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The Growth of Mice Selected for Body Size Under Two Different Nutrition Reared at Different Temperatures and Diets

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Summary

1. A reprot is given of an experiment to envestigate the extent of genotype-environment interaction in the growth rate of mice selected for different nutritional environment when kept on two different diets at two different temperatures.

2. Evidence of interaction was found in two positive cases on the growth rate. One of these was apparently due to the relatively poor growth of L mice compared with the other mice, in both low protein diet and the hot environment. The other was due to the little variation on growth of RB mice compared with H and L mcie, in every condition.

3. The growth of H mice selected for the high level nutrition were superior to L mice in every experimental conditions.

It is important for animal breeders to know what kind of environment is most effectiveness for genetic improvement of the traits. Hammond (1) reasoned that "the character required is best selected for under environmental conditions which favour its fullest expression and that other characters, specilly required by that new environment, are also present in the animal. "Falconer and Latyszewski (2), working with mice, presented an experimental evidence contradictry to Hammond's thesis. Then the studies on the genotype-environmental interaction were made by some investigators (3–11). Their experimental results differed. In the work described here to see whether the mice selected under two different nutritions would show obvious differences in their reactions to another condition such as temperature or diet. Further more the present study discussed wheter environmental conditions that enhance the expression of the desired character will render selection for character more successful than unfavourable conditions.

Materials and Methods

Animals. The original population of the three lines, was derived from a four-way cross of inbred strains, AA. RR. DSD and SS. RR females were crossed with DSD males and SS females with AA males, and reciprocal crosses were made of the F1, s. This basic population (generation 0) was regarded as randambred (RB) and two lines (H and L) were selected from it. The two lines were selected in the same manner for larger body-size at 45 days of age, one line (H) was fed 18% protein diet and the other (L) was fed 13% protein diet. Individuals were selected by the deviations from their litter means, selection therefore being within litters. Litter size was standarized as far as possible to six young at birth. Fifteen pair matingsin each line represented one generation and the rate of inbreeding was kept to be minimum. A repetition of the original four-way cross, maintained without selection, constituted the control line (RB), it was fed 18% protein diet. In generation 32, body weights of male mice at 45 days of age were havier in the H line being 25.7 g., L line 23.1 g. and RB line 20.8 g.. Male mice used for each lines were taken from generation 33.

The environments. The hot and cold environmental temperatures arranged were 32°C±1°C and 8°C±2°C respectively. Experimental mice were housed on rice straw in a metal cage. The chemecal components of the two diets are shown in Table 1..

TABLE 1. *Chemical Component of Feed*

Component	High protein diet	Low protein diet
	(%)	(%)
Water	7.1	12.1
Crude protein	2.65	13.1
Crude fat	6.1	3.1
Nitrogen free extracts	49.8	67.7
Crude fibre	4.1	1.1
Crude ash	6.5	2.9
Calorie (gr.)	3.60	3.51

The design of the experiment. The experiments consisted of a foundation stock of three lines of mice forty male animals each. Each line was divided into two, twentyfour mice being put into a 'hot' environment and twentyfour into a 'cold' environment. The mice were placed in their environments just after weaning and at about the same time. Of each twentyfour, twelve were fed high protein diet and the others law protein diet.

Characters measured. Measurements were taken at every fifth day from weaning to 60 days of ages.

Results

Main effects. In the experiment, males of H, L and RB mice were kept under the hot and cold temperatures, and fed on high and low protein diets. The main effect of the lines, diets and temperatures are shown in Fig. 1. These cruves are obtained by averaging all the appropriate factors in the different groupings, e.g. the H mice curves is the average of all the H mice in the experiment. The differences between the cruves were significant.

