Acta Theriologica 35 (3–4): 261–267, 1990.
PL ISSN 0001–7051

Geographic distribution and relative abundance of four species of soricine shrews in Hokkaido, Japan

Satoshi OHDACHI and Koji MAEKAWA

Ohdachi S. and Maekawa K. 1990. Geographic distribution and relative abundance of four species of soricine shrews in Hokaido, Japan. Acta theriol. 35: 261–267.

Geographic distribution and relative abundance of four species of *Sorex* in Hokkaido were investigated. *S. unguiculatus* Dobson, 1890, *S. caecutiens* Thomas, 1907, and *S. gracillimus* Thomas, 1907 are distributed throughout the mainland of Hokkaido, and *S. minutissimus* Thomas, 1906 appears to be distributed only in the northern and eastern regions. *S. unguiculatus* was recorded on 5 out of 10 investigated islands near the mainland, *S. caecutiens* was recorded on one island, *S. gracillimus* was recorded on three islands, and *S. minutissimus* was recorded on one island. *S. unguiculatus* was the dominant species in a majority of habitats (22 out of 32) and was the second most dominant in the others. *S. caecutiens* was the second or third most dominant species in a majority of habitats (26 out of 32) and was the dominant in the others. *S. gracillimus* was a less dominant species in a majority of habitats (19 out of 23) but was the dominant in the moors and highlands in the northern regions. *S. minutissimus* was the rarest species in Hokkaido.

Department of Biology, The University of Michigan, Ann Arbor, Michigan 48109–1048, U.S.A. (SO); National Research Institute of Fisheries Science, Ueda, Nagano, Japan 386 (KM)

Key words: geographic distribution, species composition, *Sorex*, Hokkaido

Introduction

Four species of *Sorex*: *S. unguiculatus* Dobson, 1890, *S. caecutiens saevus* Thomas, 1907, *S. gracillimus* Thomas, 1907, and *S. minutissimus hawkeri* Thomas, 1906, are found in Hokkaido. Imaizumi (1960) and Abe (1967, 1988) reported the geographic distribution of shrews in Hokkaido, and other authors briefly commented on the relative abundance of the shrews in a certain number of other regions and habitats (e.g. Abe 1968, 1984, Abe *et al.* 1978, Kondo 1983, 1986, Maekawa 1981, Shimazaki and Masatomi 1986). However, differences in species compositions between regions or habitats throughout Hokkaido has not been reported.

In this paper, we report the geographic distribution and the relative abundance of the four species of *Sorex* in Hokkaido.

Materials and methods

Collection locations and dates are shown in Table 1. The samples from approximately two thirds of the locations examined were taken from the field by us, but the others were the data cited from literature (Abe *et al.* 1978, Kondo 1983, 1986, Shimazaki and Masatomi 1986, Yoneda 1979). The numbers of the samples and the locations are given in Fig. 1.

