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Some Observations on the Japanese Field Vole, *Microtus montebelli* (MILNE-EDWARDS) in Captivity II

Reproduction and growth of voles according to size of litter

By

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Summary : One hundred and twenty-nine litters produced by 16 first-generation females of the Japanese field voles from the breeding stock collected at Sugadaira Plateau provided information on reproductive performance. On the other hand, twenty-five litters (51 males and 44 females) from wild voles caught at the bank of the Tone River were used for the study of the growth according to the size of litter.

The most frequent interval between successive pregnancies was 20～21 days, and the minimum interval between litters was 18 days.

The mean litter size was slightly larger in the first-generation females compared with in the wild-trapped females.

The third litter size tended to be the largest of litter orders, presenting an average of about 4.6 young. The number of young declined gradually in subsequent litters, dropping to an average of about 3.3 in the last litter of the series.

The average weight and all the dimensions at birth varied according to size of litter. They were greatest in small litters and declined gradually as the scale of litter size rose. Thereafter, only the body weight continued this tendency up to at least sixty days of age. The mean body weight of individuals from small litters and large litters averaged respectively 2.7 g and 2.4 g at birth, 18.2 g and 16.7 g at weaning, and 34.9 g and 28.8 g at sixty days of age.

Introduction

Postnatal growth and development of the Japanese field vole, *Microtus montebelli* (MILNE-EDWARDS), in captivity has already been reported by the author (NAKATSU, 1975). In order to carry out any experiment on this species, it is necessary to establish basic parameters of the population. This paper reports reproductive activity of the laboratory colony, with particular emphasis on gestation period and litter size. This study also involves the work on the comparative growth of litters of different sizes. In addition to establishing the basic population parameters, it is also necessary to know if some reproductive traits in this animal change under domestication. Therefore, this paper is further to compare the reproductive performance of the first laboratory generation with that of free-living wild voles.

Materials and methods

The original stock of voles whose first-generations were used as parents in this study derived from some pairs of *Microtus montebelli*, which were kindly offered me by Mr. M. SUZUKI

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Table 1. Age at which fiirst litter was born

Parents	Date of birth of parents	Date when first litter was born	Age of parents (days)	Litter size
Male	Apr. 24, 1973	Jun. 30, 1973	67	3
Female	Apr. 26, 1973		65	
Male	May 23, 1973	Jul. 19, 1973	57	3
Female	May 24, 1973		56	
Male	May 30, 1973	Jul. 28, 1973	59	6
Female	May 23, 1973		66	

and Dr. M. Abe who collected them from Sugadaira Plateau, Nagano Prefecture, Japan, in the spring of 1972. However, the voles whose progeny were used for the experiment of the comparative growth according to the size of litter were live-trapped by the present author at the bank of the Tone River, Chiba City, Japan, in the spring of 1976. These voles were kept under conditions identical with those in the previous experiments (Nakatsu, 1975). They were at all times fed on potatoes, sweet potatoes and cabbage trimmings, in addition to the same basic food as reported in the previous paper. Drinking water was supplied *ad lib.* by means of drop bottles. The lighting was made only in the daytime throughout the period of this experiment. All cages containing pregnant voles were carefully examined daily and all new litters were recorded. The litters were weaned at about twenty days of age and placed in separate cages. As shown in Table 1, at about forty days of age, the first generation parents became matured to be mated. Inbreeding was avoided by means of mating males and females of different litters from the other parents. The growth data of the voles according to litter size were taken at the age of birth, three days (sexing was possible at this age), twenty days (age of weaning), and sixty days (regarded as to be adult) respectively. And the methods for weighing and measuring the tail length and hind foot length of these voles were the same as in the previous work (Nakatsu, 1975). The measurements and weighing were all made by the author himself in order to maintain any personal error as constant. In reckoning age, the day of birth was considered as zero day.

