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Short Communication

Burrowing Habits and Earthworm Preferences of Three Species of *Sorex* in Hokkaido

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Yoshino and Abe (1984) investigated the burrowing habits of *Sorex unguiculatus* and *S. caecutiens* in Hokkaido. They revealed that *S. unguiculatus* made burrows down to 30 cm and frequently used underground foods, while *S. caecutiens* made only superficial burrows and did not take food in deep soil. In Hokkaido, there is in fact another common *Sorex* species, *S. gracillimus* (Ohdachi and Maekawa 1990a), the diet of which is more similar to that of *S. caecutiens* than that of *S. unguiculatus*. The main prey of *S. gracillimus* and *S. caecutiens* is small epigeal arthropods, while that of *S. unguiculatus* is earthworms (Ohdachi in preparation). It is suspected, therefore, that *S. gracillimus* shows epigeal habits as does *S. caecutiens*. It is of interest to establish whether *S. caecutiens* and *S. gracillimus* potentially use earthworms in their diets, which are the main food of *S. unguiculatus* and an abundant underground food resource. In this study, I examined the burrowing habits and earthworm preferences of *S. unguiculatus*, *S. caecutiens*, and *S. gracillimus* in Hokkaido.

Materials and Methods

Ten *Sorex unguiculatus*, 10 *S. caecutiens*, and six *S. gracillimus*, which were captured in Yufutsu Moor (Tomakomai, Hokkaido, Japan) between 14–18 June 1992 and in a wind-shelter belt near the Teshio Experimental Forest of Hokkaido University (Horonobe, Hokkaido) between 25 June and 27 August 1992, were used for experiments. The trapping procedure was basically the same as described by Ohdachi (1992). Captured animals were kept individually in plastic cages (35 cm L × 20 cm W × 25 cm H) under a "16-hr light, 8-hr dark" photoperiodic cycle at 20 ± 2°C. Mixed paste diet was supplied every day. The diet was made of pork meat, pork liver, canned tuna, dog chum, and pellets for rabbits. Experiments were conducted from 4 October to 6 December, 1992.

The burrowing habits of the shrews were examined as follows: a frozen silkworm pupa (*Bombyx mori*) was placed at each of the four bottom corners of a plastic cage, and then a 15cm deep layer of soil was put into the cage. The soil hardness was approximately 1.5 kg/cm². A wooden nest box was placed on the center of the soil surface, and trays of the mixed paste and water were placed on the nest box. A shrew was introduced into the experimental cage

during the light period (about two hours after the light was put on). Approximately 24 hours later, the shrew was removed from the experimental cage. Then, it is examined whether the shrew made simple vertical burrows, a tunnel system (complex burrows with more than two entrances and/or horizontal burrows), or neither of them and whether the silkworm pupae at the bottom corners were eaten. Preliminary observations showed that all the three species preferred the silkworm pupae to the artificial foods.

The earthworm preferences of the shrews were examined as follows: a living earthworm (*Pheretima* sp.) was cut into small fragments (0.1–0.6 g) and a fragment was put into an empty plastic cage with the mixed paste diet. Then, a shrew was introduced into the experimental cage and the shrew's behavior was observed either until the entire earthworm fragment was eaten, or until one hour had passed. When a shrew ate at least more than half of the earthworm fragment, I considered that the shrew "ate" earthworms. For most individuals of *S. caecutiens* and *S. gracillimus*, experiments were replicated twice, but experiments were not replicated for the other individuals. When an individual showed different results, the result of the individual was determined as to be proportional to the numbers of the replication of each result.

Results and Discussion

Most *S. unguiculatus* ate the silkworm pupae buried 15 cm under the soil surface, whereas the other two species never ate them (Table 1). Six out of eight *S. unguiculatus* constructed tunnel systems, while neither *S. caecutiens* nor *S. gracillimus* created tunnel systems although some of them made simple burrows (Table 1). Additional observations revealed that one *S. caecutiens* constructed a crude tunnel system when it was kept in a large cage (65 cm L × 30 cm W × 38 cm H) with soil (12 cm deep) for more than four days, but no

Table 1. Burrowing habits of three *Sorex* species in Hokkaido.

	<i>S. unguiculatus</i>	<i>S. caecutiens</i>	<i>S. gracillimus</i>
No. of shrews examined	8	9	5
No. of shrews which ate pupae in soil ^a	7	0	0
No. of shrews which made tunnel systems	6	0	0
No. of shrews which made simple burrows ^b	2 (8.0 cm) ^c	6 (3.2 cm)	2 (5.5 cm)

^aThe number of the shrews which ate at least one out of the four silkworm pupae placed at the bottom corners (15cm under the soil surface) of a cage.

^bExcept for the shrews which made tunnel systems.

^cMean maximum depth of observed holes.

S. gracillimus constructed tunnels even if kept in the large cage for more than five days. Thus, *S. unguiculatus* had the greatest burrowing ability and *S. gracillimus* the lowest, while *S. caecutiens* was intermediate.

The interspecific differences in burrowing ability appear to be related to morphology. *S. unguiculatus* has relatively large forefeet with long claws to its body size, while the other two species have relatively small forefeet with short claws (Abe 1967). In addition, body weights are the greatest in *S. unguiculatus*, intermediate in *S. caecutiens*, and smallest in *S. gracillimus* (Ohdachi and Maekawa 1990b). It is plausible that large forefeet with long claws are good digging tools and that a large body size guarantees a robust muscle system for the forelimbs and supplies sufficient energy for digging.

All *S. unguiculatus* ate earthworms (*Pheretima* sp.) while some *S. caecutiens* and most *S. gracillimus* did not eat them (Table 2). This result was consistent with that of dietary analysis of wild-caught shrews (Ohdachi in preparation); *S. unguiculatus* was a heavy consumer of earthworms, *S. caecutiens* consumed them only as a small portion of its diet, and *S. gracillimus* did not eat them at all. Furthermore, all *S. unguiculatus* ate the entire earthworm fragments within a few minutes. An additional experiment demonstrated that *S. unguiculatus* even attacked whole earthworms (1–2 g) immediately after earthworms were introduced to shrews, and ate them within a few minutes (see also Yokohata 1990). In contrast, *S. caecutiens* and *S. gracillimus* hesitated to eat the earthworm fragments although they frequently smelled them.

Earthworms seem not to be a good food item for *S. caecutiens* and *S. gracillimus*, since their gape and body sizes are too small to handle a large animated earthworm. However, handling efficiency does not fully explain the interspecific difference in earthworm preference, because earthworms were cut into small fragments in the present study so that *S. caecutiens* and *S. gracillimus* could deal easily with them. The smell or chemical substances might provoke the disfavor against earthworms in these species.

It may be worthy to note the following anecdote. Another kind of earthworm (*Eisenia foetida*) was also used in an additional experiment, instead of *Pheretima* sp. However, *S. caecutiens* and *S. gracillimus* did not eat *Eisenia*

Table 2. Earthworm preferences of three *Sorex* species in Hokkaido.

	No. of shrews which ate earthworms ^a	No. of shrews which did not eat earthworms ^b
<i>S. unguiculatus</i>	10	0
<i>S. caecutiens</i>	6.5	3.5
<i>S. gracillimus</i>	1	5

^{a,b}The numbers of shrews which either ate or did not eat an earthworm fragment within one hour. When an individual showed different results among replications of experiment, the result of the shrew was determined as to be proportional to the replication of each result.

foetida and even *S. unguiculatus* hesitated to eat it.

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