Variations of the Number of Embryos in *Microtus montebelli* (MILNE-EDWARDS)*

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ABSTRACT.—The distribution of embryos in uterine horns, seasonal changes of body weight in pregnant females, and relation between the number of embryos, body size and age of pregnant females, micro-habitat and season were described in *Microtus montebelli*. Number of specimens, which were collected on rice field, rice field in fallow and young plantation, was 84. There was no statistically significant deviation from a random distribution of embryos within the uterus. The average body weight of pregnant females subtracting the weight of embryos was not significantly different during a year. The average number of embryos increased from class 6 to 8 and decreased from class 9 to 11 in age-group of pregnant females. There was a tendency that the average body weight of pregnant females increased with the increase of the number of embryos at the same class in age-group. The number of embryos in the same weight of pregnant females on levees was larger in September than in May. A comparison between two neighboring October populations showed that the number of embryos in the same body weight was larger on rice field in fallow than in young plantation. It is suggested in this vole that the differences of food quality brought about the variation of the number of embryos of the same age and body size of pregnant females in different micro-habitats in the same season and/or in different seasons in the same micro-habitat.

Introduction

It has been well known that the number of embryos or litter size varies with season, year, body size, population density, habitat, altitude and latitude. Several papers have been published in *Microtus* from wild populations in Europe and North America on the variation of the number in relation to age, season, year, habitat, body size and latitude (JAMESON, 1947; BEER *et al.*, 1957; BEER & MACLEOD, 1961; KOTT & ROBINSON, 1963; NEGUS & PINTER, 1965; TAST, 1966; EVANS, 1973). In the Japanese field vole, *Microtus montebelli*, however, few works have been carried out on the variation of the number of embryos, except the following papers: the number changed with season during a year in a locality in Japan (MIYAO *et al.*, 1966; SHIRAISHI, 1967; ABE, 1974; KANEKO, 1976) and with habitats in neighboring October populations in a year (KANEKO, 1978b).

The present purpose of this paper is to describe the distribution of embryos in uterine horns, seasonal changes of body weight in pregnant females, and the relations between the number of embryos, body size and age of pregnant females, micro-habitat and season in the Japanese field vole, *Microtus montebelli* (MILNE-EDWARDS).

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Materials and Methods

In this study 84 specimens of the Japanese field vole were taken on rice field, rice field in fallow and young plantation in the following five localities in Japan: Morioka, Iwate Pref.; Ryōzu, Niigata Pref.; Iwakura, Kyoto Pref.; Jinseki and Kurome, Hiroshima Pref.; and Fukuoka, Fukuoka Pref. The specimens caught at Iwakura, Jinseki and Kurome were the same as previously described in KANEKO (1976, 1978a & b). The specimens were captured by snap-traps with pumpkin seeds as bait. All females were weighted and their body sizes were measured. The number of visible embryos in both horns of the uterus was counted with the naked eye, and the total weight of embryos was measured including the foetal membranes and uterus. Body weight subtracting the weight of embryos was used as that of each pregnant female.

The class in age-group of pregnant females was determined by the morphology of occipital process and ridges, which was described in the previous paper (KANEKO, 1978a).

Since there was a good correlation between body weight and the length of head and body (KANEKO, 1978a), body weight of pregnant females was used as body size.

Results and Discussion

1) Distribution of embryos in uterine horns

The number of visible embryos in 40 voles ranged from two to nine in the 1971–72 collections of Iwakura, Kyoto. The incidence of unilateral pregnancy was 7.5 % (3/40) and two specimens were left side pregnancies and one was right side. The proportion of bilateral pregnancies with equal numbers of embryos in both horns was 15.0 % (6/40). There was no significant deviation from a random distribution (Poisson distribution) of embryos within the uterus, according to a x^2 test as shown in Table 1

Table 1. The distribution of embryos between left(Lt) and right (Rt) uterine horns of *Microtus montebelli* at Iwakura, Kyoto, 1971–72.

Difference in nos. of embryos between horns	No. of voles Distribution between horns		Observed (total)	Expected no. (m)	$\frac{x^2}{m}$
	Lt>Rt	Rt>Lt			
0	(6)		6	8.2	0.590
1	8	7	15	13.0	0.308
2	5	6	11	10.3	0.379
3	4	3	7	5.4	0.474
4	0	0	0	2.2	2.200
5	1	0	1	0.9	0.011
					$x^2=3.962$

x, =difference between the observed and expected number of animals. Variance (s^2)=0.653.

($0.25<p<0.5$). The same finding was obtained in *M. montebelli* in Fukuoka Pref. by SHIRAISHI (1967) and in *M. pennsylvanicus* and *M. ochrogaster* by CORTHUM (1967).

