Regional Differences in Population Property of the Bedford's Red-backed Vole, *Clethrionomys rufocanus bedfordiae* (THOMAS)

By

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Summary : Regional differences in population constitution and reproductive condition of *Clethrionomys rufocanus bedfordiae* (THOMAS) and population fluctuations of microtine and murine rodents in four regions of Hokkaido from 1973 through 1975 were dealt with in this study.

In *C. r. bedfordiae*, the individuals of 31 g and over were captured at the highest rate in the northern, central and eastern regions early in June, and each group of 30 g and below was smaller in these regions. On the other hand, in the southern region, the individuals of 26 to 30 g occupied a large proportion of the population at that time. After that, the individuals of 30 g and below gradually increased especially in the former regions. No apparent regional difference in sex ratio was recognized, but the males population always predominated slightly over the female in all regions. The mean embryo numbers were larger in the former regions than in the latter region. The female or male fertility rate was higher in the former regions than in the latter region, whereas the pregnancy rate was almost the same. On the whole, there was no obvious difference between the artificial forests and the neighboring natural forests in the population constitution and reproductive condition of this species.

The dominant species in the investigation regions was *C. r. bedfordiae*, *Apodemus* spp. (*A. speciosus ainu* and *A. giliacus*) and *Apodemus argenteus* was subdominant, while *Clethrionomys rutilus mikado* was few in number. *C. r. bedfordiae* was somewhat greater in number in the artificial forests than in the neighboring natural forests, while *Apodemus* spp. showed a reverse trend. *C. r. bedfordiae* increased more rapidly from the spring to the fall in the northern, central and eastern regions than in the southern region. *Apodemus* spp. and *A. argenteus* reached their highest population density at an earlier time especially in the northern, central and southern regions than did *C. r. bedfordiae*.

Introduction

Among the small, wild rodents widely distributed in Hokkaido, *Clethrionomys rufocanus bedfordiae* (THOMAS) is the most serious pest and causes much damage to forests in regions where it is abundant. For the purpose of protecting the forest from damage, elucidation about the highly complex mechanism of the vole population fluctuation should be made, and furthermore an accurate forecast for the great outbreak of this species should be made before it inflicts much injury on forests. It has been reported that the population fluctuation of this vole varies with the region[4)9)]. Therefore, it is also necessary to study deeply into the mechanism of such regional differences in population fluctuation in order to exactly predict the pest density.

The population of small rodents is basically influenced by their birth, death, immigration and emigration under their surrounding conditions. The studies related to the population constitution and reproductive activities of this vole have been mainly carried out in provincial forests[5)~8)], but there have been a few investigations[11)14)] in national forests which occupy

Received November 25, 1980 保 護—30 For. Protection—30
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about 60 percent of the total forest area in Hokkaido.

The primary aim of this study is to make clear the regional difference in population constitution (body weight structure and sex ratio) and reproductive condition (mean embryo number and reproductive activity) of this vole, and in population fluctuation of the microtine and murine rodents, using some of the data for prediction of pest density obtained from national forests during the three years from 1973 through 1975.

Materials and methods

There are five regional forest offices in Hokkaido which have supervision over about ninety district forest offices in total. Each district forest office is composed of about five ranger districts carrying out a population census of this pest three times a year, i. e. at the beginning of June, August and October (or September) each year. From the results of these population censuses, the population change from fall to winter has been predicted, and then preventive measures for this pest have been made according to the prediction. A set of young artificial forests and neighboring natural forests was selected in principle as an inquiry in each census. To estimate the vole populations, the removal method by snap traps was adopted for three days. Fifty snap traps were set in grids of 10 × 5 at 10 meter intervals on each experimental site with an area of 0.5 hectare. The specimens were weighed and divided into four groups according to body weight (counting fractions of 0.5 and over as a whole number and disre-

