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CHARACTERISTICS OF MATERNAL BEHAVIOUR OF LABORATORY MICE FROM A SELECTION EXPERIMENT FOR THE TESTIS WEIGHT INCREASE [1]

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Summary. 160 females and 58 males of laboratory mice from 4 lines of the XIIIth generation of a selection experiment for the testis weight increase were tested by the Maternal Behaviour Test (MBT). It was found that females from selected lines reacted faster to given pups and performed more activities during MBT than females from the control lines (differences were highly significant). A similar tendency, though statistically not significant was displayed in males. Phenotypic correlations between results of MBT and traits constituting criterium of selection as well as female fertility were estimated.

Maternal behaviour and its role in rearing offspring has been long an object of studies. Nagai et al. (1979) displayed that the time spent by a mouse female with a litter during lactation is correlated with its lactation yield ($r=0.88$), as well as time spent with the young is correlated with their growth rate. Bielecka (1976) reports that the time spent by a mouse female with pups is correlated with the litter weight on the 12th day of their life ($r=0.42$). Some authors suggest that maternal behaviour may be also related with animal fertility described as a number of youngs born and weaned by a female. Maternal behaviour is particularly important at early developmental stages of pups (Legates 1972). In the present paper an attempt has been made to describe differences in maternal behaviour in relation to pups as a response correlated with the selection for an increase in the testis weight of males. Selection in this direction is an attempt of a practical verification of a hypothesis about genetic relationship between reproduction traits of males and females (Land 1973). An increase of male testis treated as an effect of hormonal stimulation (correlation between testis diameter and LH level is 0.6; Carr et al. 1975) may illustrate hormonal activity of females related with such males, which is associated with their reproduction value (genetic regression of the testis weight to ovulation rate is 2.9 egg cells per 100 mg of testis weight; Islam et al. 1976).

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MATERIAL AND METHODS

Animals originated from 4 strains of the XIIIth generation of a selection experiment carried out with animals of the Institute of Biological Bases of Animal Breeding of Warsaw Agricultural University. Each of the lines consisted of progenies from 15 males and 45 females. The lines S-1 and S-2, constituting replication, were selected for the testis weight increase. The selection criterium was the sum of the both testis weight of male fathers measured in the 11 - 12th week of life. For mating in the next generation we took sons of 4 males with the heaviest testis and daughters of 12 males. The progeny of 3 males with the lowest value of that trait was eliminated. The control line K-1 was performed by Hanoverian system as outbred. In the control line K-2 we used matings imitating selection lines (the same method and proportions of males and females randomly selected for parents of the next generation) in order to obtain a similar intralinear relation. The line K-2 was regarded as a measure of inbreed depression, which may manifest itself during a long-term selection. In all the lines, the testis weight and the body weight of males at the age of 11 - 12 weeks were studied, an indicator representing relation of the both traits was calculated and the number of life-born youngs in their first litter was checked.

The animals were maintained under conventional conditions: on a diurnal cycle of 12 hours day and 12 hours night, the Murigran mixture with the addition of vitamins was provided at libitum.

The test covered totally 58 males and 160 females from the described lines; their numbers are given in Table 1. The Maternal Behaviour Test (MBT) was performed on males and naive females (i.e. such individuals which had no contact with suckling beyond siblings of the same litter) at the age of 42 - 56 days. Each animal was isolated in a cage supplied with food and water for 18 - 24 hours prior to the test, after which two 2-day pups were placed in the cage and the animal was observed for 5 minutes from the first contact with a pup and if the animal displayed no interest to a pup for 10 minutes, the observations were interrupted. The following activities were noted (modified after Noirot 1972): sniffing the pup (0) — in case if an animal sniffed a pup touching it with its nostrils for minimum 2 seconds, licking the pup (L) — if an animal licked a pup keeping it by its forefeet for not shorter than 2 seconds, retrieving the pup (P) — if an animal retrieved the pup for the distance over 2 cm, lactation position (PK) — if an animal covered a pup with its body for at least 2 seconds, nest-building (BG) — if an animal transferred, picked or pushed bedding litter for not less than 2 seconds. Agression (A), when an animal attacked the pup, was also noted. Each activity was noted only once and scored as follows: 0-1 point, L—2 points, P—4, PK—4 and BG—4. The sum of points constituted a result of the Maternal Behaviour Test. Agressive animals were not scored in MBT. The time of response latency (t_{or},) between placing of pups into a cage and the first contact of an animal with them was also noted. Results were treated by the method of the analysis of variance according to a linear model:

$$x_{ij}=\mu+\alpha_i+e_{ij} \tag{1}$$

Table 1. Characteristics of studied traits in females and males mice from 4 selected lines

