dams per group was performed within each line.

Within *M*, dams were selected for milk production as measured by average body weight of individuals within a nursed litter at 12 days of age (12-day weight). Mice in *W* were selected for individual body weight at 42 days (42-day weight). A selection index based on the two traits was used in *B*. The index was constructed each generation using parameter estimates from the previous generation in *B*. Equal economic weightings were assumed for the two traits. Random selection

* Animal Research Institute, Research Branch, Agriculture Canada, Ottawa, Ontario K1A 0C6, Canada.

was performed in *C* (Control line). The litter born to a mother which nursed the litter with the largest 12-day weight of the four in a crossfostering group was selected for reproduction from each crossfostering group in *M*. The male and female with the heaviest 42 day weight were selected from each nursed litter in *W*, while in *B*, the male and female with the highest index value were selected. Twelve day weight was recorded in *M*, *W*, *B* and *C*. Forty-two day weight was recorded in *W*, *B* and *C*.

RESULTS AND DISCUSSION

Data on 12-day weight and 42-day weight were analyzed within line and generation. The means of 12-day weight and 42-day weight at the initial generation were 8.3 and 23.1 g in *P* and 9.3 and 27.3 in *Q*, respectively. Phenotypic variances of 12-day weight within crossfostering groups for *M*, *W*, *B* and *C* were 0.69, 0.54, 1.13 and 0.74 in *P*, and 0.54, 0.59, 0.82 and 0.62 in *Q*. Variation of the mean 12-day weights among crossfostering groups accounted for 10 and 8% of the total 12-day weight variance for *P* and *Q*, respectively. Phenotypic variances of 42-day weight within crossfostering groups for *W*, *B* and *C* were 4.06, 4.55 and 3.93 in *P* and 8.32, 9.18 and 6.66 in *Q*. Variation of the mean 42-day weights among crossfostering groups accounted for 13 and 7% of the total variance for *P* and *Q*, respectively.

For *M*, *W*, *B* and *C*, heritability estimates for 12-day weight from daughter-dam regressions pooled over 3 generations were 0.37, 0.27, 0.29 and 0.33 in *P*, and 0.25, 0.10, 0.17 and 0.04 in *Q*, respectively. These estimates did not differ substantially from estimates derived using variances among nursing dams within crossfostering groups. For *W*, *B* and *C*, heritability of 42-day weight estimated by doubling the prenatal component of variance within crossfostering groups was 0.20, 0.33 and 0.26 in *P* and 0.28, 0.36 and 0.34 in *Q*. These estimates did not differ from the estimates of the heritability within nursed litters. Genetic correlations between 12-day weight and 42-day weight within crossfostering groups for *W*, *B* and *C* were 0.24, 0.99 and 0.37 in *P* and -0.25 , 0.07 and 0.29 in *Q* while the estimates of phenotypic correlation were 0.01, 0.17 and 0.05 in *P* and -0.02 , -0.02 and 0.05 in *Q*, respectively. The selection index for *B* was $I = w - 0.17 m$ in *P* and $I = w + 0.18 m$ in *Q* where w and m are 42-day weight and 12-day weight, respectively. The two indices differed in sign of the coefficient for 12-day weight although in both cases, coefficient for 12-day weight was small. Twelve-day weight is affected largely by mother's milk production and it appears that milk production and 42-day weight increase mainly through increased mature weight.

From 4 generations of selection both 12-day weight and 42-day weight in the selected lines increased relative to the control line. When the body weights for the selected lines were expressed as deviations from the *C* line (Figure 1) regressions of the deviations on generation number for 12-day weight in *M*, *W* and *B* were 0.057, 0.113 and 0.078 in *P* and 0.040, 0.108 and 0.004 in *Q*, respectively, while those for 42-day weight in *W* and *B* were 0.781 and 0.686 in *P*, and 0.920 and 0.393 in *Q*, respectively. Selection response in *B* differed between the two populations: both response in 12-day weight of *B* relative to *M* and the response in 42-day weight of *B* relative to *W* were larger in *P* than in *Q*. Response to selection in 12-day weight was larger in *W* than in *M* for both *P* and *Q*. This result suggests that genetic improvement of milk production as measured by 12-day weight can

