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The effect of female age and subsequent number of litter on the number of standard chinchilla kits (*Chinchilla lanigera)* born and reared

Wpływ wieku samic, oraz kolejności miotów na liczbę urodzonych i odchowanych szczeniąt szynszyli odmiany standard (*Chinchilla lanigera)*

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Abstract

The objective of this study was to prove how the number of kits born and reared is affected by female's age and the subsequent number of whelping during a given year. Our research was carried out on a farm in Poland, with the use of 532 chinchilla females of the standard variety. Significant influence of the year and the females' age on the number of kits born and reared, as well as the subsequent number of litter in a given year on the number of chinchillas born was established. It was found that the largest litters occur with two-year old females; while there is a gradual decrease of prolificacy in older females. It was also observed that in females of any age the number of chinchilla kits born and reared was the highest in the first litter of a given year**.** The least numerous litters were found in mothers giving birth the third time in a given year.

Keywords: *Chinchilla lanigera*, number of animals born, number of animals reared, subsequent number of litter

Streszczenie

Celem pracy było wykazanie wpływu wieku matek oraz kolejnego wykotu w danym roku na liczbę urodzonych i odchowanych szczeniąt. Badania przeprowadzono na jednej z ferm w Polsce. Badaniami objęto 532 samice szynszyli odmiany standard. Wykazano istotny wpływ roku badań oraz wieku samic na wyniki dotyczące liczby urodzonych i odchowanych szczeniąt szynszyli oraz kolejności miotu w danym roku na liczbę urodzonych szynszyli. Stwierdzono, iż największe mioty dają samice w wieku dwóch lat. U starszych samic plenność stopniowo spadała. Zaobserwowano również, iż niezależnie od wieku samic najwyższą liczbę urodzonych i odchowanych

szczeniąt szynszyli odnotowano przy pierwszym miocie w danym roku. Najmniej liczne mioty natomiast wykazano u matek kocących się trzeci raz w danym roku.

Słowa kluczowe: *Chinchilla lanigera*, kolejność miotu, liczba odchowanych, liczba urodzonych

Szczegółowe streszczenie

W przedstawionej pracy podjęto badania mające na celu wykazanie wpływu wieku matek oraz kolejnego miotu w danym roku na liczbę urodzonych i odchowanych szczeniąt. Badaniami objęto 532 samice szynszyli odmiany standard. Wyniki dotyczące rozrodu (liczby urodzonych i odchowanych szczeniąt) analizowano u samic podzielonych w zależności od wieku na pięć grup: dwuletnie, trzyletnie, czteroletnie, pięcioletnie oraz sześcioletnie i starsze (7-mio, 8-letnie). W każdej grupie wiekowej brano pod uwagę kolejność miotu w danym roku (I, II, III). W obrębie grup dokonano charakterystyki statystycznej (obliczając średnią arytmetyczną oraz odchylenie standardowe) liczby urodzonych i odchowanych szczeniąt z trzech kolejno występujących miotów w ciągu badanych lat. Uwzględniając liczbę urodzonych szczeniąt w kolejnych miotach w danym roku oraz liczebności odsadzonych po około 49 dniach określono procent odchowu szynszyli. Dla liczebności urodzonych i odsadzonych szczeniąt w poszczególnych grupach, wykonano wieloczynnikową analizę wariancji wykorzystując model stały. Model uwzględniał efekty: rok badań, kolejność miotu w danym roku, wiek samic. W badaniach własnych największą średnią liczbę urodzonych, jak i odchowanych szynszyli uzyskanych od matek w ciągu trzech możliwych miotów w danym roku wykazano u samic dwuletnich. Stwierdzono, iż liczba urodzonych szczeniąt w miocie w ciągu roku zmniejszała się w zależności od wieku samicy od 4,2 u samic dwuletnich do 2,9 u samic sześcioletnich (P≤0.01). Podobnie jak w przypadku liczby urodzonych w miocie liczba szczeniąt odchowanych była niższa u matek starszych (P≤0.01). Najmniej liczne mioty wykazano u matek rodzących po raz trzeci w ciągu roku od 1,9 u samic dwuletnich do 1,5 u samic pięcioletnich. Biorąc pod uwagę liczbę odchowanych szynszyli zdecydowanie lepsze wyniki, wykazywały matki kocące się pierwszy raz w danym roku (1,6) najsłabiej odchowywały młode samice rodzące trzeci raz w ciągu roku (1,3). W badaniach wykazano istotny wpływ roku badań (P=0.01) i wieku samicy, (P=0.0002) na liczbę urodzonych oraz roku badań (P=0.005) i wieku samicy (P=0.003) na liczbę odchowanych szczeniąt w miocie, a także istotny wpływ kolejności miotu w danym roku (P=0.05) na liczbę urodzonych szynszyli w miocie. Wykazano również interakcję pomiędzy dwoma głównymi czynnikami tj.: rokiem badań i wiekiem samic P=0.007) dla liczby urodzonych i (P=0.02) dla liczby odchowanych. Stwierdzono również istotny wpływ kolejnego miotu w danym roku na liczbę odchowanych szczeniąt. Stwierdzono, iż spośród samic, które dały potomstwo w I miocie w danym roku tylko od 61-74% samic kociło się drugi raz, 24% dało miot trzeci. Najmniejszy odsetek samic kocących się po raz trzeci wykazywały matki sześcioletnie, bo zaledwie 7% w stosunku do pozostałych w swojej grupie wiekowej. Wykazano, że procent odchowanych szczeniąt zmniejszał się wraz z wiekiem matki (81% u matek dwuletnich, 67% u matek pięcioletnich).

