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The level of chinchilla reproductive traits in relation to the behaviour of females

Poziom cech reprodukcyjnych szynszyli w zależności od behawioru samic

Summary. The aim of the study was to estimate the relations between elements of chinchilla female behaviour and the level of reproductive traits. The observations involved 380 deliveries from 130 females of the breeding stock of chinchillas, var. standard. In order to assess the temperament of the animals, they were tested three times and subsequently classified into one of the following groups: confident and curious, reserved and curious, and withdrawn animals. The animal breeding value of reproductive traits was estimated in the study with the use of the BLUP method combined with the multi-trait repeatability animal model. The significance of the factors included in the model was previously verified with the multivariate analysis of variance. The additive value of the animals was used in determining the mean breeding value of the number of born and weaned kits in the 3 classes of the behaviour type observed in the particular tests. Irrespective of the type of the behavioural test, no significant differences in the breeding value of reproductive traits were observed among the differently tempered chinchilla females.

Key words: chinchillas, behaviour, BLUP, reproduction

INTRODUCTION

Chinchillas have been bred in cages for almost 90 years; yet the process of domestication has not been completed. Lanszki and Szepsi [1996] demonstrated the complexity of chinchilla behaviour. They claimed that despite the domestication process some primeval behaviour has persisted, which proves that chinchilla domestication has not been achieved as yet. Nevertheless, the changes in animal behaviour within subsequent generations imply gradual quelling of the innate fear of man. Lindsay [1996] concluded that a majority of farm animals live in an environment to which their genotype is not fully

adapted. Therefore, animal response to environmental conditions is predominantly determined by reproduction performance. According to Sulik and Seremak [2003], in chinchillas, likewise in many animal species, the care of offspring is a significant element of reproduction performance. Undoubtedly, it increases the offspring's chance of survival, and thus, of species survival. McBride [1980] reported that one of the levels of animal reaction to stress is a physiological response of the neuroendocrine system, accompanied by a behavioural response. This is manifested in decreased indices of growth and fecundity. Similarly, Broom [1997] demonstrated that behavioural reactions involve the psychic sphere and are highly correlated with the functions of physiological systems. Functional changes in the nervous system may result in lower reproductive performance.

Numerous authors observed an influence of behaviour and psyche on the reproductive usability in various fur-bearing animal species [Gacek 2002, Fortuńska *et al.* 2003, Dzierżanowska-Góryń and Kowalczyk 2005, Rozempolska-Rucińska *et al.* 2007, Ślaska and Jeżewska-Witkowska 2008]. Also, types of chinchilla behaviour that are suitable for optimal reproduction performance were described [Rozempolska-Rucińska *et al.* 2007, Ślaska and Jeżewska-Witkowska 2008]. However, a question arises: how does selection of the suitable type of behaviour affect the reproduction performance? Is elimination of animals with undesirable behaviour related to changes in the additive value of animal reproductive traits?

MATERIAL AND METHODS

The study material was provided by one of the fur-bearing animal farms in the Lublin region, where chinchilla (*Chinchilla lanigera*) var. standard were bred. The observations involved 380 deliveries from 130 females of the breeding stock. In the years 2005––2007 they were maintained in polygamous breeding in the ratio 1 : 4 with a permanent access to the male, and kept in standard bedding cages lit by artificial light only, with a 12 h light period and at approximate temperature 18°C (+/-2°C).

The data concerning the number of born (NBK) and weaned kits (NWK) were found in the farm breeding records. In the study population, most females delivered in the summer season (32.83%), slightly fewer – in the spring (27.78%) and autumn season (25.25%), and the smallest number of deliveries was observed in the winter (14.14%). As for the delivery sequence, 38.38% were females' first deliveries; the second and the subsequent deliveries constituted 25.76%, 18.69%, 11.11% and 6.06% of all the deliveries, respectively. No infertile females were found on the study farm. Females which raised all their kits constituted 71.21%, while the number of females delivering live kits and not rearing them and of aborting females was the smallest (5.56%). The number of chinchilla kits born by a dam in one delivery varied from 1 to 7, and of the weaned ones – from 0 to 5. The deliveries in which 2 kits were born constituted the biggest number (41.92%). Also, the deliveries with 2 weaned kits were a majority (47.47%). The smallest number was observed in the deliveries with 4 and more born and weaned kits. Almost 70% of the females had 3 to 7 kits per year. In 75% of the cases, the females raised 2 to 5 kits per year.