2) Seasonal changes of body weight in pregnant females

In the 40 specimens of Iwakura, Kyoto, 1971–72, the smallest weight of pregnant

Table 2. Seasonal changes of body weight of pregnant females in *Microtus montebelli* at Iwakura, Kyoto, 1971–72.

Month	N	Range (g)	Mean±SE (g)
May	7	32.5−38.9	36.13± .98
Sept.	14	29.9−41.5	35.93± .83
Nov.	7	27.7−38.5	32.26±1.50
Jan.	3	22.6−29.2	25.27±2.00
Mar.	8	26.0−37.1	33.04±1.25

females was 22.6 g in January, and the largest was 41.5 g in September (Table 2). The average monthly weight of the females varied from 25 g to 36 g. The average weight was nearly equal through a year except January, when the weight was the lowest. Although the average number of embryos differed statistically among months except between March and May (KANEKO, 1976), the average weight was not significantly different among six months. The mean body length of pregnant females did not change seasonally through the breeding season in *Clethrionomys andersoni* and *Apodemus argenteus* (MIYAO, 1969).

3) The number of embryos against classes in age-group of pregnant females

The visible embryos appeared at class 6 in age-group in the Iwakura population, Kyoto, 1971–72. The average number of embryos increased from class 6 to 8 and decreased from class 9 to 11 during a year (Table 3), though the difference between

Table 3. The number of embryos under various classes in age-group in *Microtus montebelli* at Iwakura, Kyoto, 1971–72. The statistical difference between class 8 and class 6 was $0.2 < p < 0.3$ and the difference between other classes except class 11 was $p > 0.6$.

Classes in age-group	No. in different number classes of embryos									No. of embryos (Mean±SE)
	2	3	4	5	6	7	8	9	Total	
6	1	1	2	7		1			12	4.6± .4
7	1	1		4		1		2	9	5.6± .8
8			2		1			1	4	5.8±1.2
9			2	2	2	2			6	5.2± .5
10										
11			1						1	4

classes except class 11 was statistically insignificant. NEGUS & PINTER (1965) demonstrated in *M. montanus* that the litter size increased gradually through the fifth consecutive litter and decreased the following litter.

A comparison of the number of embryos at the same class in age-group showed that the large number occurred in September, while the small one was found in January (Fig. 1). Therefore, the number of embryos at the same class in age-group of pregnant females changed with seasons.

4) Relationship between the number of embryos and weight of pregnant females

In Fig. 2 the number of embryos is plotted against the increase of body weight of pregnant females in different months at Iwakura, Kyoto, 1971–72. There was a

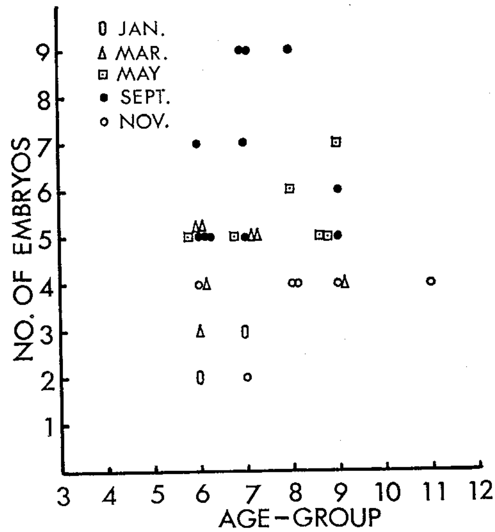

Fig. 1. Scatter diagram of the relationship between class in age-group and the number of embryos in *Microtus montebelli* at Iwakura, Kyoto, 1971–72.

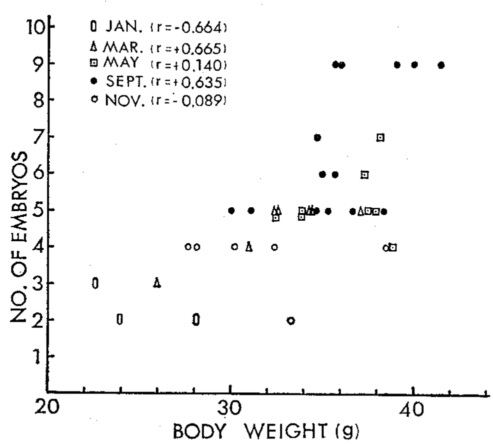

Fig. 2. Scatter diagram of the relationship between the number of embryos and body weight of pregnant females in *Microtus montebelli* at Iwakura, Kyoto, 1971–72. Body weight subtracting the weight of embryos was used as that of pregnant females. The coefficient of correlation (r) in each month was shown in this figure.

good relation between the weight of mothers and the number of embryos in all the samples during a year (r=0.647). There was not so apparent correlation between the two in each month (Fig. 2), except in September ($0.01<p<0.02$). Heavier females with large number of embryos were observed in September, while lighter female with small number of embryos occurred in January.

