GENETICAL AND MATERNAL FACTORS INFLUENCING ON GROWTH OF LABORATORY MICE

Facteurs génétiques et maternels ayant influence sur le croisement de la souris de laboratoire

Factores genéticos y maternales que ejercen influencia sobre el crecimiento del ratón de laboratorio

T. SLAWINSKI *

In the purpose of determining the extention of direct and maternal influences on mice body weight during the growth period and of the genetic interrelationship several experiments have been made.

This paper contain only a part of experimental results which are concerned with effects of selection on weaning body weight. At 3 weeks of age mice body weight is highly related on maternal influence, but simultaneously it is the time when some other factors influencing this feature start to play a role. This factors are genetical as well as environmental. This is so because the offsprings at the weaning have to be able to live outside the mother environment.

Material and methods

Selection experiment was preceded by creation of base population. This population was made by reciprocal crossing of four inbred strains of mice: *A/St*, *C57BL/6Jn*, *BALB/c*, and *BN/a* from PAN Experimental Center in Lomna-Las.

After six generations randomly mated with avoidance of inbreeding, two way selection on weaning body weight have started from the base population.

Inside both selected lines *H* (high) and *L* (low) 30 pairs of mice born in the first litter in each generation were randomly mated with avoidance of inbreeding. At three days of age litters were normalized up to six. I male and female with the most deviating body weight from the mean for whole litter were selected from each litter for mating. Inside the control line *O* (outbred) 100 pairs were

* Institute of Biological Principles of Animal Breeding, Agricultural University, 05-840 Brwinow, Warszawa, Poland.

TABLE 1

DIRECT AND CORRELATED EFFECTS OF SELECTION ON BODY WEIGHT AT 21 DAYS OF AGE (GRAMS)

	Age (days)				
	3	12	21	42	56
Body weight at generation 1:					
H line	1.67 ± 0.03	6.09 ± 0.13	8.97 ± 0.17	19.62 ± 0.26	20.14 ± 0.25
L line	1.70 ± 0.04	6.29 ± 0.12	8.76 ± 14	18.99 ± 0.24	20.69 ± 0.16
Body weight at generation 10:					
H line	1.84 ± 0.04	6.77 ± 0.14	10.64 ± 0.21	23.26 ± 0.30	25.93 ± 0.06
L line	1.68 ± 0.03	5.28 ± 0.10	7.82 ± 0.15	19.10 ± 0.24	21.37 ± 0.27
Cumulated Response (R_c).	0.16	1.49	2.82	4.16	4.56
Cumulated Selection differential (S_c)	0.62	2.84	6.99	7.51	5.99
Realized heritability (h^2_R).	$\frac{0.0201}{0.1755} \pm$	$\frac{0.1817}{0.2075} \pm$	$\frac{0.1385}{0.1194} \pm$	$\frac{0.2430}{0.1377} \pm$	$\frac{0.4639}{0.2729} \pm$
Intestinal fat weight at generation 11 (g/1 g body weight):					
H line				0.0175	
L line				0.0195	
Intestinal fat weight at generation 10 (g/1 g body weight):					
H line				0.0195	
L line				0.0240	

TABLE 2

MEAN VALUES AND STANDARD ERORS OF BODY WEIGHT AND INTESTINAL FAT WEIGHT OF MICE BORN AND NURSED IN SELECTED AND CONTROL LINES