The animals were subjected to tests in order to determine their temperaments. The observations were performed between the 4th and 8th hour of the daylight. The chinchillas were examined with the subsequent tests:

– opening of the cage door (a sound-movement test) – this test had not been used in studying animal behaviour by then; it involved opening the door of each cage and observation of animals' reaction to the sound-movement stimulus,

– a feed test – a corn cob was placed in the open cages and the behaviour of the each female was observed,

– an empathic test – a stick with a ribbon tied to its end was placed in the cages of each female. The stick was inserted without opening the cage door and placed at the height of the facial part of the animal's head. The behaviour of the individuals in the presence of a strange object in the cage was observed.

Since all sanitary-veterinary treatment had been provided by the farm owner and evoked individual behaviour of the chinchilla females towards him, the tests were applied by a person who was unknown to the animals. It was assumed that introduction of an additional stressogenous factor – a stranger – will facilitate a more precise classification of females into the types of behaviour. A mild-tempered female was presumed to display mild behaviour even in new circumstances, while the aggression level in the new conditions should be higher than in those the animal is adapted to.

Table 1. Specification of factors* in trait calculation models
Tabela 1. Zestawienie czynników* w modelach obliczeniowych poszczególnych cech

Factor – Czynnik	Trait – Cecha		
	Type[a] – Typ[a]	NBK	NWK
Sequence of litters – Kolejność miotu	F	x	x
Delivery season – Sezon wykotu	F	x	x
Litter size – Liczebność miotu	C		x
Year × season of delivery Rok wykotu × sezon wykotu	F	x	x
Additive effect of an individual Addytywny wpływ osobnika	A	x	x
Effect of individual's specific environment Wpływ specyficznego środowiska osobnika	R	x	x

*significance of the particular factors was verified with the multi-factor variance analysis
*istotność poszczególnych czynników weryfikowano wieloczynnikową analizą wariancji
x – occurrence of the factor in the model for the analyzed trait
x – wystąpienie czynnika w modelu dla analizowanej cechy
Type[a] of the factor: A – random, connected with the relatedness matrix, R – random, F – permanent, C – covariance variable (regression)
Typ[a] czynnika: A – losowy powiązany z macierzą spokrewnień, R – losowy, F – stały, C – zmienna kowariancyjna (regresja)

On the basis of the observations of chinchilla behaviour in the tests, the females which showed a similar reaction to a given stimulus were classified into the following groups:

– confident, curious animals – females which came up to the object at once or were not scared by the sound of the opening cage door,

– reserved, but curious animals – females which showed interest within the first 60 seconds of the observation, i.e., individuals which approached the object or the open door after 20-60 seconds; they sniffed the object but did not bite it, or they came up to the cage door, but did not lean out,

– withdrawn animals – females which did not react to any of the stimuli; they were sitting on the shelf or in the cage corner only observing and not showing any interest.

In the study, the animal breeding value of reproductive traits was estimated with the BLUP method, using the DMU package [Madsen and Jansen, 2000]. Multi-trait repeatability animal models were employed, the factors of which are presented in Table 1.

The lineage included 514 individuals. Data from 380 deliveries were used in estimating the breeding value of reproductive traits. The additive value of the animals was employed in defining the mean breeding value of the number of born and weaned kits in the 3 classes of behaviour assessed in the particular tests. The system of the classification used is described in the first part of the Methods chapter. The significance of the differences between the mean BLUP values in the particular animal classes was verified by the analysis of variance with the least squares means.