Introduction

Chinchillas are polyestrous animals, meaning that more than one litter can be obtained from them a year. Due to long pregnancy (approximately 111 days), they use the so-called postpartum heat, which occurs 1-2 days after whelping, enabling them to give three litters during the same year. The litter size is a significant indicator of reproduction results on a farm in a given year. Chinchilla prolificacy compared to other animals is not high (Busso et al., 2005). During the heat period in chinchillas, approximately 4 eggs are formed, meaning that four young may be born (Barabasz, 2003; Quesenberry et al., 2004). Usually, a litter brings 1 to 2 young, while larger litters of 3-4 or more animals are rare (Socha and Wrona, 2000; Sulik et al., 2001; Socha and Kasjaniuk, 2003; Felska-Błaszczyk and Kaczmarek, 2006). Low prolificacy, if you consider the number of developed Graafian follicles (approximately 16) and eggs (4), probably results from high mortality of embryos caused, among other things, by E vitamin deficiency during the first two weeks of life (Busso et al., 2012). It is therefore reasonable to further examine the chinchilla reproduction processes and the factors which could largely improve female prolificacy on farms. This is why it has been decided a research was needed to prove the effect of dam's age and the subsequent number of litter in a given year on the number of kits born and reared.

Materials and methods

The research was conducted during the years 2015-16 on one of Polish chinchilla farms. The animals were fed on complete pelleted feed and hay as per the nutritional standards for chinchillas (Gugołek, 2011). The chinchillas were maintained in a closed shed, inside polygamous breeding cages arranged in five rows of constant microclimatic conditions, meeting the guidelines for chinchilla breeding (18-22 °C and relative humidity of 55-65%) (Ministry of Agriculture and Rural Development, 2010). The research included 532 standard chinchilla females. The reproduction results (number of kits born and reared) were analysed in females divided depending on their age into five groups: two-year-old, three-year-old, four-year-old, five-year-old, and six-year-old and older (7-year-old and 8-year-old animals). One-year-old dams were not taken into account as the reproduction period in these females started midyear, and therefore they could not achieve a third litter during the analysed period. This would render it impossible to compare reproduction results with data obtained on older females. In all age groups, it was noted which subsequent litter it was in a given year (I, II, III). Within the groups, statistic analysis was done (by calculating the arithmetic mean and standard deviation) for the number of kits born and reared in three subsequent litters over the course of the analysed years. Taking into account the number of kits born in subsequent litters in a given year and the number of kits weaned after 49 days, percentage of reared chinchillas was determined. For the number of kits born and weaned in each group, a multi-factorial analysis of variance using a fixed effects model was conducted. The model incorporated the following effects: year of analysis, subsequent number of litter, female age.

$$y_{ijkl} = \mu + R_i + S_j + P_k + (R^{\times}S)_{ij} + (R^{\times}P)_{ik} + (S^{\times}P)_{jk} + e_{ijkl}$$

where:

y_{ijk} – number of kits born alive, number of kits reared

μ – total mean

R_i – i effect – year

S_j – j effect – subsequent number of litter in a given year

P_k – k effect – age

$(R^xS)_{ij}$, $(R^xP)_{ik}$, $(S^xP)_{jk}$, – interactions between factors

e_{ijkl} – random error

The significance of differences with regard to the levels of the analysed factors was determined using Scheffe's test (Kot et al., 2011). All calculations were made using the Statistica PL.9.0 data analysis software system (StatSoft Inc., 2009), version 9.0, available from: www.statsoft.com.