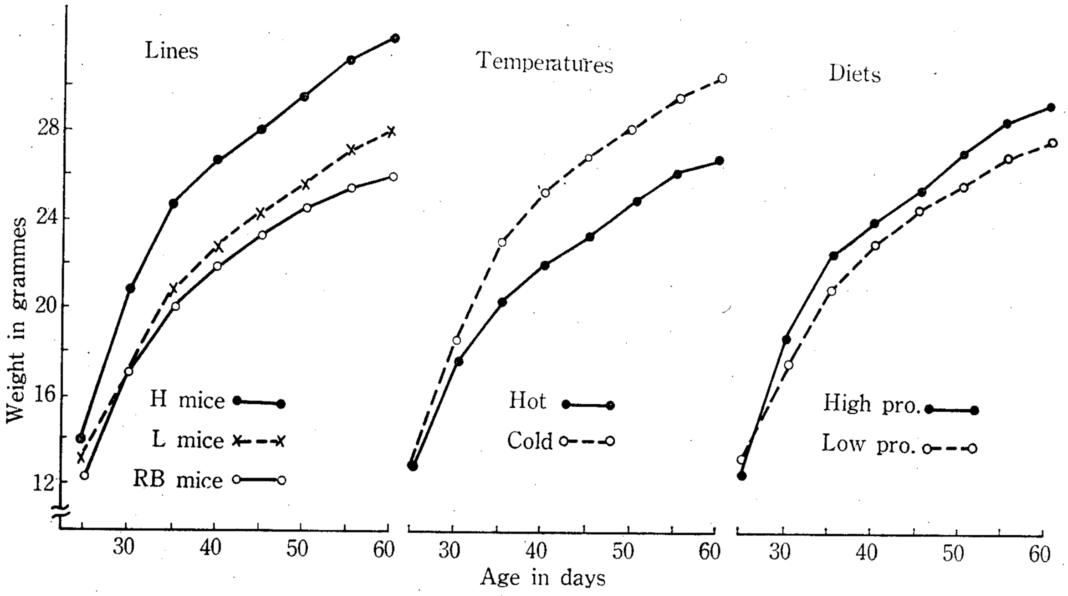

FIG. 1. Main effects of strains, foods and temperatures.

First-order interaction. The first-order interaction, that is, those involving two factors, can be seen in Fig. 2, 3 and 4. The different curves are obtained by averaging one of factors in each case, e.g. the H mice in pro. is obtained by averaging the growth of H mice high protein under the hot and cold environments.

The growth of H and L mice are shown in Fig. 2. Apart from the line/tempetature, the graphs illustrate the line/diet and temperature /diet interactions. Line/diet interaction shows a comparative weakness of L mice to the low protein diet. This interaction was found to be significant at 35, 40, 45, 50, 55, and 60 days of ages ($P<0.01$). Temperature/diet illustrates a comparative weakness of L and H mice to the low protein diet under the hot temparature. This interaction was found to be significant under at 30, 35, 40, 50, 55 and 60 days of ages ($P<0.01$). The growth of H mice was superior to L mice under every experimental condition.

The growth of H and RB mice are shown in Fig. 3. Apart from the line/diet the graphs illustrate the line/temperature and temperature/diet interactions. Line/temperature illustrates a comparative weakness of H mice under the hot