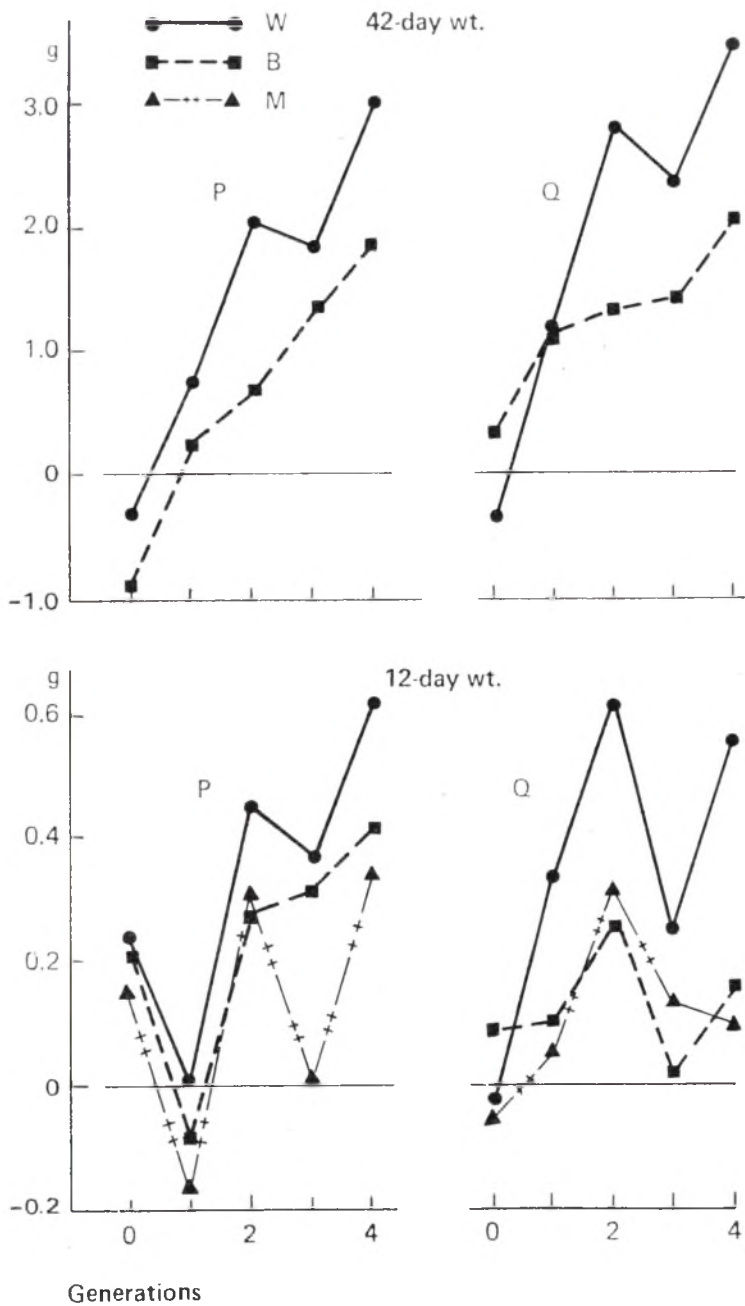


FIG. 1. Changes in body weights at 12 and 42 days for 3 lines (W, B and M) of 2 populations (P and Q) expressed as deviations from control line

be achieved more effectively by selecting for mature weight than by selecting for 12-day weight. This conclusion is in line with that of WHITE and ROBINSON (1973). They indicated that selection for increased 12-day body weight of litter born to and suckled by their mother was not associated with correlated increases in milk yield, but sizable correlated changes in milk yield accompanied bidirectional selection for weight gain during 21-42 days of age. Alternately EISEN (1973) postulated that response to selection for the 12-day litter weight was primarily due to average direct genetic effects, and the average maternal genetic effects contributed little to the response.

SUMMARY

Data from two mouse populations (P and Q) of different origin were analyzed to construct a selection index combining the average body weight of individuals within a nursed litter at 12 days (m) and body weight of individuals of a nursed litter at 42 days (w). The nursed litter contained 8 young representing 4 dams. The index constructed was $I = w - 0.17 m$ and $I = w + 0.18 m$ in P and Q , respectively. These indices indicate that major emphasis is placed on w when the two traits are selected concurrently. An experiment using line (M) selected for m , the line (W) selected for w and the line (B) selected for both m and w showed that response in m for B relative to M and the response in w for B relative to W were larger in P than in Q . There was evidence suggesting that milk production could be improved more effectively by selecting for w than by selecting for m .

RESUME

On a analysé les résultats obtenus de deux populations de souris (P et Q) d'origine différente, afin d'établir un indice de sélection faisant appel au poids moyen des individus d'une portée allaitée jusqu'à 12 jours (m) et au poids moyen des individus d'une portée allaitée jusqu'à 42 jours (w). La portée allaitée était formée de 8 souriceaux issus de 4 mères. Les indices établis ont été $I = w - 0.017 m$ et $I = w + 0.18 m$ pour P et Q respectivement. Ces indices indiquent que l'accent principal est mis sur w lorsque les deux caractères doivent être génétiquement augmentés. Une expérience faite avec la lignée (M) sélectionnée en fonction de m , la lignée (W) sélectionnée en fonction de w et la lignée (B) sélectionnée en fonction de m et w indique que la réponse en m pour B par rapport à M et la réponse en w pour B par rapport à W étaient plus grandes pour P que pour Q . Il semble que l'on peut améliorer la production de lait plus efficacement par la sélection en fonction de w qu'en fonction de m .

RESUMEN

Se han analizado los resultados obtenidos de dos poblaciones de ratones (P y Q), de diferente origen, para establecer un índice de selección referido al peso medio de los individuos de una camada amamantada hasta los 12 días (m) y al peso medio de otra camada amamantada hasta los 42 días (w). La camada amamantada estaba integrada por ocho ratoncillos nacidos de cuatro madres. Los

índices establecidos fueron $I = w - 0.17 m$, y $I = w + 0.18 m$ para P y Q , respectivamente. Estos índices señalan que el problema principal está situado en w cuando los dos caracteres deben ser genéticamente aumentados. Una experiencia realizada con la línea M seleccionada en función de m , la W seleccionada en función de w y la B seleccionada en función de m y w , indica que la respuesta en m para B en relación con M y la respuesta en w para B en relación con W eran mayores para P que para Q . Parece que se puede mejorar la producción de leche más eficazmente por la selección en función de w que en función de m .

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