Distribution and habitat of the dark red-backed vole *Clethrionomys rex* in Japan

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Abstract. The dark red-backed vole *Clethrionomys rex* is widely distributed in Hokkaido and on the adjacent islands such as Rishiri and Rebun, Japan. In Hokkaido, the vole species is recorded from the Kitami and Yubari mountains, the Shiribeshi Volcanic Plateau, the Youtei Volcanoes, and the Oshima Mountains, as well as from the Daisetsu, Hidaka, and Teshio mountains. This species occurs in wooded, montane areas ranging from 20 m to 1900 m in altitude in Hokkaido, whereas it commonly occurs in various habitats on the islands of Rebun and Rishiri.

Key words: altitude, *Clethrionomys rex*, competition, red list, status, vegetation.

The dark red-backed vole *Clethrionomys rex* Imaizumi, 1971, is of special mammalogical interest, because it shares close phylogenetic links with *C. rufocanus*, but is morphologically more primitive than that species (e.g. Imaizumi 1971, 1972; Abe 1973a, 1973b). Furthermore, *C. rex* is included as a rare species in the red list of Japan, because: (1) its known geographical distribution is confined to Hokkaido and the associated islands of Rishiri and Rebun, and (2) its populations are sparse (Environmental Agency of Japan 1991; Mammalogical Society of Japan 1997). Knowledge of the distribution and habitat of *C. rex* is, however, still far from complete at present, although such information is a prerequisite for its conservation.

According to Kostenko and Arrenova (1978), Honacki et al. (1982), Krivosheev (1984) and Koyasu et al. (1996), *C. sikotanensis* (Tokuda 1935) also occurs in Far East Asia, namely on southern Sakhalin, on Shibotsu Island in the Habomai Islands, and on Shikotan and Kunashir islands in the southern Kuril Islands. The range of *C. sikotanensis* is thus very close to that of *C. rex*, although they are geographically separated by various marine channels. Judging from the morphological descriptions of Gromov and Polyakov (1977), Kostenko and Arrenova (1978), and Krivosheev (1984), *C. sikotanensis* seems to be indistinguishable from *C. rex* and the two may prove to be conspecific (cf. Kaneko et al. 1998). Accordingly these two forms require re-examination from a taxonomic perspective. Information relating to their limited ranges may contribute to a better understanding of these two allopatric forms.

The purpose of this paper is twofold: first to report on recent records of *C. rex*, and

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second to summarize the information on its distribution and habitat in Japan.

Materials and methods

A total of 74 *C. rex* was collected personally from 18 localities in Hokkaido from 1983 to 1998. All specimens were obtained using either snaptraps or livetraps set on traplines that generally consisted of 50 traps set at 10 m intervals. Trap sites were carefully selected in order to collect specimens of *C. rex*, because this species is known to prefer mixed undergrowth of *Sasa* (dwarf bamboo) and herbage, and commonly inhabits moist areas from the bottom to the lower half of slopes of small valleys in forests (e.g. Nakata 1978, 1995; Kaneko and Sato 1993; Kaneko 1994). Other pertinent details are described in Table 1, supplemented from two unpublished collections made by T. Kuwahata and S. H. Han.

In order to clarify the localities, location codes, derived from the Environment Agency of Japan (1998), were employed. These codes represent areas of ca. 1 km × 1 km squares. In Fig. 1, each dot corresponds approximately to nine kilometers in diameter in relation to the scale of the map, thus one dot often overlaps others. In such instances only one locality is plotted on the map. Local district names and topographic terms are taken from Segawa (1974) and the Environment Agency of Japan (1998).

Regarding *C. montanus* Imaizumi, 1972, another related species reported from the Hidaka Mountains of central Hokkaido, this form is now generally considered synonymous

Table 1. Recent records of occurrence of *Clethrionomys rex* in Hokkaido, Japan.

