

INSIGHTS INTO GENETIC VARIATION IN THE DEPOSITION OF FAT FROM SELECTION EXPERIMENTS IN MICE

Perspectives sur la variation génétique de la déposition de graisse d'après de expériences de sélection chez la souris

Perspectivas sobre la variación genética de la deposición de grasa a partir de experimentos de selección en el ratón

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INTRODUCTION

Animal breeders are primarily interested in exploiting genetic variation in gross body size and in body composition. Now, in practice, definitions of these two broad characteristics are refined to take account of energetic efficiency in the case of body size and meat account of energetic efficiency in the case of body size and meat quality traits in the case of body composition. Efforts at practical level to include these refinements in breeding programmes has, unfortunately, left some embarrassingly simple questions about body size and composition largely unanswered. May I suggest two?

1. Does the age at which selection for body weight is exercised affect the carcass composition of selected strains of animals?
2. Does the plane of nutrition on which selection for body weight is carried out influence the carcass composition?

This paper reviews the literature from mice concerning these two questions and present some new results which suggest a simple model of the indirect effects of selection for body size in terms of two components of growth, food intake and energy utilisation.

EFFECT OF SELECTION AGE

Although there are many reports in the literature of correlated effects of selection for body weight at various ages on characteristics of bone, muscle and

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fat only two experiments were specifically designed to answer the question: Does selection at different ages produce animals within the same body composition? HULL (1960) selected lines of mice for high weight at 3, 4½, and 6 weeks over 6 generations. When the lines were then compared at 6 weeks of age, the line selected at 3 weeks of age had a significantly higher level of abdominal fat than the other lines or the unselected control line. But there were odd features of the responses in this experiment which need to be examined. For example, the realised heritability of weight was highest in the line selected at 3 weeks of age. This is in complete contrast to the pattern of heritability estimates expected (MONTEIRO and FALCONER, 1966) and, of course, resulted in a significant bias in fat comparisons. Also, abdominal fat only was recorded. However, it was shown that a significant difference remained after statistical adjustment for body size. The interpretation put forward by HULL was:

«It may be that at the age of 3 weeks fat deposition has just begun in some animals but not in others and that selection at this age acts by picking out those animals which will go on to lay down large amounts of fat.»

In our recent work (McCARTHY and HAYES, in press) we take a radically different view of the role of fat in selection responses.

First, a brief resume of our results which agree with those of HULL. We selected for high weight at 5 and 10 weeks of age for 15 generations and then assessed the fatness by chemical analysis of the carcass at 5, 10 and 21 weeks of age. Clear evidence was got that selection for high body weight at the early age gave fatter mice than selection at the later age. This prompted the critical question: What does selection for large body size discriminate for and against at the different ages? Food intake is an obvious choice. Previous work with selected lines has given several instances of correlated increase in appetite (e.g. TIMON and EISEN, 1970). We further suggest that selection for large body size may also discriminate against animals which are genetically most inclined to deposit fat prior to the age at which selection is exercised. Animals with high intakes will always be selected of course but fat deposition enters the picture because it is more demanding of utilisable energy than other tissues. Our interpretation assumes that the rate and timing of fat deposition are largely weight dependent traits but also possess some variance independent of body weight. The simplest way to comprehend our interpretation is in terms of an index, body size, containing two variables, feed intake and degree of fat deposition. At early ages, since there is relatively little fat deposited in the body, little or no emphasis is given to the latter variable. Therefore, in lines selected early, deposition of fat will occur at the same stage of growth and at the same relative rate as in the base population. In the case of selection for large size at later ages, some emphasis is given to the second variable in favour of animals which postpone fat deposition. The implications of this interpretation for other selection results in mice and larger animals will be discussed at this point.

EFFECT OF LEVEL OF NUTRITION AT SELECTION

The practical implications of genetical variation in rate and timing of fat deposition raises the whole question of the optimum level of food intake on which

to select animals. This will be discussed with reference to the model outlined above. The previous relevant work of FALCONER (1960) and others such as TIMON and EISEN (1970) on the effects of selection on food intake and growth will be reviewed as a background for the presentation of experiments in progress at the time of submitting this paper.

RESUME

Les implications pratiques des variations génétiques en proportion et mesure de la déposition de graisse soulève toute la question du niveau maximum de ration d'alimentation sur lequel on sélectionne les animaux. Cela sera discuté en relation avec le modèle décrit ci-dessus. Les travaux précédents et importants de FALCONER (1960) et d'autres comme TIMON et EISEN (1970) sur les effets de sélection sur la ration d'alimentation et croissance sont révisés comme base pour la présentation d'expériences en cours au moment de remettre ce papier.

RESUMEN

Las implicaciones prácticas de las variaciones genéticas en la proporción y control de la formación de grasa alcanzan a todo el problema del nivel óptimo de la ración para seleccionar a los animales. Ello será analizado con referencia al modelo citado en la comunicación. El importante trabajo anterior de FALCONER (1960) y de otros como TIMON y EISEN (1970) sobre los efectos de la selección en la ración de alimentación y crecimiento son revisados como base para la presentación de experimentos en curso en el momento de terminar el presente trabajo.

REFERENCES

- FALCONER, D. S. (1960): Selection of mice for growth on high and low planes of nutrition. *Genet. Res.*, 1, 91.
- HULL, P. (1960): Genetic relations between carcass fat and body weight in mice. *J. Agric. Sci.*, 55, 317.
- MCCARTHY, J. C., and HAYES, J. F. (1974): *The effects of selection at two different ages for high and low body size on growth and fat deposition in mice* (In press.)
- MONTEIRO, L. S., and FALCONER, D. S. (1966): Compensatory growth and sexual maturity in mice. *Anim. Prod.*, 8, 179.
- TIMON, V. M., and EISEN, E. J. (1970): Comparisons of *ad libitum* and restricted feeding of mice selected and unselected for post weaning gain. I. Growth, feed consumption and feed efficiency. *Genetics*, 64, 41.