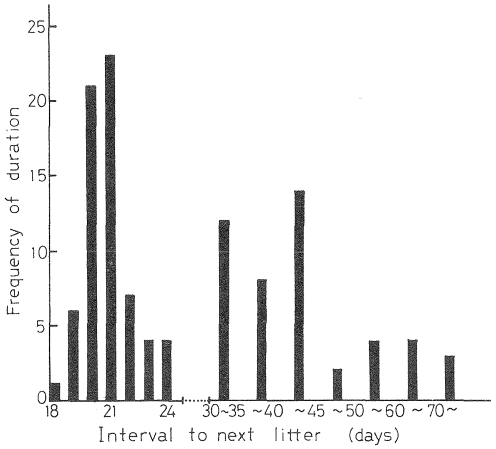

Fig. 1. Frequency distribution of durations between pregnancies.

Results

A. Interval between litters

One hundred and twenty-nine litters produced by 16 first-generation females provided information on the time interval between consecutive litters. The most frequent interval between successive pregnancies was 20~21 days, and it was almost the same interval as the gestation period for this species reported by Ranson (1934) and Shiraishi (1969), who showed that the normal gestation period was 21 days. As shown in Figure 1, the minimum interval between litters was 18 days. This figure supports the report by Shiraishi

(1975). In the present study the females were examined only once a day (9:30～10:30 a. m.) in most cases, so the interval between a parturition and the next parturition could be considered as a minimum interval with a possible error of +1 day.

B. **Litter size**

The litter size ranged from one to eight, with an average of 4.11 ± 1.49 (Table 2). The litter size from the wild-trapped parents ranged from one to eight, with an average of 3.87 ± 1.47, while, that of the first-generation parents from one to seven, with 4.19 ± 1.49 (Table 2). Figure 2 showed the number of litters used in the present study on reproductive performance. As shown in Figure 2 for the entire sample, the frequency distribution of the number of young per litter was actually normal. The mean litter size was slightly higher for the first-generation

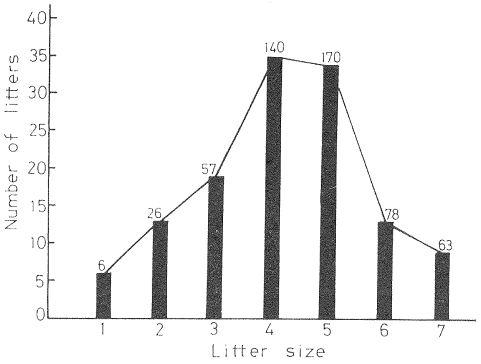

Fig. 2. Number of litters used in the present study. Total number of individuals were indicated above each bar.

Table 2. Frequencies of litter sizes in *Microtus montebelli*

Litter size	Wild-trapped	First-generation	Total
1	2	6	8
2	4	13	17
3	9	19	28
4	14	35	49
5	5	34	39
6	3	13	16
7	1	9	10
8	1	0	1
Total	39	129	168
Average	3.87±1.47	4.19±1.49	4.11±1.49

Table 3. Consecutive litter sizes of adult females in the laboratory

Litter order	No. of litters	Mean litter size	Range
1	16	3.9	1～6
2	16	4.3	1～7
3	16	4.6	2～7
4	12	3.7	2～6
5	11	4.5	2～6
6	9	4.4	3～7
7	8	4.4	3～5
8	6	4.2	1～7
9	6	4.3	2～6
10	6	4.2	1～6
11	6	3.3	2～4

Table 4. Record of succesive litters in *Microtus montebelli*

Litter order	Date of birth	Intervals between litters (days)	Litter size
1	Dec. 10, 1972	0	4
2	Dec. 28,	18	5
3	Jan. 17, 1973	20	5
4	Feb. 6,	20	4
5	Mar. 9,	31	4
6	Mar. 29,	20	7
7	Apr. 18,	20	4
8	May 9,	21	7
9	May 30,	21	5
10	Jun. 21,	22	5
11	Jul. 10,	19	4
12	Jul. 31,	21	5
13	Aug. 30,	30	5
14	Sep. 19,	20	7
15	Oct. 10,	21	6
16	Nov. 20,	41	6
17	Dec. 11,	21	3
Total		366	86