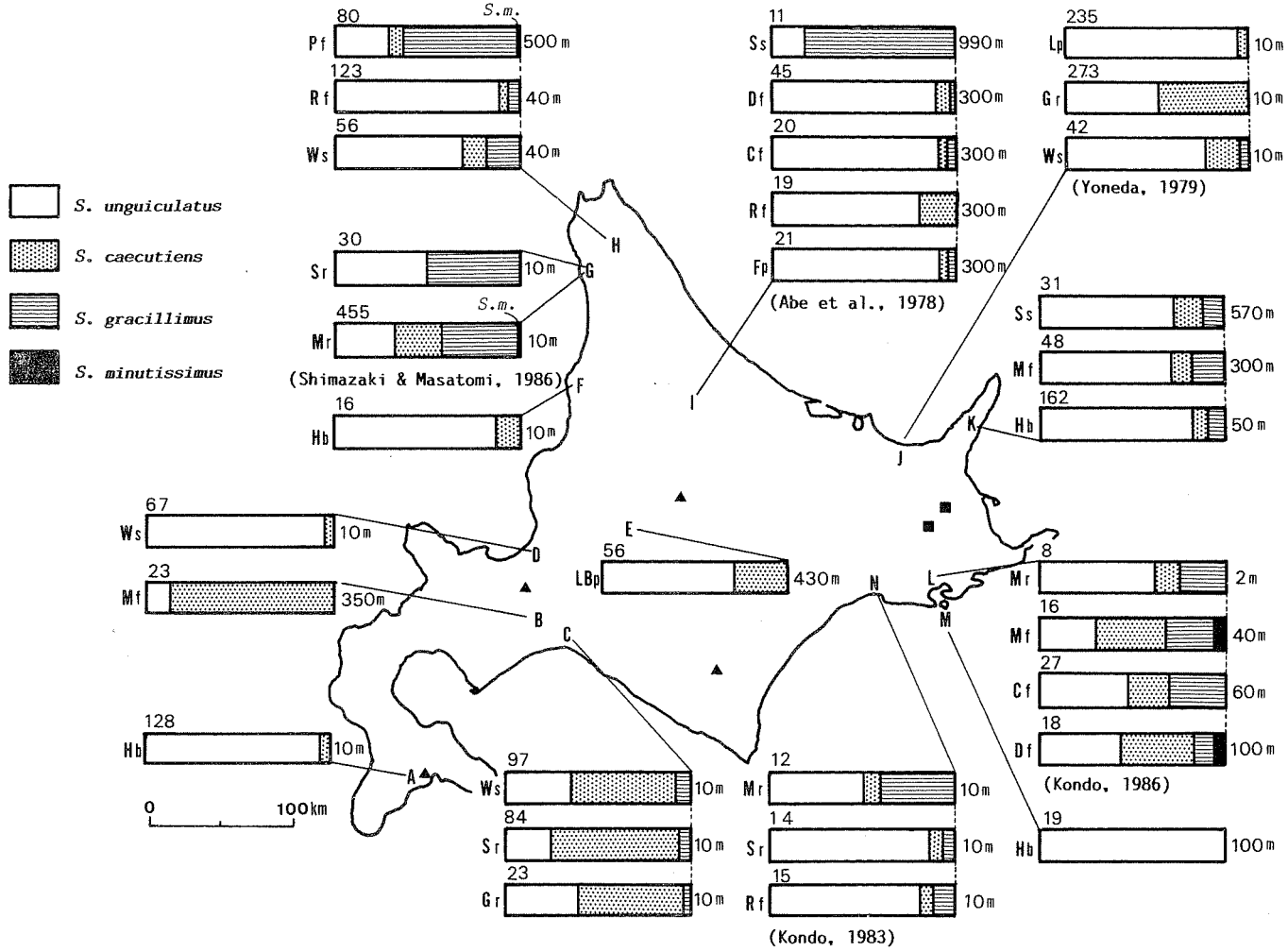

Fig. 1. The geographic distribution and the percent composition of shrew species in Hokkaido. The letter on the left side of the bar-graph denotes habitat type (see text for explanation of abbreviations), and the number on the right side denotes altitude of the habitat. The number on the upper left side indicates sample size. Small solid triangles and squares indicate the supplemental collection locations for *Sorex gracillimus* and *S. minutissimus*, respectively.

Table 1. Collection locations and dates.

	Study area	Sample size	Date
A	Kikonai	128	Mar. and each month from Jun. to Oct., 1977
B	Shikotsu	23	middle Sep., 1977
C	Tomakomai (Yufutsu meadow)	204	each month from Apr. to Aug., 1977 and Jul. and Aug., 1980
D	Sapporo (Tonden)	67	each month from Apr. to Jun., 1979
E	Furano (The Exp. For., the Univ. of Tokyo)	56	early Jul., 1988
F	Haboro	16	middle Aug., 1977
G	Toyotomi	30	late Aug., 1977
	(Sarobetsu moor)	455	Jul. and Aug., 1972–76, 1983–84[1]
H	Horonobe (Teshio Exp. For., Hokkaido Univ.)	259	each month from May to Nov., 1988
I	Shimokawa	116	late Aug. and early Sep., 1977[2]
J	Koshimizu	550	each month, 1974–77[3]
K	Shiretoko (Shiretoko Pen.)	241	May, Aug., and Nov., 1977 and Aug. to Nov., 1980
L	Akkeshi	69	middle Sep., 1985[4]
M	Daikoku island	19	late Jul., 1979 and late May, 1980
N	Kushiro (Kushiro moor)	41	middle Oct., 1983[5]

[1]Shimazaki and Masatomi (1986), [2]Abe *et al.* (1978), [3]Yoneda (1979), [4]Kondo (1986), [5]Kondo (1983).