	H - line	*N* - 216	*O* - line	*N* - 210	*L* - line	*N* - 222
	own	fostered	own	fostered	own	fostered
Body weight at days:						
3	1.96 ± 0.02	1.89 ± 0.01	1.86 ± 0.02	1.89 ± 0.01	1.86 ± 0.02	1.90 ± 0.01
12	6.62 ± 0.06	6.48 ± 0.03	6.28 ± 0.06	6.44 ± 0.04	6.02 ± 0.06	6.19 ± 0.03
21	8.70 ± 0.14	8.48 ± 0.05	8.23 ± 0.13	8.45 ± 0.04	8.17 ± 0.12	8.23 ± 0.05
35	19.51 ± 0.19	18.47 ± 0.17	18.04 ± 0.17	18.19 ± 0.14	17.56 ± 0.16	17.99 ± 0.14
42	21.31 ± 0.21	20.52 ± 0.19	20.00 ± 0.17	20.18 ± 0.16	19.38 ± 0.17	19.91 ± 0.17
Intestinal fat weight at 42 days of age	0.45 ± 0.01	0.40 ± 0.01	0.39 ± 0.01	0.40 ± 0.01	0.36 ± 0.01	0.38 ± 0.01

H = Line selected on high body weight at 21 days of age.
O = Outbred, control line.
L = Line selected on low body weight at 21 days of age.
N = Number of animals born each line.

drawn by a lot from 40 litters in each generation and were randomly mated with avoidance of inbreeding.

Mice were individually weighted in 3, 12, 21, 42 and 56 days of age. At 42 days of age 20 offsprings were drawn by lot from all litters for each line (*H*, *L*, *O*; 10 males, 10 females) and the estimation of intestinal fat has been made.

After 8 generation, experimental material was obtained from second litters. This at 56 days of age were mated inside each line (*H*, *L*, *O*) in poligamy (1 male × 3 females) with avoidance of inbreeding. Offsprings obtained from this mating at 3 days of age were separated according to a specific plan. For each dam has been left only 2 her own offsprings and the rest has been divided between females of 2 other lines which has delivered the same day.

Typical reciprocal cross-fostering groups has not been established and number of offsprings within each line was different (table 2).

Statistical analysis has been made for 648 animals obtained from 108 litters normalized up to 6 offsprings. This litters were after 63 sires and 3 lines (*H*, *L*, *O*).

Results

Direct and correlated effects of selection of 10 generation sare shown in table 1. Cummulated selection response (*Rc*) and cummulated selection differential (*Sc*) were estimated from differences between *H* and *L* lines only for 6 animals litters. Selection differential within any generation and any line was calculated as a mean of all deviations within a litters only, for this animals which gave birth the offspring as a next generation.

Realized heritability h^2_R has been estimated as a regression of commulated selection response on cummulated selection differential. Maximal cummulated selection differentiel was obtained for the age in which selection has been made, it means for 21 days of age. Correlated selection differential is diminishing with the distance of weaning time and respectively is: for 3 days of age, — 42 %; 12 days, — 60 %; 21 days, — 95 %; 42 days, — 43 %; and for 56 days, — 30 % of average body weight of animals from control line (*O*).

It has been found that realized heritability has a growing tendency with age. An increase of interestinal fat calculated on 1 g of body weight according to increase of animal body weight with comparison of two lines (*H* and *L*) has not been found.

Mice of line *L* in 10th generation has occured to be more fatty than mice of line *H*.

Average body weight and amount of intestinal fat of mice of 8th generation according to method of fostering and age are shown in tables 2 and 3. There also shown components of mean square for examining factors according to the source of variance.

Analisis of variance has been calculated according to method *RO* (Oktaba, W., 1965; *Applicationes mathematicae*, v. VIII, 127-142). With this method negative components are eliminated from the model. In the table 3 values of variance components eliminated from the model are given as *O*.

Genetic differentiation of selecting lines has occured after 8 generations of selection and it was observed in body weight as well as in amount of intestinal fat. The greatest diferences beetwen lines has been observed at 35 days of age.