The average body weight was caluculated in each number class of embryos at

Table 4. Mean body weight of pregnant females in different number classes of embryos under various classes in age-group in *Microtus montebelli* at Iwakura, Kyoto, 1971–72.

Classes in age-group	Mean* body weight (g) in different number classes of embryos								Mean±SE
	2	3	4	5	6	7	8	9	
6	29.2	26.0	29.1	33.7		34.6			32.00± .97
7	33.0	22.6		34.7		35.6		40.3	35.01±1.85
8			31.3		37.4			39.1	34.98±2.23
9			36.3	33.9	35.4	38.2			35.72± .68
10									
11		38.5							38.5

* Number of specimens was given in Table 3.

the same class in age-group (Table 4). There was a tendency that the average increased with the increase of the number of embryos at the same class in age-group. According to BEER et al. (1957), there was a steady increase in number of corpora with increase in body length. Furthermore, they showed that the total intrauterine loss varied inversely with the size of females in *M. pennsylvanicus* and *C. gapperi*. Therefore, the number of embryos at the same class in age-group increased with the increase of body size.

5) The number of embryos in different micro-habitats

The number of embryos changed seasonally in four different micro-habitats on cultivated land at Iwakura, Kyoto, 1971–72 (Table 5). The difference of average number of embryos between different micro-habitats was the largest in September among five months, though the difference was statistically insignificant in September ($0.1 < p < 0.2$). In September the vegetation of levees in fallow lands was composed mainly of *Polygonum thunbergii, Commelina communis* and *Cyperus microiria*, and *Glycine max* was planted on several levees. Three pregnant females were taken on fallow land in January (Table 5), when fallow land was densely overgrown with withering *Solidago altissima* in about 2 m height, and young *Solidago altissima*

Table 5. The number of embryos in various micro-habitats in different months in *Microtus montebelli* at Iwakura, Kyoto, 1971–72. Each figure represents number of embryos of each pregnant female collected in each micro-habitat. Number in parentheses shows the average number of embryos.

	Fallow lands densely overgrown with *Solidago altissima* ....A	Grass-grown levee in fallow land ....B	Levee in rice field C	Agricultural road ....D
May	4, 5, 7 (5.3)	5, 6 (5.5)	4, 5 (4.5)	5
Sept.		6, 7, 9, 9 (7.8)	5, 5, 5, 5, 5, 5, 6, 9, 9 (6.0)	7
Nov.	2, 4 (3.0)	4, 4 (4.0)	4, 4, 4 (4.0)	
Jan.	2, 2, 3 (2.3)			
March	5		3, 4, 4, 5, 5, 5 (4.3)	5

sprouted at the base of the withered roots.

From Table 6, it is likely that the average number of embryos in different micro-habitats on rice field in fallow did not so greatly vary in May, June, August and October in several localities in Japan.

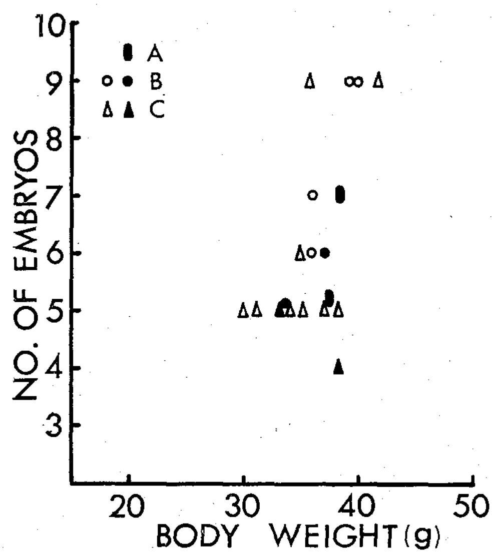

Fig. 3. Scatter diagram of the relationship between the number of embryos and body weight of pregnant females in *Microtus montebelli* in different micro-habitats at Iwakura, Kyoto, 1971–72. A; fallow land densely overgrown with *Solidago altissima*, B: Grass-grown levee in fallow land, C: Levee in rice field. Open symbols represent specimens in September, and solid ones show specimens in May.