For the census of shrews, we used tin pit-fall traps (15 cm in diameter at the opening and 24 cm in depth) in the surveys from 1977 to 1981, and polyethylene ones (16 cm in diameter at the opening and 20 cm in depth) in the survey of 1988. Traps were buried at ground level or approximately 3 cm under ground, and filled with water to a depth of approximately 10 cm. No baits were used for trapping. Each trap site had usually 20 traps in two (or rarely four) lines. The distance between traps was 7 m in the surveys from 1977 to 1981, and 5 m in 1988. Traps were set for one to four (usually two or three) night(s) in every survey. Animals were collected every day. In Daikoku island, Sherman live traps were used.

Abe *et al.* (1978) and Kondo (1983, 1986) used trapping methods similar to ours. Shimazaki and Masatomi (1986) set 100 or 150 baited pit-fall traps for insect study (exact size was unknown, but they are obviously smaller than ours) without water at 1 m intervals for 8 nights. Yoneda (1979) used Sherman live traps.

Habitats were classified into the following 14 categories based upon their vegetation types: (1) Wind-shelter belt of *Fraxinus mandshurica* in agricultural fields (Ws), (2) Deciduous forest dominated by *Quercus* spp., *Tilia* spp., *Acer* spp., and *Ulmus* spp. (Df), (3) Coniferous forest dominated by *Abies sachalinensis* and/or *Dicea jezoensis* (Cf), (4) *Picea glehnii* forest (Pf), (5) The mixed forest of deciduous trees, fir *A. sachalinensis*, spruce *P. jezoensis* (Mf), (6) Riparian forest dominated by *Salix* spp., *Alnus japonica*, and *Fraxinus mandshurica* (Rf), (7) Fir plantation mainly of *A. sachalinensis* with closed crown (Fp), (8) Larch plantation mainly of *Larix leptolepis* with closed crown (Lp), (9) Larch and birch plantation planted with *Larix* spp. and *Betula platyphylla* with partially closed crown (LBp), (10) Shrubland dominated by *Spiraea salicifolia*, *Lonicera caerulea*, and *Malus baccata* in Tomakomai (C), by *Sasa* spp., *Hydrangea paniculata*, and *Salix* sp. in Toyotomi (G), or by *Malus baccata* and *Euonymus sieboldianus* in Kushiro (N) (Sr), (11) Subalpine shrubland dominated by *Pinus pumila* and *Betula ermanii* above the forest line (Ss), (12) Grassland dominated by *Graminae* and *Cyperaceae* (Gr), (13) Herbaceous field dominated by tall succulent herbs such as *Petasites japonicus*, *Angelica ursina*, *Cirsium kamtschaticum*, and *Artemisia montana* with few ligneous plants (Hb), and (14) Moor-land developed on peat bed (Mr).

Relative abundance of a species was calculated by the formula:

$$100 \times \frac{\text{the number of individuals from a particular species}}{\text{the total number of individuals from all shrews taken in a habitat.}}$$