RESULTS

The data presented in Table 2 indicate that the highest mean breeding value of fecundity and the number of weaned kits was observed in the reserved females. The breeding value of reproductive traits in the confident and withdrawn females was slightly lower. The feed test did not reveal significant differences in the mean breeding values of the analyzed traits in the females with different temperaments.

Table 2. The mean breeding value of reproductive traits (LSM) in relation to the type of behaviour in the feed test

Tabela 2. Średnia wartość hodowlana cech reprodukcyjnych (LSM) w zależności od rodzaju zachowania w teście żywieniowym

Rodzaj zachowania w teście żywieniowym Type of behaviour in the feed test	Udział procentowy zwierząt Percentage participation (%)	Liczba urodzonych młodych w miocie Number of born kits per litter		Liczba odsadzonych młodych w miocie Number of weaned kits per litter	
		LSM	SE	LSM	SE
Ufne Confident	64.65	1.052	0.079	0.856	0.064
Powściągliwe Reserved	16.67	1.152	0.110	0.922	0.089
Obojętne Withdrawn	18.68	1.077	0.115	0.870	0.093

The mean breeding value of the reproductive traits was the highest in the case of the confident females (Tab. 3). The breeding value of fecundity and the number of weaned

kits in the group of the withdrawn females was inconsiderably lower, and the lowest additive values were only noted in the case of reproductive traits in the reserved females. The empathic test did not show significant differences in the mean breeding values of the analyzed traits in the females with different temperaments

Table 3. The mean breeding value of reproductive traits (LSM) in relation to the type of behaviour in the empathic test
Tabela 3. Średnia wartość hodowlana cech reprodukcyjnych (LSM) w zależności od rodzaju zachowania w teście empatycznym

Rodzaj zachowania w teście empatycznym Type of behaviour in the empathic test	Udział procentowy zwierząt Percentage participation (%)	Liczba urodzonych młodych w miocie Number of born kits per litter		Liczba odsadzonych młodych w miocie Number of weaned kits per litter	
		LSM	SE	LSM	SE
Ufne Confident	47.47	1.148	0.092	0.932	0.075
Powściągliwe Reserved	25.25	0.968	0.115	0.793	0.093
Obojętne Withdrawn	27.28	1.093	0.089	0.875	0.071

The highest breeding value of the number of both born and weaned kits was observed in the group of the withdrawn females, while slightly lower additive values were observed in the group of the confident and reserved females (Tab. 4). The sound-move test did not demonstrate significant differences in the mean additive value of reproductive traits between the females with different temperaments.

Table 4. The mean breeding value of reproductive traits (LSM) in relation to the type of behaviour in the sound-movement test
Tabela 4. Średnia wartość hodowlana cech reprodukcyjnych (LSM) w zależności od rodzaju zachowania w teście dźwiękowo-ruchowym

Rodzaj zachowania w teście dźwiękowo-ruchowym Type of behaviour in the sound-movement test	Udział procentowy zwierząt Percentage participation (%)	Liczba urodzonych młodych w miocie Number of born kits per litter		Liczba odsadzonych młodych w miocie Number of weaned kits per litter	
		LSM	SE	LSM	SE
Ufne Confident	35.35	1.055	0.106	0.856	0.085
Powściągliwe Reserved	38.39	1.031	0.089	0.835	0.072
Obojętne Withdrawn	26.26	1.173	0.098	0.945	0.079

DISCUSSION

In their study, numerous authors [Fortuńska *et al.* 2003, Dzierżanowska-Góryń and Kowalczyk 2005, Rozempolska-Rucińska *et al.* 2007] demonstrate that breeders should aim at selecting confident animals, since mild-tempered females display higher reproduction performance than timid or aggressive females. However, according to other authors [Gacek 2002, Ślaska and Jeżewska-Witkowska 2008], exceptionally mild-tempered females are undesirable due to their lower fecundity and worse rearing of the offspring. The type of the behavioural test is an important factor which determines classification of animals into particular behaviour groups [Ślaska and Jeżewska-Witkowska 2008]. As concluded by Grandison [2005], behavioural traits are often difficult to observe and record on a big scale. By studying behaviour, one may identify the factors which affect kits' survival, and thus increase the chance to improve maternal behaviour by upgrading the environmental conditions. These considerations, however, involve phenotypic animal traits only; breeding, however, should be based on the genotypic rather than phenotypic ranking of animals.