Localities	Dates	No. ind.	Alt.	Topogr.	Vegetation	Location code
1 Kitousu, Rebun Island	Jun 26–27 1983	5	220	m	Scrub. f.	6841-00-53
2 Sashitoji, Rebun Island	Jun 27 1983	1	40	m	Abandon. f.	6741-70-33
3 Kitachiyoda, Shosanbetsu	Oct 2–4 1988	5	65	m	Mm(As)	6641-66-43
4 Nishionobunai, Teshio	Oct 2–4 1990	2	20	m	Mf	6741-27-52
5 Rokushinai, Teshio	Oct 2–4 1990	2	50	m	Mf	6741-26-55
6 Kiyokawa, Enbetsu	Oct 2–4 1990	5	40	m	Mm(As)	6741-07-60
7 Hisamitsu, Enbetsu	Oct 2–4 1990	5	40	m	Mf	6741-06-58
8 Ariake, Shosanbetsu	Oct 4–6 1990	3	180	m	Mm(As)	6641-46-68
9 Koshunai, Bibai	Sept 21–22 1993	3	100	m	Bf	6441-76-39
10 Koshunai, Bibai	Apr 26–27 1994	1	80	m	Bf	6441-76-39
11 Tsukiura, Abuta	May 10 1994	1	250	m	Bf	6340-76-12
12 Koshunai, Bibai	Nov 1 1994	3	190	m	Bf	6441-76-29
13 Koshunai, Bibai	Jul 24 1995	1	240	m	Mm(LI)+Bf	6441-77-30
14 Koshunai, Bibai	Oct 3–5 1995	5	260	m	Mm(BE)	6441-77-30
15 Miruto, Iwamizawa	Jul 4–5 1996	9	380	m	Mm(Pg)	6441-67-25
16 Koshunai, Bibai	Oct 2–4 1996	8	180	m	Bf	6441-76-29
17 Oshiranepu, Takinoue	Oct 1–3 1996	8	275	m	Mf	6643-11-90
18 Utsai, Kuromatsunai	May 21 1998	7	170	m	Bf	6340-72-44
19 Ginsendai, Mt. Akadake*	/ /	5	1400	m	/	6542-47-17
20 Meguro, Erimo**	May 14 1995	1	80	m	Bf	6434-12-31

No. ind.=Number of trapped *C. rex*. Alt.=Altitude(m). Topogr.=Topography. m=montane area. Mf=mixed forest, Mm=man-made forest, Bf=broad-leaved forest. As=*Abies sachalinensis*, Pg=*Picea glehnii*, LI=*Larix leptolepis*, BE=Betulaceae's trees (*Alnus* and *Betula* spp.). Scrub. f.=scrubby field, Abandon. f.=abandoned cultivated field. Location code=mesh code of the Environmental Agency of Japan (1998). /=not described.

The bottom two data are derived from: *=Kuwahata (unpub.), **=Han (unpub.).

with *C. rex* (Abe 1984; Nakata 1986; Kaneko 1994; Kaneko et al. 1998) and that position is retained here.

Results and discussion

Geographic distribution of Clethrionomys rex in Japan

When the distribution of recent records of *C. rex* is compared with the previously known range covering the Daisetsu, Hidaka, and Teshio mountains (e.g. Kaneko 1994), the currently known distribution is larger, encompassing also the Kitami and Yubari mountains, the Shiribeshi Volcanic Plateau, the Youtei Volcanoes, and the Oshima Mountains (see Table 1 and Fig. 1). In particular, records from Tsukiura, Abuta, near Lake Toya (Table 1), and from Shiraigawa, Sapporo (Kadosaki and Inage 1998), were well beyond the previously known range, and confirm that *C. rex* is also distributed across the Ishikari-Yufutsu Plain (Fig. 1). Furthermore, the record from Utasai, Kuromatsunai, is now the westernmost (Fig. 1), extending the range of *C. rex* farther into the Oshima Peninsula across the Kuromatsunai Depression, a depression that demarcates bioclimatic vegetation zones in Hokkaido (cf. Tatewaki 1958; Hamet-Ahti et al. 1974). The specimens possess a third upper molar which has four prominent salient angles both on the inner and outer sides, and a third lower molar

Fig. 1. Known localities of the dark red-backed vole *Clethrionomys rex* in Hokkaido and adjacent islands. Data are derived from Tokuda (1935), Abe et al. (1971), Imaizumi (1972), Ueda and Kuwahata (1975), Nakata (1978, 1989, 1995), Haga et al. (1979), Shibano and Takeuchi (1985), Onoyama et al. (1986, 1993), Takeuchi et al. (1987), Kashiwabara and Onoyama (1988), Yanagawa and Itoh (1990), Kaneko and Sato (1993), and Table 1. For the locality numbers see Table 1. According to Kostenko and Arrenova (1978), Krivosheev (1984) and Koyasu et al. (1996), the localities in Shibotsu Is., Shikotan Is. and Kunashir Is. were shaded irrespective of the precise point of each locality.

forming a nearly symmetrical anterior loop (see Fig. 2). The enamel patterns of their molars answer the original description of *C. rex* (cf. Imaizumi 1971).