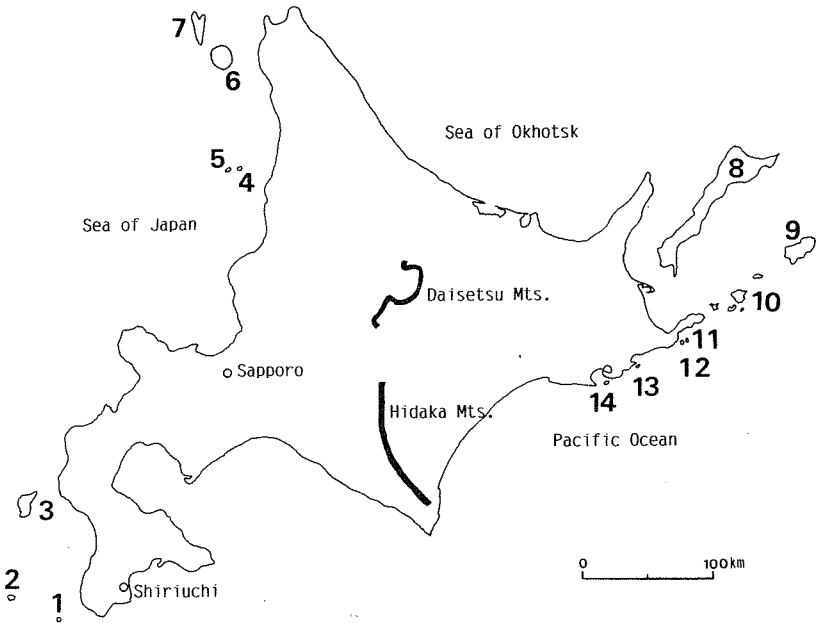

Fig. 2. The locations of 14 islands near the mainland of Hokkaido.

In this paper, we assumed that population cycles of each species were synchronized between seasons, between years, or between locations, and thus the results of the species composition were able to be directly compared between locations. When the percent composition was not available, only collection locations for *S. gracillimus* and *S. minutissimus* were indicated in Fig. 1. Such data are collected for *S. gracillimus* in Shiriuchi (southwestern Hokkaido) by Obara and Nara (1984), at Mount Soranuma (Sapporo) by H. Abe (pers. comm. on December 1, 1988), in the Hidaka Mountains (the southern Central Hokkaido) by Imaizumi (1972), and in the Daisetsu Mts. (Central Hokkaido) by us (personal observation from 1977 to 1988), and for *S. minutissimus* in Eastern Hokkaido by Abe (1961), Komiya (1972), and Maekawa (1981).

For the detection of the presence of shrews on islands near the mainland of Hokkaido, we examined 14 islands (Habomai archipelago was regarded as one island), and very minor islets were ignored (Fig. 2). The data for the 14 island were obtained from published literature (Imaizumi 1960, Abe 1967, 1988, Dolgov 1985), personal communications with H. Abe, N. Kondo, and K. Takahashi, and our observation from 1977 to 1988.

Results and discussion

S. unguiculatus occurred in all locations and habitats examined on the mainland (Fig. 1), and was recorded on 5 out of 10 islands where census for small mammals has been conducted (Table 2). It was the dominant species of in 22 out of 32 habitats examined; however, it was the second most dominant in *Picea glehnii* forest (Pf) at 500 m in Horonobe (H), subalpine shrubland (Ss) at 900 m in Shimokawa (I), all habitats in Shikotsu (B) and Tomakomai (C), grassland (Gr) in Koshimizu (J), and the mixed forest (Mf) in Akkeshi (L) (Fig. 1).

Table 2. The presence of shrews on 14 islands near the mainland of Hokkaido. Su—*Sorex unguiculatus*, Sc—*S. caecutiens*, Sg—*S. gracillimus*, Sm—*S. minutissimus*, nr—no records, p—present, — —not studied.

No.	Island	Species			
		Su	Sc	Sg	Sm
1	Oshimakojima	—	—	—	—
2	Oshimaohshima	nr	nr	nr	nr
3	Okushiri	nr	nr	nr	nr
4	Yagishiri	nr	nr	nr	nr
5	Teuri	—	—	—	—
6	Rishiri	p	nr	p	nr
7	Rebun	p	nr	p	nr
8	Kunashiri	p	p	p	p
9	Shikotan	p	nr	nr	nr
10	Habomai arch.	?	?	?	?
11	Moyururi	nr	nr	nr	nr
12	Yururi	nr	nr	nr	nr
13	Kenbokki	—	—	—	—
14	Daikoku	p	nr	nr	nr