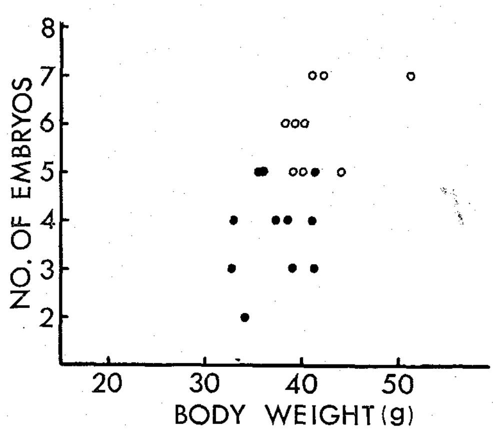

Fig. 4. Scatter diagram of the relationship between the number of embryos and body weight of pregnant females in *Microtus montebelli* in neighboring October populations, Hiroshima Pref., 1972. Open circles represent females on rice field in fallow and solid ones show females in young plantations.

Table 6. The number of embryos of *Microtus montebelli* in various micro-habitats in different localities in Japan. Each figure represents number of embryos of each pregnant female collected in each micro-habitat. Number in parentheses shows the average number of embryos.

Locality	Month	(A) Fallow land densely over-grown with grasses	(B) Grass-grown fallow land except A	(C) Levee in fallow land	(D) Levee	(E) Agricultural road	(F) Ridges of vegetable field	Mean±SE	N
Morioka	May–June, 1973	6	4, 4, 5, 5, 6 (4.8)	4, 5, 5, 5, 5, 5 (4.8)	4, 5, 6 (5.0)			4.9±.7	15
Ryōzu	August, 1971				3, 3, 4, 4, 5, 5, 5 (4.1)	3, 5 (4.0)		4.1±.3	9
Jinseki	October, 1972	7		5, 5, 5, 6, 7, 7 (5.8)	6	6		6.0±.3	9
Fukuoka	May, 1973				5, 6, 7 (6.0)		3, 5, 6, 6, 6, 6, 6, 8 (5.8)	5.8±.4	11

Since the number of embryos at the same class in age-group increased with the increase of body weight (Table 4), comparisons of the number in the same weight were made among different micro-habitats (Fig. 3). The number in the same weight on levee was larger in September than in May (B & C in Fig. 3). It follows that the number of embryos in the same weight of pregnant females collected in the same micro-habitat changed with seasons.

In the previous paper (KANEKO, 1978b), habitat differences between neighboring October populations brought about the variation of the average number of embryos, through both populations were considered to be the same in age composition. Figure 4 shows that the number of embryos in the same body weight is larger on rice field in fallow than in young plantation.

Summaring these findings above mentioned, comparisons of the same size and age showed in *Microtus montebelli* that the number of embryos changed primarily with the different types of micro-habitat in the same collecting period and with seasons in the same micro-habitat. Although EVANS (1973) showed in *M. agrestis* that there were no significant differences in potential litter sizes between young plantation and limestone grassland, NEGUS & PINTER (1966) revealed in *M. montanus* that small dietary supplements of either sprouted wheat or acetone-ether extracts of sprouted wheat elicited improved reproductive performance. Furthermore, they demonstrated that the improvement resulted primarily in more frequent postpartum maitings and lower rates of litter loss. Therefore, it is suggested that the differences of food quality brought about the variation of the number of embryos in the same age and size of pregnant females in different micro-habitats in the same season and/or in different seasons in the same micro-habitat.

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摘　要

金子之史: ハタネズミにおける胎児数の変化

水田，水田休耕地および若令造林地で採集した 84 個体のハタネズミ妊娠雌について，胎児の左右子宮内での分布，妊娠雌の体重の季節的変化，および胎児数と妊娠雌の体重・年令，捕獲された微小棲息場所，捕獲時期との関係を調査した。

1. 子宮内の胎児の分布のし方は，ポアソン分布から統計的に有意な差を示さなかった。
2. 胎児体重を差し引いた妊娠雌の体重は，1 年間で有意な差は示さなかった。
3. 平均胎児数は妊娠雌の age-group 6 から 8 にかけて増大し，9 から 10 にかけて減少したが，統計的に有意のある差ではなかった。
4. 同一クラスの age-group の妊娠雌で比較すると，胎児数の増加は妊娠雌の平均体重の増加に伴なっていた。
5. 畦で捕獲された同一体重の妊娠雌における胎児数は，5 月よりも 9 月の方が大きかった。
6. 同時期に採集した近接した 2 個体群内の同一体重の妊娠雌の胎児数は，水田休耕地の方が若令造林地よりも大きかった。

7. 以上のことから，同一の大きさで同一の年令の妊娠雌で比較すると，ハタネズミ胎児数は同一棲息場所の異なった採集時期，および同一時期に採集した異なった微小棲息場所，によってもたらされる食物の質のちがいによって変化することが示唆された。

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