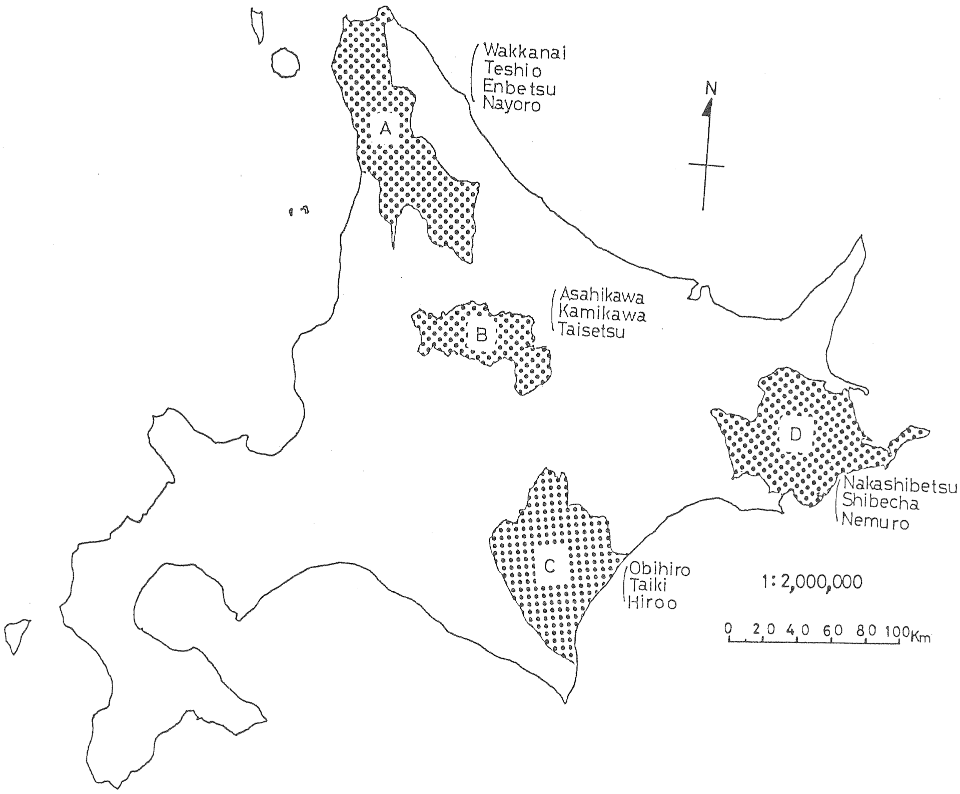

Fig. 1 Location of trapping areas.

A : Northern part, B : Central part, C : Southern part, D : Eastern part.

garding the rest), namely 20 g and below, 21 to 25 g, 26 to 30 g and 31 g or more. Pregnant females, females having swollen uterus or uterus with placental scars and males with large testes were considered to be in reproductive activity. In Fig. 1, the trapping areas are outlined, and all the sample sizes used in the present study for three years are summarized in Table 1. The inquiry was not able to be held in Hakodate district because of its incomplete data. The numbers of study sites in each area (i. e. A, B, C, and D) were 340, 241, 187 and 455 in the artificial forests, and 330, 243, 71 and 172 in the neighboring natural forests, respectively. The artificial forests consist mainly of Japanese larch and Todo-fir.

Results and discussions

Since there was, in general, no apparent difference in population constitution and reproductive conditions between the vole populations from the artificial forests and the neighboring natural forests in each trapping area during the experimental periods, the data obtained from both populations were dealt with by the lump in the following.

1. Population constitution in *C. r. bedfordiae*

1) Body weigt structure

It is necessary to accurately determine the absolute age of wild animals in order to understand many features of their natural populations and to obtain correct information about practical control measures. By establishing an exact age-determination technique, it becomes possible to analyze the age structure of a population and to estimate the growth rate, breeding age and longevity of the animals, still more to forecast their population densities.