The results obtained in the present study testify to the fact that, irrespective of the behavioural test used, the phenotypic classification of chinchillas into the particular groups cannot be useful in genetic improvement of reproduction traits in chinchillas. Selection aimed at obtaining a specific behaviour type in animals will not result in desirable upgrading of the additive value of reproduction traits.

Similar conclusions were drawn by various authors in the study on other animal species. According to Grandison [2005], maternal behaviour is essential in animal production. Environmental factors, which are crucial for survival and development of the offspring in numerous breeding animal species, greatly affect the behaviour. It is the maternal behaviour traits that play a significant role in survival and rearing of the offspring. Only a few of these traits are (to an insignificant degree) genetically conditioned, therefore their improvement through selection is difficult to achieve. Everett-Hincks *et al.* [2005] concluded similarly that sheep behaviour was only minimally genetically controlled. The heredity and repeatability coefficients for maternal behaviour were both 0.09. Heredity and repeatability of the litter were 0.0 and 0.11, respectively. Also, according to Gäde *et al.* [2008], behaviour traits in pigs are low-heredity genetic parameters. The heredity coefficient for belonging to the particular behavioural groups was 0.07. They also concluded that genetic improvement of sow's temperament may prove difficult.

Since the reproductive traits are characterized by low heredity [Rozempolska-Rucińska *et al.* 2006, Ślaska *et al.* 2007], improvement of the breeding value of reproduction traits in the stock may be obtained more easily by indirect selection. Maternal behaviour traits, which undoubtedly affect their reproduction performance, seem to be a useful factor in indirect selection aimed at upgrading of the breeding value of the reproductive traits. However, the present results demonstrate that chinchillas' behaviour may not be employed in the genetic improvement of their reproductive traits.

CONCLUSIONS

1. Irrespective of the behavioural test applied, no significant differences in the mean breeding value of reproduction traits were observed between the females with a different temperament. This implies lack of a behavioural test which could serve as one of the factors in indirect chinchilla selection aimed at improving the breeding value of reproduction traits in the stock.

2. By selection of a specific type of animal behaviour, regardless the behavioural test used, we will not obtain significant upgrading of the additive value of reproduction traits.

3. Phenotypic classification of chinchilla females into particular behavioural groups may not be useful in genetic improvement of their reproduction traits.

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Streszczenie. Celem pracy była ocena powiązań pomiędzy elementami behawioru samic szynszyli a poziomem cech reprodukcyjnych. Obserwacjami objęto około 380 wykotów od 130 samic stada podstawowego szynszyli odmiany standard. Zwierzęta poddano trzem testom, w celu określenia ich temperamentu, a następnie zakwalifikowano do jednej z grup jako: zwierzęta ufne i ciekawe, powściągliwe i ciekawe oraz zwierzęta obojętne. W pracy oszacowano wartość hodowlaną zwierząt pod względem cech reprodukcyjnych, wykorzystując metodę BLUP w połączeniu z wielocechowym, powtarzalnościowym modelem osobniczym. Istotność czynników uwzględnianych w modelu weryfikowano uprzednio wieloczynnikową analizą wariancji. Wartość addytywna zwierząt posłużyła do określenia średniej wartości hodowlanej pod względem liczby urodzonych i odchowanych młodych w 3 klasach, uwzględniających rodzaj zachowania w poszczególnych testach. Niezależnie od rodzaju testu behawioralnego nie zaobserwowano istotnych różnic średniej wartości hodowlanej cech reprodukcyjnych pomiędzy samicami szynszyli o różnym temperamencie.

Słowa kluczowe: szynszyle, zachowanie, BLUP, reprodukcja