Results

As can be seen from the data shown in Table 1 the highest mean number of chinchillas born in three litters achievable during a given year was found in two-year-old females. It was established that the number of kits born in a litter decreased during a year depending on female's age: in 2016, from 3.5 to 2.5; the following year, from 4.3 to 2.6; and totally, from 4.2 in two-year-old females to 2.9 in six-year-old females (P≤0.01) (Table 1). Similarly, as with the number of kits born in a litter, the number of kits reared was lower in older females (P≤0.01) (Table 1). The highest number of kits reared in a litter was found in two-year-old females, 3.4 animals in total (Table 1).

Table 1. The average number of puppies born and reared chinchilla variety standard of three litters received in 2015-2016

♀	2015			2016			Total		
age*	n	$\bar{x}$		n	$\bar{x}$		n	$\bar{x}$	
		a	b		a	b		a	b
2	62	3.5^{ABCD}	2.3^{ABC}	48	4.3^{ABCD}	3.5^{ABCD}	110	4.2^{ABCD}	3.4^{ABCD}
3	62	3.7^{AEFG}	1.8^{ADEF}	54	3.3^{AE}	2.4^{AE}	116	3.8^{AE}	2.9^{AEF}
4	64	3.2^{BEH}	2.8^{BDGH}	34	3.2^{BF}	2.5^{BF}	98	3.6^{BF}	2.7^{BG}
5	42	3.2^{CFG}	2.1^{CEG}	26	3.2^{CG}	2.8^{CEFG}	68	3.7^{CG}	2.5^{CE}
6>	80	2.5^{DGH}	2.3^{FH}	60	2.6^{DEFG}	1.9^{DG}	140	2.9^{DEFG}	2.4^{DFG}

$^{AA...}$Statistically significant differences at P≤0.01 occurring between female age groups (the same letters differ significantly); *age of females in years; a – born; b – reared; n – number of females; $\bar{x}$– arithmetic average.

Table 2. The effect of age and the subsequent number of litter in standard chinchilla on the number of kits born and reared

		Years					
		2015			2016		
♀ age*	Nl[1]	n	Born $\bar{x}$/Sd	Reared $\bar{x}$/Sd	n	Born $\bar{x}$/Sd	Reared $\bar{x}$/Sd
2	I	62	2.3^{A}±0.97	1.9^{F} ± 0.85	48	2.1^{N}± 0.76	1.7^{WV}± 0.83
	II	38	1.9^{A} ±1.08	1.7^{F} ± 1.16	30	2^{O} ± 0.93	1.3^{W} ± 1.04
	III	12	1.7^{A}±0.82	1.3^{F} ± 1.03	14	1.7^{NO} ± 1.15	1.3^{V} ± 1.53
3	I	62	2.3^{B}±0.86	1.7^{G} ± 0.82	54	1.9^{P}± 0.77	1.3± 1.04
	II	50	2^{B}±0.84	1.7^{JH} ± 1.03	36	1.6^{P}± 0.98	1.2± 1
	III	14	1.6^{B}±0.53	1.3^{GH} ± 0.75	10	2.1^{P} ± 0.71	1.2± 0.89
4	I	64	2^{C}±0.8	1.6^{I} ± 0.71	34	1.8^{R} ± 0.8	1.2^{Z} ± 0.88
	II	46	1.9^{C}±0.88	1.7^{J} ± 0.75	24	1.9^{S} ± 0.79	1.7^{Y} ± 0.9
	III	12	1.7^{C}±0.82	0.5^{IJ} ± 1.05	10	1.2^{RS} ±0.45	0.6^{Y} ± 0.55
5	I	42	2^{D}±0.67	1.6^{K} ± 0.67	26	1.7 ± 0.75	1.4^{Y} ± 0.87
	II	14	2.3^{D}±1.6	1.6^{L} ± 0.85	34	1.6 ± 0.52	1.2 ± 0.79
	III	6	1.3^{D}± 0.58	1.0^{KL} ± 0.9	10	1.6± 0.55	1.2 ± 0.84
6>	I	80	1.7^{E}±0.75	$1.6^{Ł}$ ± 0.84	60	1.4^{T} ± 0.6	1.1 ± 0.7
	II	46	1.9^{E}± 0.79	1.7^{M} ± 0.78	40	1.7^{TU} ± 0.9	1.1 ± 1.1
	III	6	1.1^{E}± 0.9	$1^{ŁM}$ ± 0.7	6	1.5^{U}± 0.7	1.1 ± 0.9