Table 5. Comparison of growth according to litter size

Range (litter size)		Small (1～2)	Medium (3～5)	Large (6～7)
No. of litters (Male, Female)		5 (4, 4)	15 (32, 24)	5 (15, 16)
Body weight	0 age in days	2.7 g	2.5 g	2.4 g
	3	3.8	4.1	3.8
	20	18.2	18.0	16.7
	60	34.9	31.2	28.8
Weight gain	(3～20 days)	14.4 g	13.9 g	12.9 g
	(3～60 days)	31.1	27.1	25.0
Tail length	0 age in days	8.8 mm	8.2 mm	7.9 mm
	3	10.9	11.0	10.5
	20	31.7	34.7	33.2
	60	41.2	40.3	40.3
Tail length gain	(3～20 days)	20.8 mm	23.7 mm	22.7 mm
	(3～60 days)	30.3	29.3	29.8
Hind foot length	0 age in days	7.0 mm	6.6 mm	6.5 mm
	3	8.3	8.5	8.1
	20	17.2	18.2	17.7
	60	18.5	18.7	19.0
Hind foot length gain	(3～20 days)	8.9 mm	9.7 mm	9.6 mm
	(3～60 days)	10.2	10.2	10.9

parents than for the wild-trapped parents. This difference, however, was not significant under the level of 95 per cent confidence.

Litter size may be influenced by the number of pregnancies in the reproductive life and by the physiological condition of the female. In many species it has been observed that litter size increases with the number of pregnancies to the largest value, then remains constant, and again eventually declines toward the end of reproductive life (King, 1924; Tomita *et al.*, 1976). In the adult field voles raised in this laboratory, a similar trend was observed (Table 3). An increase in average litter size was obvious in the first three litters. The mean size of the fourth litter decreased to 3.7, but the higher mean litter size (4.5) was attained in the fifth litter. The average size of the sixth through the eleventh litter decreased slightly. However, the effect of sequence of pregnancy on litter size was not significant in this group of females. This decrease was not in particular prominent in the group of continuous litters (Table 4). But, Table 4 gives an instance of the data from only one female. The author could not determine whether the wild-trapped females had yielded young before they were captured, so he was unable to state the real number of pregnancies per female in this wild-trapped group.

C. **Growth according to litter size**

The weight according to size of litter was shown in Table 5. The average weight at birth of the 95 voles was 2.5 g. This table showed that the average weight at birth was greatest in small litters and decreased continuously as the scale of litter size rose. This tendency was similarly shown in the tail length and the hind foot length. Both at weaning (20 days of age) and at getting to the age of adult (60 days of age), only the body weight kept this tendency. The average weight at weaning and at sixty days of age were 17.6 g and 32.2 g respectively.

Discussion

Data on the gestation period obtained from one hundred and twenty-nine litters were presented in Figure 1. It was shown that breeding pairs most frequently produced a next litter within 20～21 days, then within 30～45 days, while some others produced irregularly. Delany (1972) has suggested that caging breeding pairs for a long period could lead to irregular litter intervals. In this paper precise length of gestation period from coitus could not be obtained, but it was supposed that these figures were somewhat shorter than the periods given for other species of the genus. Hatfield (1935), Hamilton (1941) and Ranson (1941) gave those of *M. californicus*, *M. pennsylvanicus* and *M. agrestis* as 21 days.

Although the difference in average litter size between the wild-trapped stocks and the first-generation stocks was not significant, the first-generation parents tended to have slightly larger litters than the wild-caught parents. However, if the litter order of the wild-trapped females before their capture can be determined and if the first litters are eliminated from the data and the litter size of original and first-generation mothers in lactating and nonlactating states compared, the effect of domestication and lactation on litter size may be more accurately expected. Thus, when the wild-caught animal is suddenly brought into captivity and confronted with a condition of new environmental stimuli different from those in nature, activity may be reduced and physiological condition may be obliged to change in the early part of experiments. But, when they have lived in the laboratory for a long time, they will become accustomed to the new environment and be able to exhibit their ability to some extent.