Trait \ Line	K-1			K-2			S-1			S-2			General		
	n	$\bar{x}$	$\sigma\bar{x}$	n	$\bar{x}$	$\sigma\bar{x}$	n	$\bar{x}$	$\sigma\bar{x}$	n	$\bar{x}$	$\sigma\bar{x}$	n	$\bar{x}$	$\sigma\bar{x}$
Males															
MBT [lg(pk+1)]	10	0.534	0.1527	14	0.5753	0.0729	11	0.7482	0.0898	15	0.6703	0.0998	50	0.6336	0.0447
latency time (s)	13	1.6045	0.0772	15	1.32	0.1606	15	1.7095	0.1308	15	1.1183	0.2024	58	1.5875	0.0496
body weight (g)	13	29.58	0.5278	15	27.91	0.7101	15	27.15	0.4751	15	29.27	0.5138	58	28.44	0.3070
testis weight (mg)	13	256.85	7.1334	15	227.00	10.7049	15	270.13	10.4441	15	326.40	8.2779	58	270.55	8.0768
mg/g·1000 indicator	13	8.64	0.2088	15	8.12	0.3202	15	9.87	0.2633	15	11.16	0.2530	58	9.48	0.2621
Females															
MBT [lg(pk+1)]	41	0.5906	0.0623	39	0.6188	0.0601	37	0.7110	0.0663	38	0.8970	0.0480	155	0.7016	0.0120
latency time (lg s)	41	2.2039	0.0675	41	1.7447	0.1083	40	1.5278	0.1058	38	1.2022	0.0912	160	1.6793	0.0381
no. born alive	41	1.0044	0.2864	41	9.80	0.2595	40	8.98	0.3494	38	9.74	0.2840	160	9.75	0.1505

where μ—total mean, α_i—line influence, $i=1\ldots 4$, e_{ij}—random influence. Phenotypic correlations between the results of the test (sum of points) and latency time and data characterizing the studied lines were estimated.

Statistical calculations were made on translated results formed of MBT and latency time according to the models:

$$\text{a) } x'=\lg (x+1) \tag{2}$$

where x'— a MBT result after transformation, x — a MBT result scored 9 points,

$$\text{b) } x'=\lg x \tag{3}$$

where x'—a result of the latency time after transformation, x— a result of the latency time (seconds).

A 0 - 1 analysis of variance for the number of the performed activities was made according to model 1.

RESULTS AND DISCUSSION

Since traits characterizing lines are different in males (body weight, testis weight, indicator) and in females (number of live-born youngs), it seams reasonable to discuss the results concerning maternal behaviour and correlation with the mentioned traits separately for each sex. Collected results are given in Table 1.

1. MALES

The frequency of particular actions made by females of the studied lines did not differ statistically significantly (Fig. 1). Differences in the studied traits between the lines in the course of selection were significant (Tab.2, Fig. 2). Correlation between the latency time (response latency) and the body weight, testis weight and indicator ($r=0.44$; $r=0.03$; $r=0.11$, respectively), as well as correlation between results of the Maternal Behaviour Test and the mentioned traits ($r=-0.06$; $r=0.06$; $r=0.19$, respectively) (Tab. 2) were estimated. Of interest are correlations with the indicator (time of delay $\times$indicator $r=0.11$ and MBT$\times$indicator $r=0.19$). Simultaneously it may be noticed that females from the line S-2 had the longest latency time and the best results concerning the body weight, testis weight and indicator (Tab. 1). Selection lines (S-1, S-2) had markedly higher MBT values.