Numbers of the islands are the same as in Fig. 2. 1, 5, and 13: census for small mammals has not been conducted; 2 and 4: H. Abe (pers. comm.); 3: N. Kondo (pers. comm.); K. Takahashi (pers. comm.); Our record; 6 and 7: Imaizumi (1960), Abe (1967, 1988); 8, 9, and 10: Imaizumi (1960), Abe (1967), Dolgov (1985); 11 and 12: N. Kondo (pers. comm.); 14: Abe (1967), Our record. On Habomai archipelago (10), there seem to be no shrews according to Imaizumi (1960), Abe (1967), and Dolgov (1985); however, their information is ambiguous.

S. caecutiens occurred in all locations and most habitats (30 out of 32) on the mainland (Fig. 1), and was recorded on one island (Kunashiri island) out of 10 investigated (Table 2). It was the second or third most dominant species in 26 out of 32 habitats examined; however, it was the dominant in all habitats in Shikotsu (B) and Tomakomai (C), grassland (Gr) in Koshimizu (J), and the mixed forest (Mf) in Akkeshi (L) (Fig. 1). It may be worthy to note that soil in Shikotsu and Tomakomai study areas consists of volcanic ashes.

S. gracillimus occurred in 8 out of 13 locations and 23 out of 32 habitats examined on the mainland (Fig. 1), and was recorded on 3 out of 10 investigated islands (Table 2). In addition, it was concluded that *S. gracillimus* was distributed in all parts of the mainland, by including the supplemental data of collection records. It occupied small parts of the percent composition in a majority of habitats (19 out of 23) where it occurred; however, it was the dominant shrew in *Picea glehnii* forest (Pf) in Horonobe (H), in subalpine shrubland (Ss) in Shimokawa (I), and in moor-land (Mr) and shrubland (Sr) in Sarobetsu (G) (Fig. 1). Imaizumi (1972) reported that *S. gracillimus* was the dominant shrew in alpine area of the Hidaka Mts. It was also collected in the highlands in Ishikari district, although it has not been recorded in the lowlands (H. Abe, pers. comm. on December 1, 1988). Thus, *S. gracillimus* probably dominates other shrews in the highlands and on the moors in Hokkaido.

S. minutissimus was found only in Northern and Eastern Hokkaido (Fig. 1) and was recorded on one island (Kunashiri island) out of 10 investigated (Table 2). It

occupied very small parts of species composition where it occurred (Fig. 1). Larch plantation, the mixed forest, deciduous forest, and moor have been reported as the habitats for this shrew in Hokkaido, and these locations are at relatively low altitudes (lower than 100 m) (Abe 1961, Komiya 1972, Kondo 1986, Shimazaki and Masatomi 1986). We obtained this species from a relatively high habitat (*Picea glehnii* forest at 500 m) in Horonobe (H). This is new information on the distribution of *S. minutissimus* in Hokkaido.

S. unguiculatus and *S. caecutiens*, or *S. unguiculatus* and *S. gracillimus*, were the dominant and the second most dominant species in all habitats examined (Fig. 1). However, the combination of *S. caecutiens* and *S. gracillimus* was not recorded as the dominant and the second dominant species. This finding might indicate that interspecific competition is more severe between *S. caecutiens* and *S. gracillimus* than between the other species combinations (excluding *S. minutissimus*).

Acknowledgments: Drs H. Abe and T. Saitoh reviewed the early manuscript and gave us important suggestions. Dr M. Yoneda permitted us to use the data of his Ph. D. dissertation. Drs N. Kondo and K. Takahashi supplied their unpublished data for us. The students of Institute of Applied Zoology, Hokkaido Univ., members of Shiretoko Animal Research Group, and the staffs of the College Experiment Forests of Hokkaido Univ. and Hokkaido Experimental Forest of the Univ. of Tokyo supported our field surveys. We wish to thank all of them deeply.

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Received 19 March 1990, accepted 27 February 1991.