Table 3 shows a result of a little different from the facts that the second litter tended to be the largest of the series in albino rats (SLONAKER and CARD, 1923; IMAMICHI and HONDA, 1965) and mice (PARKES, 1924; MURRAY, 1934), the fifth litter for *M. montanus* (NEGUS, 1965), then beyond this point there was a gradual decline in the number of young. In this experiment, the largest size of the series was found at the third litter. This result was the same as the report of TOMITA (1976). As stated by several observers (NOBUNAGA *et al.*, 1965; IMAMICHI and HONDA, 1965; NORMAN, 1965; TOMITA *et al.*, 1976), litter size is affected by the age, but in the present work the age has not been considered because of the small sample size.

In general, the weight of a polytocous animal must be dependent upon the mother's nutrition to a great extent during the period of foetuses through lactation. This difference in nutrition must have an influence upon the weight of the young, and the degree will be inversely proportional to their number. Table 5 showed the tendency that body weight and all the dimensions of this species at birth were greatest in small litters and declined gradually accompanied by the increase in litter size. This trend was found continuously only in the average weight until the age of sixty days, and not in the tail length and the hind foot length. Litter size may be influenced by some physical conditions of the female. But these factors were not analysed in the present work.

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References

1) DELANY, M. J. : The ecology of small rodents in tropical Africa. Mammal Review, **2**, 1, 1～42, (1972)

2) HAMILTON, W. J. : The reproduction of the field mouse, *Microtus pennsylvanicus*. Cornel Univ. Agr. Exp. Sta. Mem., 237, 1～23, (1941)

3) HATFIELD, D. M. : A natural history study of *Microtus californicus*. J. Mammal., **16**, 4, 261～271, (1935)

4) IMAMICHI, T. and K. HONDA : The relation between litter order and litter size in Wister-Imamichi rat (in Japanese). 12 th Ann. Meet. Exp. Anim., **14**, 3, 122～123, (1965)

5) KING, H. D. : Litter production and the sex ratio in various strains of rats. Anat. Rec., **27**, 5, 337～366, (1924)

6) MURRAY, W. S. : The breeding behavior of the dilute brown stock of mice. Am. J. Cancer., 20, 573～593, (1934)

7) NAKATSU, A. : Some observations on the Japanese field vole, *Microtus montebelli* (MILNE-EDWARDS) in captivity I. Postnatal growth and development. Bull. Gov. For. Exp. Sta., 276, 23～29, (1975)

8) NEGUS, N. C. and A. J. PINTER : Litter size of *Microtus montanus* in the laboratory. J. Mammal., **46**, 3, 434～437, (1965)

9) Nobunaga, T., Nakamura, K., Yoshida, Y., Shintani, S. and T. Kitano : Influence of age and litter order size in the mice (in Japanese). 12 th Ann. Meet. Exp. Anim., **14**, 3, 122, (1965)

10) Parkes, A. S. : Fertility in mice. J. Exp. Biol., **2**, 1, 21～31, (1924)

11) Ranson, R. M. : The field vole (*Microtus*) as a laboratory animal. J. Anim. Ecol., 3, 70～76, (1934)

12) ——————— : Prenatal and infant mortality in a laboratory population of voles. Proc. Zool. Soc. (London), A, III, 45～57, (1941)

13) Shiraishi, S. : The growth of the Japanese field vole, *Microtus montebelli* (in Japanese). Trans. 80 th ann. Meet. Jap. For. Soc., 259～260, (1969)

14) ——————— : Some notes on a breeding experiment of the Japanese field vole, *Microtus montebelli*, in captivity (in Japanese). Zool. Mag., **84**, 4, 462, (1975)