2. FEMALES

The frequency of performing separate actions within the line is presented in Fig. 1. Differences between the lines in performing the following actions: licking the pup, retrieving the pup and lactation positions were statistically significant ($P=0.05$). It was found that females from the line S-2 displayed more activities (O, L, P) and were not agressive in relation to their pups. Regarding the number of live-born youngs,

the latency time and MBT results differences between the lines were significantly high ($P=0.01$) (Tab. 3). Correlation between the number of live-born youngs and the latency time is low, practically zero, $r=0.032$, whereas difference between the num-

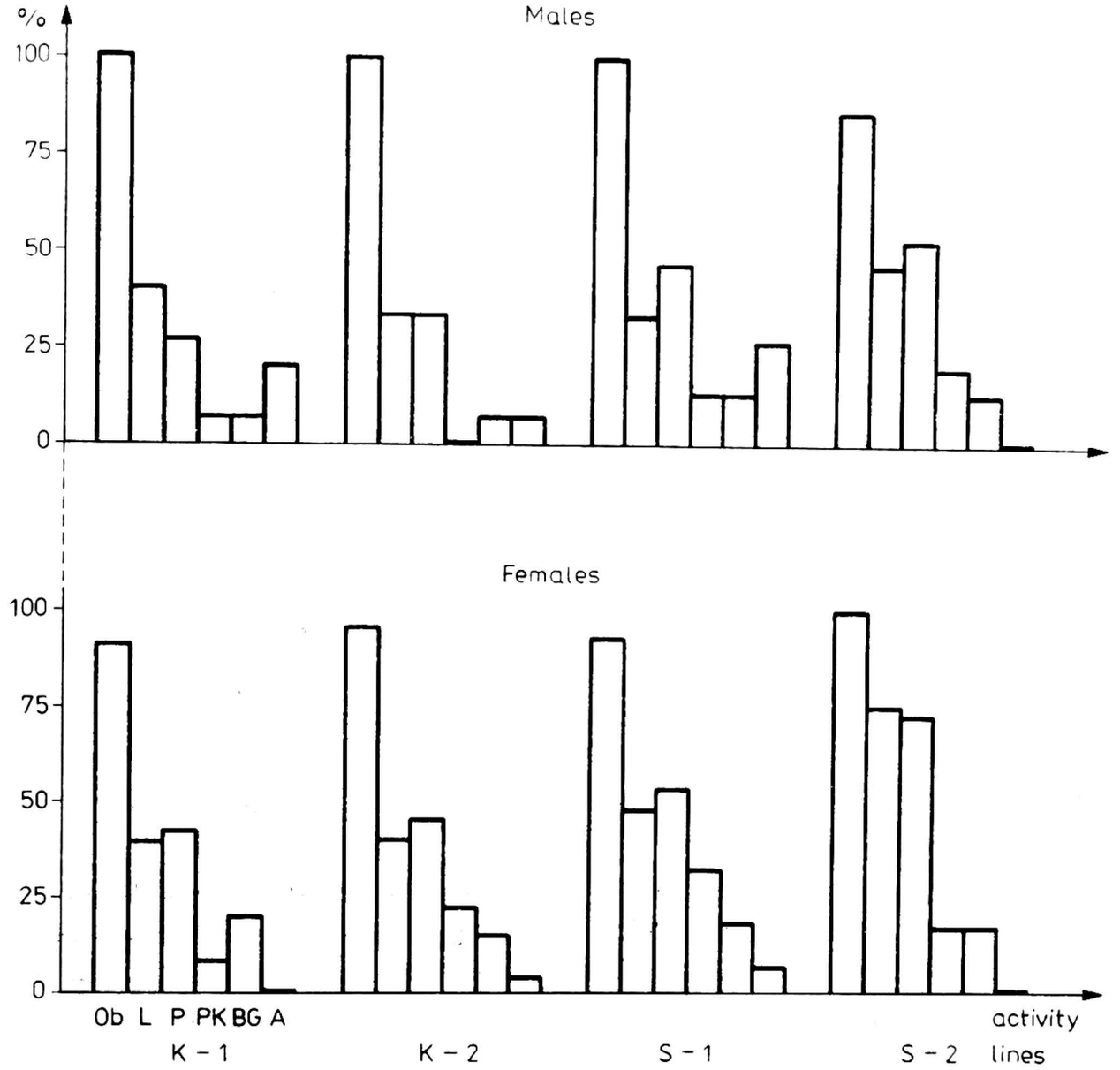

Fig. 1. Activities performed by animals during maternal behaviour test

Table 2. Results of variance and covariance analysis of observed traits in males

Source of variation	df	Mean squares				Mean deviation products		
		body weight	testis weight	indicator	latency time	$x y_1$	$x y_2$	$x y_3$
		y_1	y_2	y_3	x			
		a) all males $n=58$						
Between lines	3	18.9027**	49879.6330**	57.9621**	0.5225	0.5535	93.5187	3.0937
Error	54	4.7193	1222.724	0.9867	0.3696	0.6426	−3.917	−0.0334
						$r_{xy_1}=0.44$	$r_{xy_2}=0.03$	$r_{xy_3}=0.11$
		b) without aggressive males $n=50$						
		y_1	y_2	y_3	MBT z	$z y_1$	$z y_2$	$z y_3$
Between lines	3	14.3893**	25503.6660**	25.6990**	0.1037	−1.4473	27.1521	1.0952
Error	46	4.7680	1332.0217	1.0924	0.0994	0.0461	−0.6898	0.0315
						$r_{zy_1}=-0.06$	$r_{zy_2}=0.06$	$r_{zy_3}=0.19$

* statistically significant $P\leqslant 0.05$
** statistically high significant $P\leqslant 0.01$

ber of live-born youngs and MBT results is $r = -0.284$; the negative value of that reaction is striking.

In conclusion, it should be emphasized that sel ection in the direction of the testis weight was successful (Fig. 2), i.e. a direct respon se to selection has been obtained,