[AA...]Statistically significant differences P≤0.01 between successive litter within the female age for a number of age born and reared puppies; [1]number of litter subsequent number of litter in a year; *age of females in years; n–number of females; $\bar{x}$–arithmetic average.

As regards the subsequent number of litter in a given year, the highest mean number of kits were born in the first two litters. The only exception were six-year-old and older females, in which the second and third litter yielded the best results. The smallest litters were found in females giving birth for the third time during the same year: from 1.9 in two-year-old females to 1.5 in five-year-old females. In terms of the number of

chinchilla reared, much better results were achieved by females whelping for the first time in a given year (1.6); while the number of young reared by those giving birth for the third time proved to be the lowest (1.3) – Table 2.

Table 3. Statistically significant difference between the years for medium- born puppies in liter and reared puppies according: the age of females and subsequent litter

♀ age	Subsequent number of litter in a year	Born	Reared
	I	*	*
2-year-old	II		*
	III		
	I	*	*
3-year-old	II	*	*
	III	*	
	I	*	*
4-year-old	II		
	III	*	
	I	*	
5-year-old	II	*	*
	III	*	
	I	*	*
6>year-old	II	*	*
	III	*	

*Statistically significant differences between years of research for the born and reared puppies.

Better reproduction results were observed in the year 2016, which was proved statistically (P≤0.01) (Tables 2 and 3). Significant differences between female age groups in the number of kits born and reared within subsequent litters in a year were not found (Tables 2 and 3).

Our results prove the existence of a significant effect of the year of analysis (P=0.01) and female age (P=0.0002) on the number of animals born, as well as the year of analysis (P=0.005) and female age (P=0.003) on the number of kits reared in a litter, and also a significant effect of the subsequent number of litter in a year (P=0.05) on the number of chinchillas born in a litter. Furthermore, it was proved there is an interaction between two main factors, being the year of analysis and the female age (P=0.007), with respect to the number of kits born (P=0.02) and reared, while significant effect of the subsequent number of litter on the number of kits reared has not been found (Tables 3 and 4).

Table 4. F_{emp} value and the significance of the effect of the year of analysis, female age and the subsequent number of litter on the number of chinchilla kits born and reared

Factors	Born F_{emp} /P	Reared F_{emp} /P
Year of analysis	6.13/0.01	8.01/0.005
Subsequent number of litter in a year	2.98/0.05	1.69 0.19
Female age	6.86/0.0002	4.08/0.003
Year of analysis x subsequent litter in a year	2.14/0.12	0.16/0.85
Year of analysis x female age	4.14/0.007	3.16/0.02
Subsequent number of litter in a year x female age	1.05/0.39	0.85/0.56
Year of analysis x subsequent number of litter in a year x female age	1.39/0.22	0.76/0.6

Based on Figure 1, it can be said that among females that produced offspring in the 1st litter of a given year only 61-74% whelped for the second time, and the third litter was given only by approximately 24% dams. The smallest percentage of females whelping for the third time was found in six-year-old dams at merely 7% of all females in this age group. Analysing the results concerning the percentage of reared kits from a female, and taking into consideration the subsequent number of litter in a given year, high variations within age groups were observed. At the same time, it was established that the percentage of reared kits decreased with dam's age (81% in two-year-old dams; 67% in five-year-old females). On the other hand, a considerable increase in the number of reared young was noted in six-year-old and older females at 83% (Figure 2).