Among procedures for estimating age, the determination of the developmental stage of the second and third upper molar (M^2 and M^3) has been considered to be the most accurate procedure for rodent species with the tooth root[2]. In the present study, however, the pre-

Table 1. Specimen number of microtine and murine rodents examined (1973～1975)

Trapping area*	Species	Artificial forests	Neighboring natural forests
A	*C. r. bedfordiae*	2,799	2,629
	C. r. mikado	8	0
	A. s. ainu, A. giliacus	301	372
	A. argenteus	743	721
B	*C. r. bedfordiae*	2,166	2,011
	C. r. mikado	35	110
	A. s. ainu, A. giliacus	594	873
	A. argenteus	922	1,030
C	*C. r. bedfordiae*	1,354	419
	C. r. mikado	34	2
	A. s. ainu, A. giliacus	944	336
	A. argenteus	361	110
D	*C. r. bedfordiae*	3,967	936
	C. r. mikado	58	0
	A. s. ainu, A. giliacus	906	386
	A. argenteus	222	82

*: Abbreviations as in Fig. 1.

sumption of age was done, not by the above-mentioned procedure, but by the body weight. Therefore, the method used here provided only a rough index to age determination, that is, individuals to 20 g seemed to correspond to juveniles from birth to about 25 days of age, ones of 21～25 g to subadults (to 55 days of age for females and to 35 days of age for males), ones of 26～30 g to adults-I (to 150 days of age for females and to 45 days of age for males), and ones of 31 g or more to adults-II (151 days and over for females and 46 days and over for males).

The frequency distributions of body weight in the vole are shown in Fig. 2. Early in June, individuals of more than 31 g were distributed at the highest rate and ones of less than 20 g were at the lowest rate in the northern, central and eastern regions, especially in the former two regions. In the southern region, however, individuals of 26 to 30 g occurred more frequently than in the other regions. After that, the voles of less than 30 g increased gradually in the northern, central and eastern regions, although there was no such a changeable tendency in the southern region.

It has been revealed that while proceeding toward the north and the east of Hokkaido, the proportion of the overwintered individuals in the vole population gradually becomes higher in the spring, but in the southern region (especially in the Hakodate district) the current year's individuals hold as much as 70 percent of the population at that time[6]. This shows

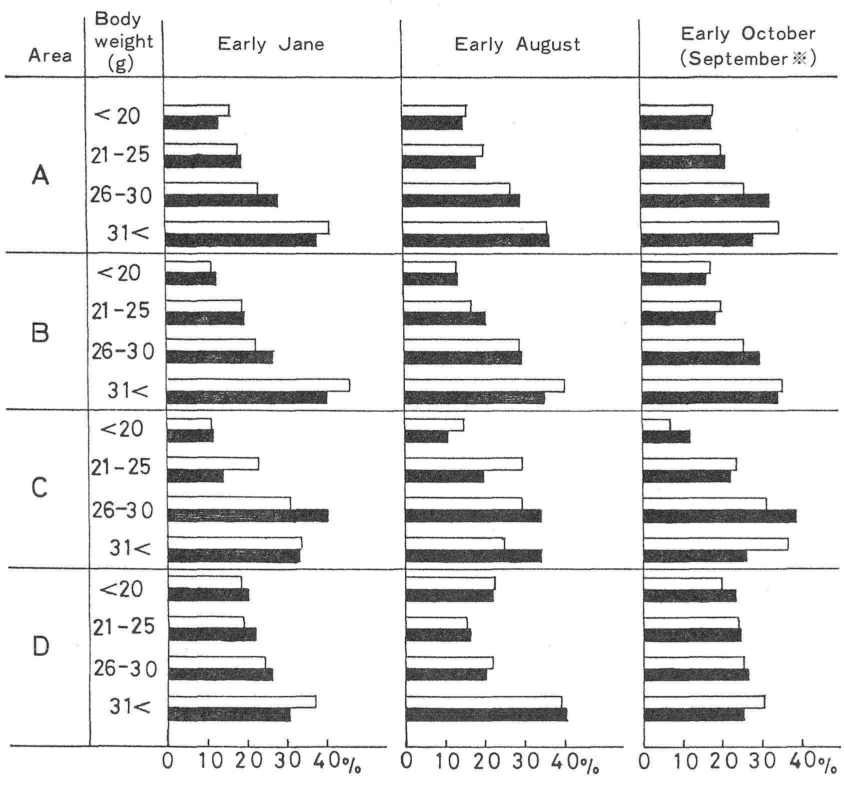

Fig. 2　Body weight structure of *Clethrionomys rufocanus bedfordiae* in each trapping area (1973～1975).