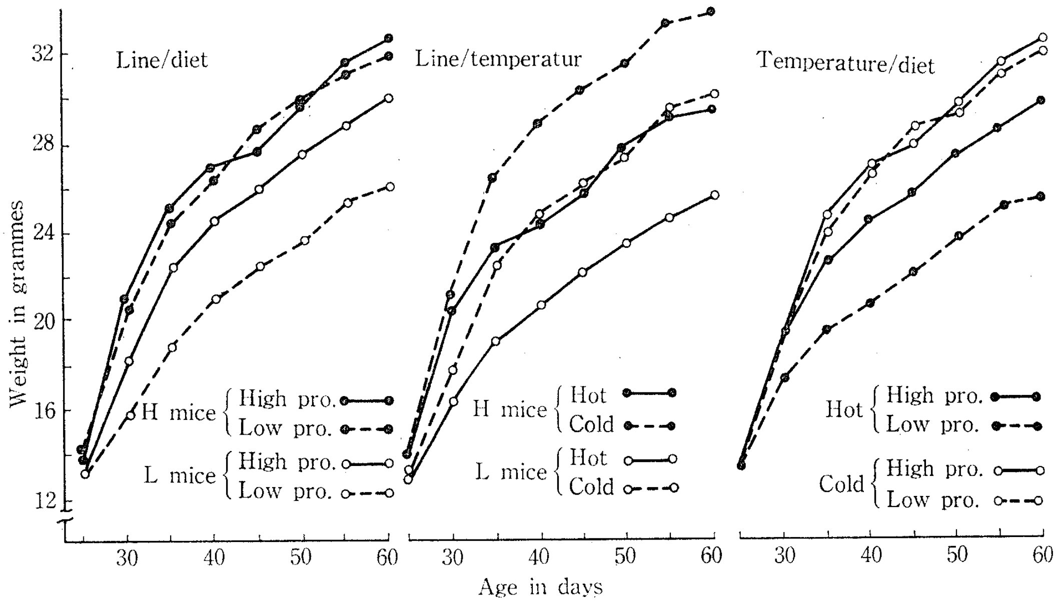

FIG. 2. Graphs showing the first-order interaction (H mice and L mice).

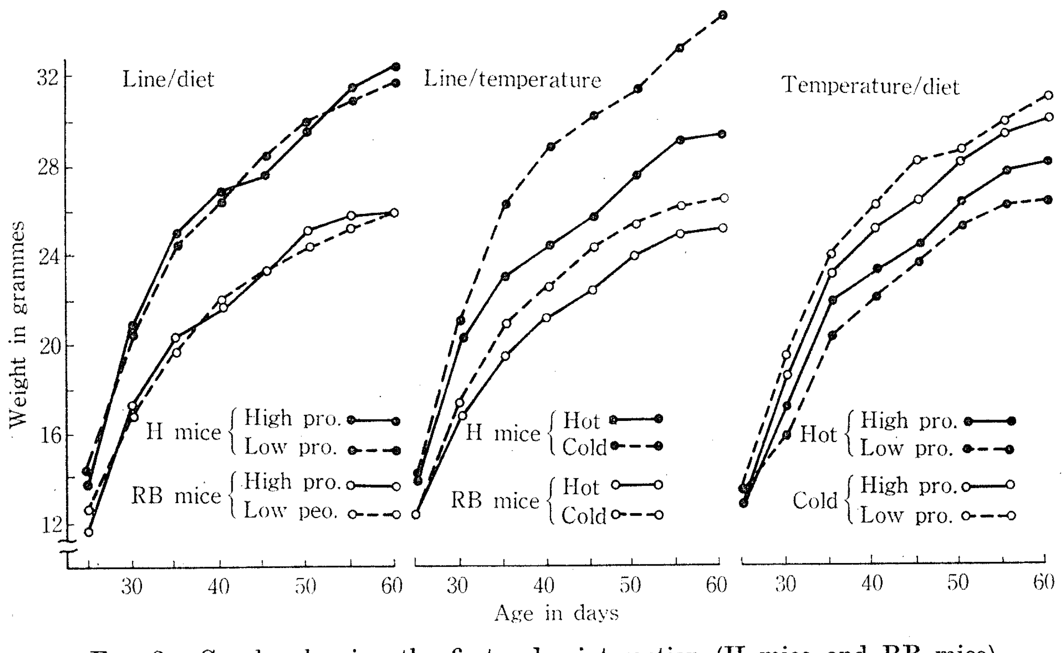

FIG. 3. Graphs showing the first-order interaction (H mice and RB mice).

environment. This interaction was found to be significant at 40, 45, 50, and 60 days of ages ($P<0.01$). Temperature/diet interaction seemed to be due to the different susceptibility to the diets and the temperatures between H and RB mice. This interaction was found to be significant in the analysis at every age. The growth of H mice were superior to the every condition than that of RB mice.