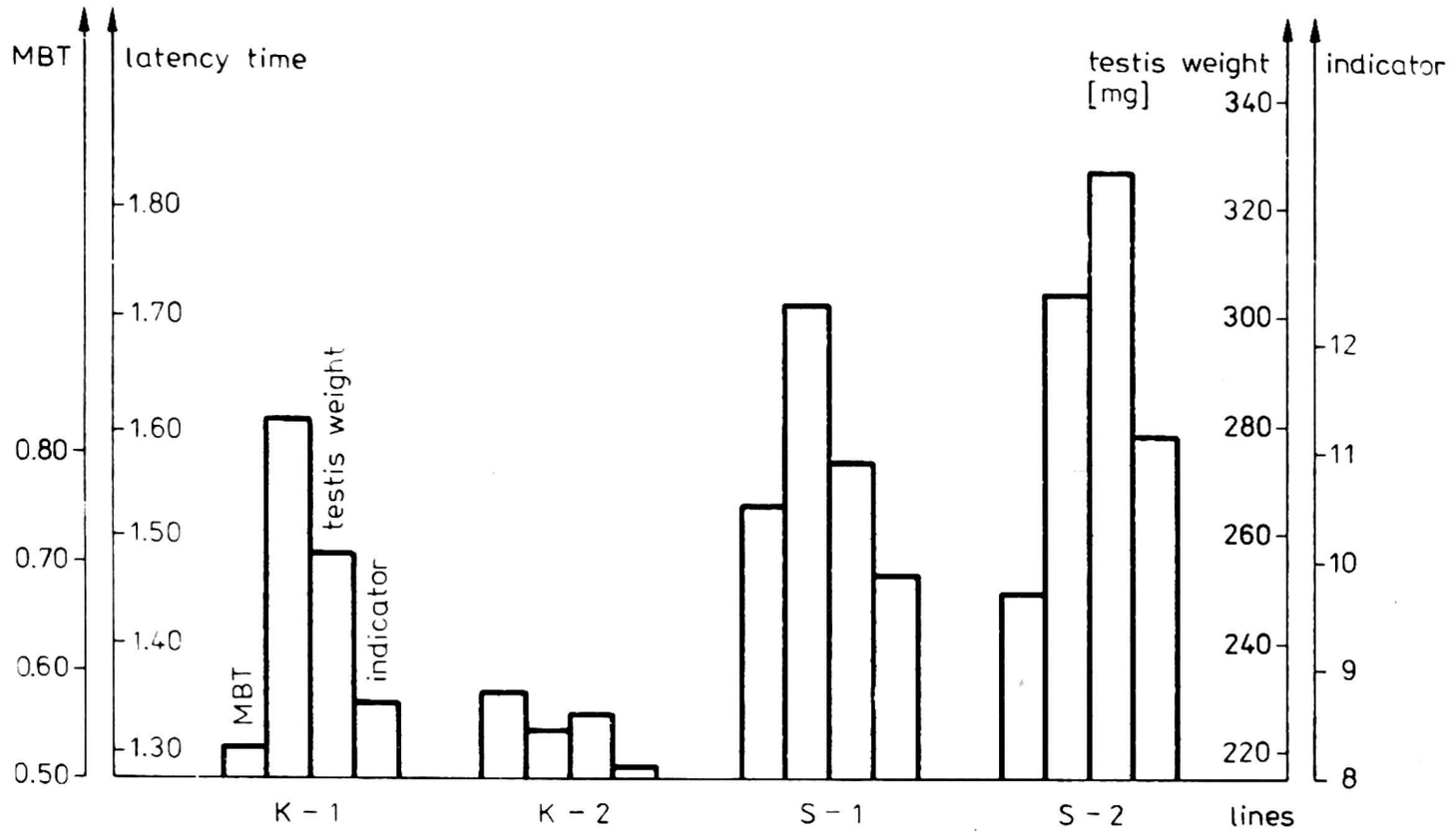

Fig. 2. Mean values of studied traits in males from 4 lines

whereas selection has not caused a correlated response concerning female fertility. Females of the line S-2 distinguished by the largest number of points scored during the MBT and by the shortest time of the maternal response latency; males of that line had the heaviest testae. Thus, an increase in the weight of the male testae in the

Table 3. Results of variance and covariance analysis of observed traits in females

Source of variation	df	Mean squares: No born alive y	Mean squares: Latency time x	$y \times x$	Correlation
		a) all females ($n=160$)			
Between lines	3	14.5377**	7.0089**	19.8998	0.0320
Error	156	3.4159	0.3568	−0.0842	
		b) without aggressive females ($n=155$)			
		y	MBT z	yxz	
Between lines	3	14.4536**	0.7407**	−1.1662	−0.2839
Error	156	3.3827	0.1378	−0.0539	

** statistically high significant $P \leqslant 0.01$

selection lines gave an indirect reaction expressed in larger maternal activity of females. No positive correlation was obtained in the reaction of fertility, i.e. no increase in the litter size was observed. Data from the literature (Islam et al. 1976)

inform only about correlation between the testis weight and ovulation rate. In turn, correlation between the number of ovulating egg cells and the number of born youngs in multipregnant animals is very low (Bradford 1969, Land et al. 1969 — in mice, Cunningham et al. 1979 — in swine), which explains to a certain degree the obtained results.

CONCLUSIONS