White and black columns represent that of females and males, respectively.　※: In C and D.

that in the southern region the onset of breeding activity begins at an earlier period of the year than it does in the northern and eastern regions, and consequetly young individuals occupy a high proportion in the spring population in this region. In the present study, individuals of 31 g or more (adult-II) showed the highest proportion in the northern, central and eastern regions early in June, whereas ones of 26 to 30 g (adult-I) showed a higher proportion especially in males in the southern region. Subsequently until the fall, young individuals increased more and more in the above-mentioned three areas. Therefore, as stated also by FUJIMAKI (1972), it was suggested that the current year's individuals took the place of the overwintered ones at a later period of the year in the northern, central and eastern regions than in the southern region, while the great part of the population had already replaced with the current year's ones and started on breeding from an earlier period of the year in the latter region than in the former regions.

2) Sex ratio

Table 2 presents data on the sex ratio for all the voles used in the present study. In all areas, the sex ratio showed male dominance during all of the experimental period as a result

Table 2. Sex ratio of *Clethrionomys rufocanus bedfordiae* (1973~1975)

	Time of trapping		No. of females (%)	No. of males (B)
Trapping area	A	Early June	306 (47.7)	333 (52.3)
		August	856 (43.4)	1,116 (56.6)
		October	1,171 (41.6)	1,644 (58.4)
	B	Early June	202 (45.6)	241 (54.4)
		August	581 (46.4)	670 (53.6)
		October	1,171 (47.2)	1,312 (52.8)
	C	Early June	141 (44.3)	177 (55.7)
		August	291 (43.4)	380 (56.6)
		September	346 (44.1)	438 (55.9)
	D	Early June	171 (44.3)	215 (55.7)
		August	775 (46.2)	904 (53.8)
		September	1,358 (47.9)	1,480 (52.1)

Table 3. Mean embryo numbers in pregnant females of *Clethrionomys rufocanus bedfordiae* (1973~1975)

Trapping area	Early June	Early August	Early October (September*)
A	5.6	5.2	5.1
B	5.8	5.7	6.0
C	5.0 ± 1.1**	4.3 ± 1.1**	4.7 ± 1.1**
D	5.9 ± 1.4**	5.4 ± 1.4**	5.1 ± 1.3**

* : In C and D, ** : Mean ± S. D.

of trapping, although it had no apparent regional difference. As possible causes of the male dominance, some differences in size of home range, behavior and physiological condition and mortality between both sexes have been cited[3], but no evidence was obtained to explain the disparity in this study.

2. **Reproductive conditions in *C. r. bedfordiae***

1) Mean embryo number

Table 3 gives the mean embryo number for this species. Mean embryo numbers were generally more in the northern, central and eastern regions than in the southern region. Fujimaki (1972) reported that the mean litter size of this vole was larger in the northern and eastern regions only early in June. It was also reported that litter size in *Peromyscus* was positively correlated with latitude and altitude, and it was large in the northern population[13]. Judging from the above-mentioned facts, it is considered that there is a possibility for the Bedford's red-backed voles to have increased more rapidly in the northern, central and eastern populations than in the southern population.

2) Reproductive activity

The reproductive activities of females of this species are shown in Tables 4 and 5, and those of males in Table 6. The female fertility proportion of the adult females examined was higher in the northern, central and eastern regions than in the southern region (Table 4). Regional differences, however, in the pregnancy rate were not so apparent, except for a tendency of a gradual decrease from the spring to fall in the northern and central regions (Table 5). The male fertility proportion of the adult males examined was higher in the northern, central and eastern regions than in the southern region throughout the whole period, and it decreased with the change of season, although it showed a rather reverse trend in the southern region (Table 6).