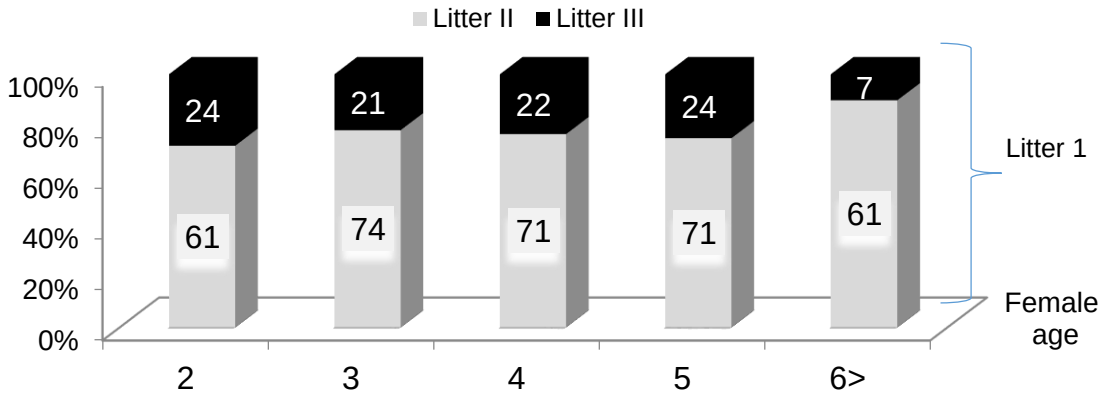
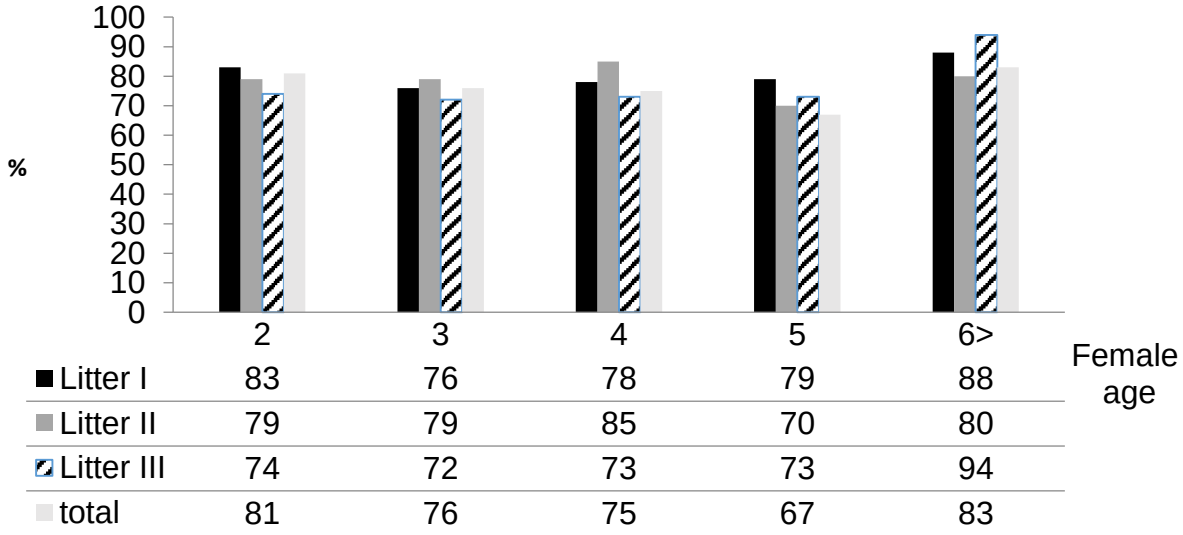


Figure 1. Percentage of females whelping II or III time within a year as compared to their first whelping



	2	3	4	5	6>
Litter I	83	76	78	79	88
Litter II	79	79	85	70	80
Litter III	74	72	73	73	94
total	81	76	75	67	83

Figure 2. Percentage of kits reared in females depending on their age and the subsequent number of litter in a year