Two inferences are possible from these new data. First, the occurrence of *C. rex* at Utsai, Kuromatsunai, implies that this species prevails over the Oshima Peninsula, because the peninsular habitats stretching southwards beyond Kuromatsunai consist of forested areas with narrow inter-montane valleys, which are the preferred habitats of *C. rex* (see Nakata 1995). Second, *C. rex* may occur more sparsely in the region east of the Kussharo-Akan Volcanoes than in other regions of Hokkaido. On the basis of findings in the literature, indicating that *C. rex* also occurs in the Shikaribetsu area, Tokachi District, on the south-east slope of the Daisetsu Mountains (Onoyama et al. 1993), it was assumed that this species also occurs in the other mountain ranges of eastern Hokkaido. Until now, however, no such evidence has been available, despite numerous surveys being conducted by research mammalogists (e.g. Kondo 1984, 1987; Nakata 1984; Nakata's unpublished trapping data at Otofuke, Rikubetsu, Ashoro, Koshimizu, Kiyosato, Shari, Shibeche, Teshikaga, Nakashibetsu, Bekkai and Nemuro). According to Imaizumi (1972) and Nakata (1995) *C. rex* is presumed to be out-competed by the more dominant *C. rufocanus bedfordiae*, which has very similar ecological requirements. Such competition might be one factor contributing

Fig. 2. Left upper and left lower molars of *Clethrionomys rex* captured at Utsai, Kuromatsunai, Hokkaido.

to the scarceness of *C. rex* in easternmost Hokkaido where *C. rufocanus bedfordiae* is found at its highest average levels of abundance (Nakata 1986; Saitoh et al. 1998).

Habitat in relation to altitude and vegetation

Clethrionomys rex has been found from locations as low as 20 m in altitude, such as along riversides at Nishionobunai, Teshio, and up to 1900 m on ridges near the peak of Mt Poroshiri, in the Hidaka Mountains (Table 1; Fig. 3; Haga et al. 1979). Until the 1970s, the insular populations were known to occur at lower altitudes, whereas the Hokkaido populations had only been recorded from altitudes of 750 m and higher (Abe et al. 1971; Imaizumi 1972; Haga et al. 1979). Subsequent lower-altitude records, have gradually increased (e.g. Nakata 1978, 1989; Shibano and Takeuchi 1985; Kashiwabara and Onoyama 1988) such that now there is substantial evidence to show that *C. rex* is widely distributed in Hokkaido irrespective of altitude (see Table 1).

Clethrionomys rex appears to be particularly associated with mountainous habitats in Hokkaido (see Table 1), with no individual ever having been captured from an alluvial plain. For example, despite hundreds of trappings sessions in the Bibai district on the Ishikari Plain, no specimens of *C. rex* have been obtained from either wind-shelterbelts nor grasslands (including areas with dwarf bamboo) on the plain, even though a population of *C. rex* reaches the border of the Plain (Table 1: localities 9 and 10). Similarly, all trapping on the Teshio Plain ended in failure, despite *C. rex* occurring in the foothills of the Teshio Mountains (Table 1: localities 3, 4, 5 and 7). Furthermore, *C. rex* was not always captured

Fig. 3. The relationship between altitude and vegetation type where *Clethrionomys rex* occurs. 1=*Abies sachalinensis* plantation; 2=*Picea glehnii* plantation; 3=broad-leaved forest (including a *Larix leptolepis* plantation invaded intensively by broad-leaved trees); 4=*Betula maximowicziana* forest; 5=mixed forest consisting of broad-leaved and coniferous trees; 6=coniferous forest such as *A. sachalinensis* and *Picea jezoensis*; 7=*Betula ermanii* and *Quercus mongolica* forest; 8=*B. ermanii* and *P. glehnii* forest; 9=*B. ermanii* forest including the dwarf-shrub heath; 10=*Pinus pumila* and *Alnus maximowiczii* scrubby thicket; 11=*P. pumila* scrubby thicket; 12=not described. Data are as in Fig. 1, although the number of dots is not equal to that in Fig. 1, because a single dot often overlaps one or more localities in relation to the scale of the map (see text).

even in suitable montane habitats, whereas *C. rufocanus* was collected from every trap site to site (Nakata's field observations for this study). It seems therefore that populations of *C. rex* are sparsely distributed.

Clethrionomys rex was captured in various habitats including natural forests, forestry plantations, scrubland, grass fields, and abandoned cultivated fields (Table 1). Insular populations were found in all habitats (Imaizumi 1971; Kaneko and Sato 1993; Table 1), whereas the Hokkaido mainland populations were restricted to areas with forests. On the Hokkaido mainland, *C. rex* has never been recorded from grass-fields in lowland plains, and this is considered to be partly due, at least, to the predominance of *C. rufocanus bedfordiae* in these habitats. Furthermore, the mainland localities of *C. rex* include alpine scrubby thickets and dwarf-shrub heaths on high mountains (Haga et al. 1979; Yanagawa and Itoh 1990). A rather strong affinity for wooded localities is thus evident on the mainland.

Clethrionomys rex has a wide distribution in Hokkaido in different geobotanical zones, ranging from temperate to orohemiarctic forest vegetation (Tatewaki 1958; Hamet-Ahti et al. 1974). During this study, *C. rex* was captured from eleven vegetation types (see Fig. 3): four types of broad-leaved forest, one type of coniferous forest, two types of mixed forests, two types of forestry plantations, and two types of alpine thickets, indicating that *C. rex* shows no ecological preference for either coniferous or broad-leaved forest.

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