On the basis of the above-mentioned data, it was revealed that in the northern, central and eastern regions, many individnals of both sexes were in active reproductivity during the whole period, especially in early June, although the reproductive activity silghtly went down

Table 4. Fertility rate of females in *Clethrionomys rufocanus bedfordiae* (1973～1975)

	Time of trapping		No. of estrous or postpartum females	No. of adult females examined	Fertility rate (%)
Trapping area	A	Early June	48	200	24.0
		August	210	543	38.7
		October	339	717	47.3
	B	Early June	38	140	27.1
		August	152	405	37.5
		October	281	721	39.0
	C	Early June	13	93	14.0
		August	21	160	13.1
		September	23	237	9.7
	D	Early June	33	106	31.1
		August	128	478	26.8
		September	196	757	25.9

Table 5. Pregnancy rate in *Clethrionomys rufocanus bedfordiae* (1973～1975)

Trapping area		Time of trapping	No. of pregnant females	No. of adult females examined	Pregnancy rate (%)
	A	Early June	152	200	76.0
		August	319	543	58.7
		October	370	717	51.6
	B	Early June	102	140	72.9
		August	249	405	61.5
		October	383	721	53.1
	C	Early June	44	93	47.3
		August	98	160	61.3
		September	120	237	50.6
	D	Early June	63	106	59.4
		August	241	478	50.4
		September	422	757	55.7

Table 6. Fertility rate of males in *Clethrionomys rufocanus bedfordiae* (1973～1975)

Trapping area		Time of trapping	No. of fertile males	No. of adult males examined	Fertility rate (%)
	A	Early June	224	224	100.0
		August	725	738	98.2
		October	899	1,001	89.8
	B	Early June	162	163	99.4
		August	409	439	93.2
		October	728	850	85.6
	C	Early June	56	130	43.1
		August	138	262	52.7
		September	154	287	53.7
	D	Early June	118	123	95.9
		August	495	552	89.7
		September	677	763	88.7

toward the fall; on the other hand, the reproductive activity in the southern region was not so high during the whole period as that in the other regions.

Clethrionomys rufocanus inhabiting Finland and situated further north than Hokkaido attains sexual maturity at a younger age than the same species inhabiting Japan[10]. Further, Abe[1] (1968) reported that the age at which *C. r. bedfordiae* reaches to sexual maturity, even in Hokkaido, was lower in the northern and eastern regions than in the southern region, and consequently suggested that the individual numbers in the former regions increased abruptly in the fall. The same tendency was also recognized in this study.

3. **Population fluctuation of microtine and murine rodents**

Outlines of the population fluctuations of microtine and murine rodents in Hokkaido are shown in Table 1 and Fig. 3. *C. r. bedfordiae* (THOMAS), *Apodemus* spp. (both *Apodemus speciosus ainu* (THOMAS) and *Apodemus giliacus* (THOMAS) are hereinafter called so) and *Apodemus argenteus* (TEMMINCK) were usually trapped, but *Clethrionomys rutilus mikado* (THOMAS) only occasionally. As for the population density, *C. r. bedfordiae* was dominant in each trapping site. *A. argenteus* was subdominant in the northern region, while *Apodemus* spp. were so in the southern and eastern regions. In the central region, *A. argenteus* was slightly greater in