The growth of L and RB mice are shown in Fig. 4. The graphs illustrate

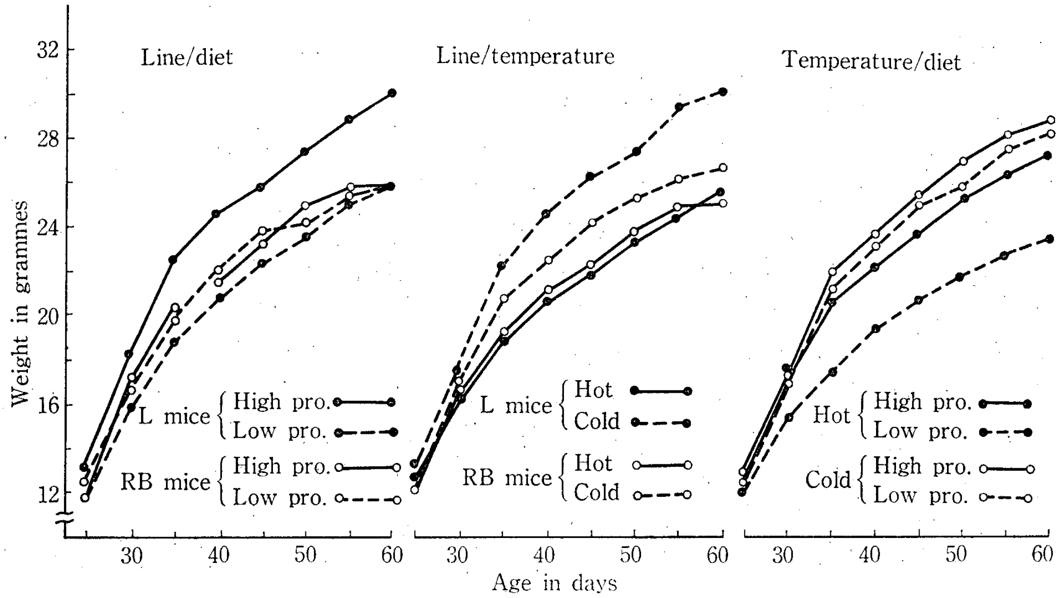

FIG. 4. Graphs showing the first-order interaction (L mice and RB mice).

the line/diet, line/temperature and temperature/diet interaction. Temperature/diet interaction was found to be significant in the analysis after 30 days of age (P<0.01). This interaction illustrates a comparative weakness of L mice to the low protein diet under the hot environment. Line/diet and line/temperature illustrate a comparative weakness of L mice to the low protein diet and hot environment.

The growth of RB mice shows a smaller variation than that of H and L mice under any environment.

Second-order interactions. The line/diet/temperature interaction was found to be signfiicant in the analysis of L and RB mice at 40, 45, and 50 days of ages. This interaction seem to be due to the comparative susceptibility of L mice to poor environment than RB mice.

TABLE 2. *Analysis of Variance of Body Weight*

Source of variation	d.f.	Variance (Days of ages)						
		30	35	40	45	50	55	60
Strains, S	2	222.51**	313.63**	319.00**	304.05**	357.80**	437.80**	488.98**
Temperature, T	1	23.85	264.06**	387.44**	469.08**	370.24**	420.25**	513.78**
Foods, F	1	32.87*	84.64**	49.94**	24.09*	72.10**	92.80**	96.70**
S×T	2	2.52	10.89	36.16**	28.70**	30.95**	42.71**	47.75**
F×S	2	17.67	41.95**	51.00**	59.75**	44.53**	45.68**	53.50**
T×F	1	28.80*	46.02**	69.44**	97.19**	57.64**	55.01**	100.00**
S×T×F	2	0.27	0.55	8.29	18.63	10.32	1.95	4.74
Error	118	6.84	3.88	3.40	3.80	3.44	3.97	4.12

1) 121-3=118: three missing values

* Significantly different at 5% level.
** Significantly different at 1% level.

Discussion

In the present work a number of possible genotype-environment interactions were investigated, and two positive cases have been found. One of these was apparently due to the relatively poor growth of L mice compared with H and RB mice, in the low protein diet and the hot environment. The other was due to the little variation on growth of RB mice compared with H and L mice, in all conditions. The similar genotype-environment interaction have been obtained by Young (11), useing three inbred lines of mice. Diet/temperature interaction was observed on the growth among three lines of mice. In the previous studys, the selection experiments with mice were carried out under the same qualitative environment, e.g. high and low planes of nutritions or high and low temperatures (2–10). But the interaction as described above seemed to be necessary to do the selection experiment for body size on combined environments.

The growth of H mice selected for high plane of nutrition were superior to L mice at every experimental conditions. Namely, improvement of the genotype for rapid growth on high plane of nutrition carried with it improvement for growth on low plane. But improvement of the genotype for growth on a low plane carried with it no improvement for growth on high plane. It is indicated that the results in our experiment do not suport the results of Falconer's experiment, but Hammond's thesis. Therefore, a number of experiments are required to further illustrate this problem.

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