15) Slonaker, J. R. and T. A. Card : Effects of a restricted diet IV. On the age of greatest productivity. Amer. Jour. Phys., **64**, 2, 203～209, (1923)

16) Tomita, S., Hayao, T., Uchida, H. and T. Sawada : Lifetime reproductive performance and lifespan of SPF C 3 H mice reared under a single pair mating system (in Japanese with English abstract). Exp. Anim., **25**, 3, 135～140, (1976)

飼育下における日本産ハタネズミの研究　II
繁殖および1腹産子数別成長について

中　津　　篤(1)

摘　要

野ネズミが森林に及ぼす被害の大きいことは，北海道のエゾヤチネズミの被害例を初めとして，本州，九州のハタネズミおよび四国のスミスネズミの被害が挙げられる。エゾヤチネズミに関してはその研究の歴史も古く，被害の防除に貢献をしているが〔上田　明一ほか9名—「エゾヤチネズミ研究史」(1966)〕，ハタネズミに関してはスミスネズミを含め，ある程度個体群的に取り扱われてはいるものの断片的で，個体生態学的研究はほとんどなされていないのが実情である。著者は加害鼠であるハタネズミについての基礎的研究の必要性を感じ，まず人工飼育条件下で繁殖したハタネズミの仔獣を材料にして，その繁殖状態さらには前回報告〔中津（1975)〕のデータを発展させて，1腹産子数別における成長のちがいについてしらべた。繁殖（とくに連産性と1腹の子供の数）と成長は野外における個体群の変動の基礎母体となっていると考えられるため，本種の発生予察法の確立の基礎的資料として重要と考えられる。

1972年5月に長野県菅平で捕獲したハタネズミ *Microtus montebelli* (Milne-Edwards) 12つがい（雌雄各12頭）を，20～25℃の一定温度条件下で約1年間繁殖させ，その仔獣（飼育第1世代目）32頭（雌雄各16頭）を任意に組み合わせ16つがいをつくり，それから産出させた129腹（540頭）の繁殖例（飼育第2世代目）にもとづいて，分娩間隔，1腹産子数などの繁殖状態をしらべた。

また1976年5月に，千葉県利根川河川敷より採集したハタネズミ8つがい（雌雄各8頭）については，それらが約5か月間に出産した25腹（雌44頭，雄51頭—飼育第1世代目）を材料とし，1腹当りの産子数別の成長のちがいを比較検討した。

菅平産の飼育第1世代16つがいの繁殖例（129腹）からえられた分娩から分娩に至るまでの最小間隔は18日，最大間隔は165日で最も頻度の高い分娩間隔は20～21日の間に集中した（Fig. 1)。1腹産子数の大きさについては，飼育第1世代による産子数4.19頭（129腹平均）は野外産の飼育下における産子数3.87頭（39腹平均）に比較して大きい傾向を示した（Table 2)。また，産次回数別の産子数をみると，初産3.9頭（16例平均)，第2産4.3頭（16例平均)，第3産4.6頭（16例平均）となり，第3産目が最高でそれ以後はわずかながら減少の傾向を示した（Table 3)。

千葉県産8つがいの繁殖例（25腹）からえられた1腹産子数別の仔獣の成長のちがいをみると，生時においては1腹産子数が小（1～2頭)，中（3～5頭)，大（6～7頭）と多くなるにつれ，体重が2.7 g（小—5腹平均)，2.5 g（中—15腹平均)，2.4 g（大—5腹平均)，尾長が8.8 mm（小)，8.2 mm（中)，7.9 mm（大）および後足長が7.0 mm（小)，6.6 mm（中)，6.5 mm（大）と各々小さくなる傾向がみられた。その後の成長では，体重の場合においてのみ哺乳期（生時から約20日齢まで)，離乳期（約20日齢）を通じて，全般的に生時と同様の傾向がそのままつづき，増体重は1腹当りの産子数が多くなるにつれて小さくなった。尾長，後足長の成長については，体重のような傾向はみられなかった（Table 5)。

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(1) 保　護　部