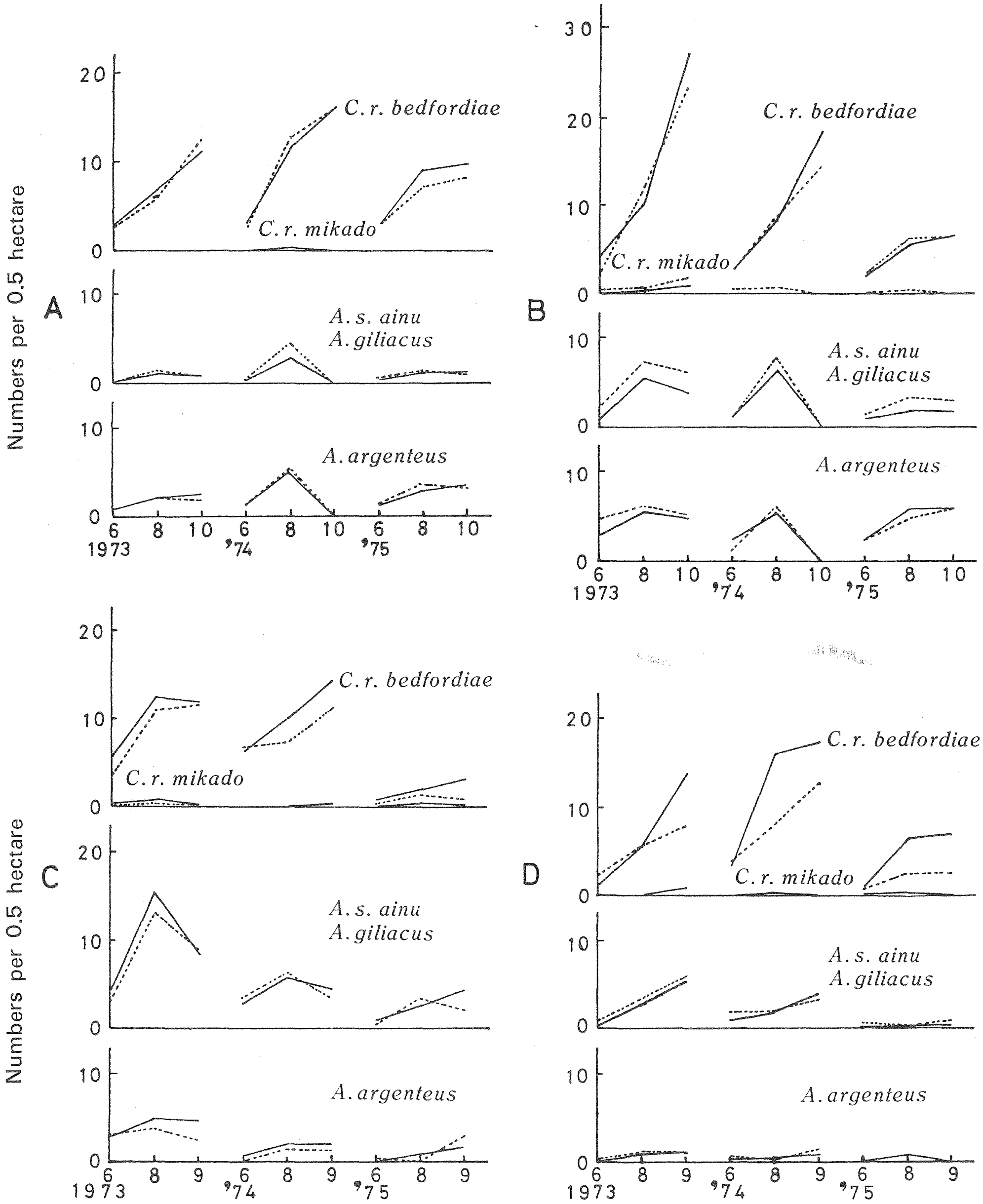

Fig. 3 Population fluctuation of microtine and murine rodents in each trapping area (1973～1975).

—— : Artificial forest, ······ : Neighboring natural forest.

number than *Apodemus* spp.

On the whole, *C. r. bedfordiae* was somewhat greater in number in the artificial forests than in the neighboring natural forests, while *Apodemus* spp. were in contrast with this. *A. argenteus*, however, did not show such a constant tendency between the two forests; this result was different from the general trend of it being dominant in the natural forests[12]. This could be explained by the reason that *A. argenteus* couldn't show its own character, as compared with *C. r. bedfordiae* and *Apodemus* spp., in the two forests that were set adjoining each other.

Individual numbers of *C. r. bedfordiae* in the population increased more rapidly in the northern, central and eastern regions from June to October (or September) in this vole's outbreak year of 1973 to 1974 than in the southern region. In the latter, they increased at a comparatively slow rate, although the numbers in early June (especially in 1974) were slightly more than those in the other regions. On the other hand, the population densities of *Apodemus* spp. and *A. argenteus* reached a peak phase more early in the summer, especially in the northern, central and southern regions, than did *C. r. bedfordiae.* Such population changes in these small rodents were also reported by Fujimaki (1969).