In the described selection experiment, females from the selection lines displayed better results in their behavioral traits, and males were observed to have a similar tendency. It may be suggested that there exists a correlated response to a selection in the direction of the testis weight concerning traits of maternal behaviour in females and that it may have a physiological basis.

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CHARAKTERYSTYKA ZACHOWANIA OPIEKUŃCZEGO MYSZY LABORATORYJNYCH Z DOŚWIADCZENIA SELEKCYJNEGO W KIERUNKU ZWIĘKSZENIA MASY JĄDER

Streszczenie

Przetestowano Testem Zachowania Matecznego 160 samic i 58 samców myszy laboratoryjnych z czterech linii XIII pokolenia doświadczenia selekcyjnego w kierunku zwiększenia masy jąder. Stwierdzono, że samice z linii selekcyjnych reagowały szybciej na podłożone oseski

wykonując więcej czynności w czasie TZM, niż samice z linii kontrolnych (różnice wysoce istotne). U samców wystąpiła podobna tendencja (nieistotna statystycznie).

Oszacowano korelacje fenotypowe między wynikami TZM, a cechami stanowiącymi kryterium selekcji samców oraz plennością samic.

ХАРАКТЕРИСТИКА ПОПЕЧИТЕЛЬСКОГО ПОВЕДЕНИЯ РОДИТЕЛЕЙ У ЛАБОРОТОРНЫХ МЫШЕЙ В СЕЛЕКЦИОННОМ ЭКСПЕРИМЕНТЕ, ПРОВОДИМЫМ С ЦЕЛЬЮ УВЕЛИЧЕНИЯ ВЕСА ЯДЕР

Резюме

160 самок и 58 самцов лабороторных мышей из четырёх линий поколения XIII селекционного эксперимента, проводимого в направлении увеличения веса ядер, было подвергнуто тесту материнского поведения (ТМП). Установлено, что самки селекционных линий быстрее реагировали на подложенные им сосунки и делали при этом больше движений, чем самки контрольных линий (высоко существенные разницы). У самцов выступила подобная тенденция, хотя не была она статистически существенна. Определены фенотипические корреляции между результатами ТМП и признаками, являющимнся критерием селекции самцов, а также между ТМП и плодовитостью самиц.