Discussion

As our results have shown, the age of females has a very significant effect on the number of born and reared kits in a litter. The largest litters were obtained from females at the age of 2 years. It was observed that older females gave birth to a lower number of offspring. Similar results, at 4.09, were obtained by Ślaska et al., (2012). They proved that the highest prolificacy was present in dams giving birth to the third, fourth and sixth litters. According to numerous authors, the number of chinchilla kits born and reared varies depending on the female's age (Socha and Kasjaniuk, 2003; Felska-Błaszczyk and Kaczmarek, 2006; Ślaska et al., 2012). These authors observed that the smallest litters occur with one-year-old females; whereas dams at the age of two to five years have a higher number of chinchillas

born and reared. In their research on the effect of age and origin on certain reproductive performance indices in chinchilla, Felska-Błaszczyk and Kaczmarek, (2006) proved that among Polish chinchillas the best results are obtained from females at the ages of 1.5 to 2 years (2.07); while in Danish chinchillas of 2.5 to 4 years (2.05). Similar results were obtained by Frana et al. (2013). According to some authors (Felska-Błaszczyk and Kaczmarek, 2006), litter size is the largest in females which have been used for reproduction for over six years. Taking into consideration the results of Felska-Błaszczyk and Kaczmarek (2006) it can be said that females at the age of 7.5 to 8 years demonstrate a return to high prolificacy. However, the number of such females on a farm is relatively small compared to younger dams, and within this group there are some females with exceptional reproductive traits. As Mazurero et al. (2013) observed with regard to deaths among chinchilla kits at weaning, better rearing results were achieved by females for which the litter was not the first one in their lives (multiparas) – the mortality rate for these females was 4.1%. However, Socha and Kasjaniuk (2003), who analysed factors which effect the prolificacy of selected coloured varieties of the chinchilla, found significant negative correlations between dam's age and the number of offspring born (-0.18) and reared (-0.209). This confirms earlier observations that older females gave birth to and reared less young. During a single year, chinchillas are able to produce offspring three times, as confirmed by our own as well as other authors' results (Felska-Błaszczyk and Kaczmarek 2006; Ślaska et al., 2012). According to Socha and Kasjaniuk (2003), the subsequent number of litter in a given year has a significant effect on the number of animals born and reared. The said authors found a correlation between the subsequent number of litter and the number of kits born (-0.167) and reared (-0.153); whereas Ślaska et al. (2012) rule out the effect of the number of litters in a year on the female reproduction indices. Based on our own observations, it is fair to say that the best reproduction results are obtained by dams in the first litter of a given year, and the litter size gradually decreases in the subsequent litters. The worst results were observed in females whelping for the third time during a year. Moreover, it was established that among females who produced offspring in the year's 1st litter, 61-74% whelped for the second time; while the third whelping took place with 7 to 24% of dams. What is more, our results confirmed that this factor has a significant effect (P=0.05) on the number of animals born in a litter (Figure 1, Table 4). Analysing the number of reared kits, similar dependencies as in the case of the number of kits born were noted. The number of kits in a litter which were reared fluctuated between 3.4 and 2.4 (Table 1). The best rearing results were seen in young females, and then above the age of five years they started to decrease. Nyrek-Koczkodaj and Brzozowski (2006), who based their opinion on the results of research on chinchilla reproduction depending on the age of females used in reproduction for the first time, believe that females in the 2nd to 3rd year of reproduction were the best at rearing. Felskiej-Błaszczyk and Kaczmarek (2006) on the other hand, reported the best rearing results, both in Polish as well as Danish chinchilla, with the 7 to 8-year-old group (1.71), and the worst in Polish chinchilla at the age of 6.5 to 7 years, and Danish chinchilla at the age of 2.5 to 3 years of age (1.54). In our research the percentage of weaned kits decreased in all age groups in each subsequent litter of a given year. The lowest values were obtained for females whelping for the third time in a year.

Conclusions

It may be concluded that the female age and the subsequent number of litter both have a significant effect on the number of chinchillas born and reared. There is reason to question the point of a female being mated three times a year, as this is related to a considerable exertion of the body, and thus represents a heavy use of females. Even though with such low prolificacy in chinchillas, one does need to look for intensive reproduction use of females, two litters during one year will actually have a positive effect on reproduction results of females and will prolong the period of their use. It is important for a breeder to maintain females which give birth to and rear the highest number of young. Having a 3rd litter in a year results in a small percentage of reared kits, especially in older females. Our rearing results for six-year-old and older dams cannot be used as a pattern to be followed by breeders as the number of these females, especially at the third whelping, was low.

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