TABLE 3

COMPONENTS OF VARIANCE OF BODY WEIGHTS AND COMPONENTS OF VARIANCE OF INTESTINAL FAT WEIGHT AT 42 DAYS OF AGE IN GRAMS

Source	d. f.	Body weights at days of age										Intestinal fat weight	
		3		12		21		35		42			
		σ^2	%	σ^2	%	σ^2	%	σ^2	%	σ^2	%	σ^2	%
1. Genetical lines (L)	2	0.0025	2.6	0.0360	4.33	0.1525	3.95	0.9414	12.13	0.7509	4.67	0.0014	4.84
2. Fostering lines (F)	2	0.0000	0.00	0.0054	0.65	0.0817	2.12	0.0000	0.00	0.0000	0.00	0.0000	0.00
3. $L \times F$	4	0.0000	0.00	0.0204	2.45	0.0000	0.00	0.0555	0.72	0.0000	0.00	0.0000	0.00
4. Sires within genetical line ($S\,w\,L$)	59	0.0062	7.35	0.0713	8.57	0.0000	0.00	0.9450	12.17	2.3733	14.75	0.0041	14.19
5. $F \times (S\,w\,L)$	118	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
6. Dams within Sire within genetical ($D\,w\,S\,w\,L$) line.	46	0.0359	42.54	0.0343	4.12	2.6942	69.83	0.0000	0.00	0.0000	0.00	0.0000	0.00
7. $F \times (D\,w\,S\,w\,L)$	92	0.0164	19.43	0.4861	58.42	0.5879	15.24	0.0000	0.00	0.0000	0.00	0.0015	5.19
8. Within progeny within $FDSL$	324	0.0234	27.72	0.1786	21.46	0.3419	8.86	5.8203	74.98	12.9676	80.58	0.0219	75.78
TOTAL	647	0.0844	100.00	0.8321	100.00	3.8582	100.00	7.7622	100.00	16.0918	100.00	0.0289	100.00

Differences between lines in postnatal as well as interaction between direct and maternal effects of lines has not been observed. Genetic covariance of body weight between sire half-sib has shown a growing tendency according to the age with exception of body weight at 21 days of age when there was no possibility to determine it.

It has not been also stated the interaction between direct genetic affect determined from covariance between sire half-sib and postnatal maternal effect of line.

A significant and high influence of dams within sires and within lines on mice body weight during suckling period it has been observed. It was also high interaction between maternal effect and postnatal effect of line, especially at 12 days of age. It means that own offspring is much better fostered by mother than offspring given her to rear.

The absence of influence of dams within sires and within lines on body weight and amount of intestinal fat during after weaning period may be is given by negative genetic correlation between direct and maternal effect in that period of time.

SUMMARY

Analysis of direct and correlated effects of two way within family selection on weaning body weight (at 21 days) of laboratory mice during 10 generations was made.

Realized heritability of body weight h^2_R at age of 3, 12, 21, 42 and 56 days are respectively 0.02, 0.18, 0.14 and 0.46.

After 8 generations of selection it has been stated high prenatal maternal effect, high interaction between prenatal maternal effect and postnatal effect of line according to preweaning body weight.

RESUME

Dans cette étude on a analysé les effets directs et correlés de l'intrafamiliale sélection dans deux directions opposées de souris de laboratoire. La sélection était effectuée pour le poids vif à 21 jours, au sevrage, pendant dix générations.

Coefficients d'héritabilité réelle (h^2_R) sont suivants: à 3 jours, — 0,02; 12 jours, — 0,18; 21 jours, — 0,14; 42 jours, — 0,24; 56 jours, — 0,46. Après 8 générations sélectionnées nous avons constaté l'important effet maternel prenatal et l'intéraction entre cet effet et postnatal effet de lignées sur le poids vif avant sévrage.

RESUMEN

Se analizan los efectos directos y correlacionados de la selección intrafamiliar en dos direcciones opuestas, en ratones de laboratorio. La selección fue efectuada para el peso vivo a los 21 días, al destete, durante diez generaciones.

Los coeficientes de heredabilidad real (h^2_R) son los siguientes: a los tres días, — 0,02; 12 días, — 0,18; 21 días, — 0,14; 42 días, — 0,24; 56 días, — 0,46. Al cabo de ocho generaciones en selección, los autores han comprobado el importante efecto materno prenatal y la interacción entre este efecto y el postnatal de las camadas sobre el peso vivo antes del destete.