PRENATAL AND POSTNATAL EFFECTS IN MOUSE LINES SELECTED FOR WEANING WEIGHT

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SUMMARY

Selection for eight generations in mice for either total weight weaned or total weight weaned divided by the dam's nine week weight increased both the genetic potential for growth and maternal performance but reduced the fitness-related character, survival.

INTRODUCTION

A response to selection for preweaning growth has been demonstrated in mice (Eisen *et. al.* 1970, Luxford and Beilharz 1982). Variation in body weight can be partitioned into prenatal and postnatal components by the use of cross-fostering techniques (Bateman, 1954; Cox *et. al.* 1959). Several studies have shown that in lines selected for preweaning growth, postnatal maternal performance is responsible for a large portion of the variation in pre- and weaning weight (Young *et. al.* 1965; El Oksh *et. al.*, 1967; Rutledge *et. al.* 1972; La Salle *et. al.*, 1975).

Mouse lines were available that had been selected for 8 generations for different traits and that showed differences in weaning weight (Luxford, unpublished). The objectives of this study were to evaluate, using a cross-fostering experiment, the contributions of prenatal and postnatal effects to the response in weaning weight.

MATERIALS AND METHODS

Mice: Three lines of mice (D,E,F) had been selected for eight generations. Selection in line D was for the total weight weaned in the first litter divided by the nine-week weight of the dam. Line F was selected for the total weight weaned in the first litter. Line E was a natural-selection control where individuals were selected at random.

In each line a sample of 9-week-old mice were mated at random in pairs, avoiding full sib matings. At partuition three dams one from each of the lines, that littered within a twelve hour period, were assigned to a crossfostering group. Litters were standardised to nine young. Each dam was allocated three of her own pups and three pups from each of the other two dams in her crossfostering group.

The mice were provided with a standard pellet ration and water *ad. libitum*. They were housed in a clean facility which was maintained at approximately 22oC and 50-60% relative humidity.

Measurements: Each mouse was identified for its prenatal line at birth and individually identified at ten days of age. Each mouse was weighed out 12, 21, 42 and 63 days of age. Weaning occured at 21 days of age.

At 12 days of age, lactational performance was measured using the pup suckling technique (Nagai ,1971). These data will be presented in a subseqent paper.

Statistical Analysis: The main effects, and interactions are presented here in a preliminary analysis consisting of a two way analysis of variance.

RESULTS

Means for individual body weights are shown in Table 1 and the corresponding analysis of variance in Table 2.

Preweaning: Means for prenatal effects were ranked in the order D F E. D line dams were also superior to F line and control line dams, although there was little difference between dams of the D and F lines. The magnitude of the mean squares in Table 2 indicates that the prenatal and postnatal dam lines had a similar, although not significant, effect on 12 day weight. At 21 days, the postnatal effect was greater than the prenatal effect, although neither was significant.

Postweaning: Progeny of line D dams had mean weights similar to the control line E at 42 and 63 days. Line F had the highest postweaning weights. The prenatal dam line had a significant ($P<.05$) effect on 42 and 63 day weight.

Interaction: None of the prenatal by postnatal interactions were statistically significant.

Table 3 presents the weaning data from the previous generation in comparison with the data obtained in the crossfostering experiment. The traits compared areare mean individual 21-day weight, the mean weight weaned per dam and the number of mice weaned per dam. Standardization of litter size to nine resulted in the number and total weight of mice weaned being of a lower order than in the previous generation.

DISCUSSION

In the previous generation, lines D and F had a higher individual and litter weight weaned than the control line E (Table 3). The postnatal means (Table 1) and the analysis of variance (Table 2) indicate a naternal effect on weaning cut, with the performance of dams of both selected lines being superior to that of the control line dams. Selection for total weaning weight therefore led to an increased in individual body weight at weaning apparanetly expressed via postnatal maternal performance.

Dams of the F line had a lower litter weight weaned than both the D and control lines, due to a lower number of pups weaned. The number of progeny born to line F dams surviving to weaning was the same as in line D. (Table 3). This suggests that in line F there is a negative maternal effect on survival. This would increase the resources available to the remaining progeny and allow them to express their genetic potential for growth.

In contrast, a greater weight of line E progeny were weaned per dam, because a greater number survived to weaning, (Table 3). The dams of the control line were similar to line D in total weight weaned and number weaned. This indicates that there is a genetic effect ensuring survival of line E mice.

There are two possible explanations for an increase in survival rate. Line E mice were selected at random. Mice with a higher value for a 'survival' character may have been selected.

However, it is unlikely that there would be any additive genetic variation remaining in such a character, to respond to selection.

The alternative explanation relates to the theory proposed by Luxford and Beilharz, (1982) and Beilharz (this reference). This theory proposes that in an adapted population, in a constant environment, fitness or a closely related measure such as lifetime reproductive performance cannot be raised. Selection for a component of fitness may be successful, but an increase in that component must lead to a decrease in the total character. Luxford and Beilharz 1982) successful selected 2 lines for an increase in total weight weaned divided by the dam's nine week weight and the number born divided by the dam's nine week weight in the first parity. But in both lines, overall lifetime reproduction was greatly reduced. In my data, selection for total weight weaned divided by the dam's nine week weight, and total weight weaned, in lines D and F respectively, may have resulted in a decrease in the fitness-related character survival.

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TABLE 1: MEANS FOR INDIVIDUAL WEIGHTS

Line	12 day wt mean	21 day wt mean	42 day wt mean	63 day wt mean
		Prenatal line		
D	6.80	10.48	25.34	30.54
E	6.60	10.34	25.14	30.43
F	6.65	10.39	26.31	31.44
		Postnatal line		
D	6.75	10.54	25.63	30.82
E	6.57	10.15	25.41	30.81
F	6.73	10.52	25.71	30.74

TABLE 2: ANALYSES OF VARIANCE FOR INDIVIDUAL WEIGHTS

Source	df	Mean Squares 12 day wt	21 day wt	42 day wt	63 day wt
Prenatal	2	2.34	1.11	84.00**	66.16*
Postnatal	2	2.31	10.55	3.50	0.80
Prenatal x Postnatal	4	1.72	9.50	9.59	5.49
Error (at least)	648	0.87	4.38	14.13	20.32

* (P < .05)
** (P < .01)

TABLE 3: MEANS FOR WEANING TRAITS

Line	Trait: Weaning wt mean	Trait: Wt weaned /dam	Trait: No. weaned /dam
		Previous generation	
D	10.8	109.1	10.1
E	10.1	99.0	9.8
F	12.1	106.5	8.8
		Prenatal line	
D	10.5	61.4	5.9
E	10.3	67.2	6.5
F	10.4	61.2	5.9
		Postnatal line	
D	10.6	64.7	6.1
E	10.1	63.4	6.2
F	10.5	61.7	5.9