Acknowledgements

The author is indebted to Dr. S. Higuchi, Head of the Forest Protection Division of the Tohoku Branch of the Forestry and Forest Products Research Institute, and Prof. Dr. T. A. Uchida and Assoc. Prof. Dr. S. Shiraishi, of the Faculty of Agriculture, Kyushu University for their helpful advice. The author is also grateful to Mr. M. Maeda, Chief of the Section of Wildlife Management of the Hokkaido Branch of the Forestry and Forest Products Research Institute, for providing the samples.

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エゾヤチネズミ *Clethrionomys rufocanus bedfordiae* (THOMAS) における個体群性格の地域差に関する研究

中 津 篤[1]

摘 要

北海道において造林施業上最も問題になっている害獣としてエゾヤチネズミがあげられる。この種による造林木への被害を未然に防ぐためには，本種の個体群変動機構を解明して，正確な発生予察を行うことが重要である。そのためには，本種における個体群変動の地域差の発現機構を解明することが先決である。そこで，ここでは1973年から1975年までの北海道4地区（Fig. 1）における定期発生予察調査（年3回）で得られたエゾヤチネズミ16,281頭を主な材料として，そのネズミの個体群構成，繁殖状態および個体群変動について他の野鼡類との比較をも一部考慮して地域差の検討を行った。

調査は造林地と周辺天然林において並行して行われ，材料をすべて体重（小数点以下第1位を四捨五入）区分別に，20 g 以下（幼獣），21～25 g（亜成獣），26～30 g（成獣Ⅰ），31 g 以上（成獣Ⅱ）の4つのグループに分けた。繁殖状態については，雌では妊娠中のもの，および発達したあるいは分娩後の子宮を持つものを，雄では大きな精巣を持つものを繁殖活動個体と見なした。

エゾヤチネズミの体重構成については，6月上旬では31 g 以上の個体（成獣Ⅱ）が北・中・東部で最も高い割合を示したが，南部では26～30 g の個体（成獣Ⅰ）が高い割合を示した。その後，季節の推移と共に，とくに北・中・東部において30 g 以下の個体が徐々に増加した（Fig. 2）。

性比には地域差は認められず，予察資料からみた限りではすべての地域で雄は雌に比べて個体数が多かった（Table 2）。

平均胎児数については，北・中・東部が南部に比べて多い傾向にあった（Table 3）。また，発生予察期（年3回）における雌雄成獣の総個体数に対して占める繁殖活動個体数の割合は，雌雄ともに南部に比べて北・中・東部でより高い値を示した（Table 4, 6）。一方，妊娠率における地域差は明確には認められなかった（Table 5）。なお，エゾヤチネズミの個体群構成および繁殖状態については，造林地と周辺天然林の間に明確な差異は認められなかった。

優占種はエゾヤチネズミであり，*Apodemus* spp.（エゾアカネズミ *A. speciosus ainu* (THOMAS) とカラフトアカネズミ *A. giliacus* (THOMAS) の両種を含む）およびヒメネズミ *Apodemus argenteus* (TEMMINCK) の個体数はエゾヤチネズミに比べると少なく，ミカドネズミ *Clethrionomys rutilus mikado* (THOMAS) は最も少なかった（Fig. 3）。エゾヤチネズミの個体数は周辺天然林よりも造林地に多く，*Apodemus* spp. のそれは逆の傾向を示した。つぎに，エゾヤチネズミの個体群変動については，南部に比べて北・中・東部でより急激な増加を示した（Fig. 3）。このことは，前述の個体群構成および繁殖状態の結果をよく反映しており，これらが野外における個体群変動に重要な役割を演じていることが判った。更に，最大密度の到達時期について他種との比較を試みると，東部を除いた地域では *Apodemus* spp. およびヒメネズミ（8月）がエゾヤチネズミ（9月または10月）に比べて早い時期に認められた。

1980年11月25日受理
(1) 北海道支場