

A New Species of *Sorex* (Insectivora, Soricidae) from Sado Island, Japan

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Abstract A new species of red-toothed shrew belonging to the *caecutiens-arcticus* section of the *Sorex minutus* group is described from Sado Island, under the name *Sorex sadonis*. The species is similar to *Sorex arcticus* KERR, 1792 in having a large skull and massive teeth, but the 2nd lower tooth has a secondary cusp and the lateral pelage is much darker than the ventral. This species is easily distinguished from *Sorex shinto shinto* THOMAS, 1905 from Honshu, *Sorex shinto saevus* THOMAS, 1907 from Hokkaido, and *Sorex shinto shikokensis* ABE, 1967 from Shikoku, Japan, by the much bigger claws of the forefoot and the decidedly darker coloration.

The terrestrial mammal fauna of Sado Island, Japan, has attracted the attention of a number of mammalogists during last fifty years (ABE, 1967; JONES, J. K. & Y. IMAIZUMI, 1958; KATO, 1971, KURODA, 1940, 1971; MIYAO *et al.* 1967; NAWA, 1964; TOKUDA, 1933). They collected small mammals at several places on this island, which is about 857 square km and separated from Honshu by the Strait of Sado. The strait is about 32 km wide and more than 200 m deep.

In the late spring of 1972, a red-toothed shrew was obtained on this island and donated to the Mammal Section of Department of Zoology, National Science Museum by Mrs. Kyoko KATO. It was the first record of *Sorex* from this Island. We at once noticed that the specimen was different from the common red-toothed shrew of Honshu, *Sorex shinto shinto* THOMAS, 1905, in its much darker coloration and bigger claws.

After that, other specimens of the same shrew were collected at several places (Table 1) on the island by Mrs. Kyoko KATO, and Messrs. Haruo SATO, Takashi SAITO, Kazuhiko MACHIDA and Teruyuki KOMIYA, which we have had the opportunity to study.

After careful examination of six specimens, we concluded that the shrew is an undescribed species related both to *Sorex arcticus* and superspecies *caecutiens*, but clearly different from them. This new form is described here.

Sorex sadonis sp. nov.

[Japanese name: Sado-togarinezumi]

Holotype. NSMT-M16180, adult female, skin and skull, obtained from the neighborhood of human habitations, Ikari, Sawada-machi, Sado-gun, Sado Island, alt. 20 m, by Mrs. Kyoko Kato, on 19th April 1972. The holotype is preserved in the

Table 1. Examined materials of *Sorex sadonis* sp. nov. from Sado Island.

Collection no.	Collecting site	Collector
NSMT-M16180 (skull and skin)	Alt. 20 m, Ikari, Sawada-machi	K. KATO
NSMT-M26602 (skull and in spirits)	Ditto	Ditto
NSMT-M26593 (skull and skin)	Alt. 40 m, Kawachi, Ryotsu City	H. SATO
NSMT-M26601 (skull and in spirits)	Ditto	Ditto
NSMT-M26600 (skull and in spirits)	Alt. 50 m, Tatsuma, Ryotsu City	Ditto
OB 2309 (skull and skin)	Alt. 350 m, Shimizu-Daira, Niigata Prefectural Reserve for Japanese crested ibis, Niibo-mura	T. KOMIYA
SM81.9.1 (skull and skin)	Alt. 896 m, Mt. Myoken	T. SAITO and K. MACHIDA

Table 2. External measurements (in mm) of *Sorex sadonis* sp. nov. from Sado Island.

Collection no.	Total length	Tail length	Head and body	Tail percent	Hind foot cum unguis	Hind foot sine unguis	Ear length	Body weight
1. NSMT-M16180 ♀ adult (Holotype)	121.0	43.5	77.5	56.1	13.5	12.3	7.0	8.8
2. NSMT-M26602 ♀ subadult	99.5	41.0	58.5	70.1	12.8	11.5	6.5	—
3. NSMT-M26593 ♂ old	108.0	40.0	68.0	58.5	13.0	11.5	—	6.1
4. NSMT-M26601 ♀ adult	100.0	40.0	60.0	66.7	14.0	12.3	7.5	5.2
5. NSMT-M26600 ♂ adult	113.0	44.0	69.0	63.8	13.0	12.2	7.5	9.1
6. OB 2309 ♂ subadult	109.0	46.5	62.5	74.4	14.0	13.0	7.1	6.0
7. SM81.9.1 ♂ adult	108.0	49.0	59.0	83.1	13.7	12.5	8.0	4.7

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Measurements of the holotype (in mm). Head and body 72.5, tail 43.5, hind foot cum unguis 13.5, hind foot sine unguis 12.3, ear 7.0, body weight 8.8 g (measured in the fresh specimen). Greatest length of skull with incisor 18.36, condylobasal length of skull with incisor 18.16, cranial breadth 8.67, maxillary width 4.91, interorbital width 3.59, width across M2–M2 4.42, length of the upper tooth row 7.80, length of the unicuspid tooth row 2.50, length of mandible 8.48.

Diagnosis: Belongs to the *minutus* group. Similar to *Sorex arcticus* KERR, 1792 and superspecies *caecutiens* which contains *Sorex caecutiens* LAXMANN, 1788, *Sorex shinto shinto* THOMAS, 1905, *Sorex shinto saevus* THOMAS, 1907, and *Sorex shinto shikokensis* ABE, 1967, but different in much darker pelage both on dorsal and lateral surfaces, longer claws, and the following cranial and dental characters. Skull and teeth relatively large and massive; coronoid fossa broad and deep, posterior mandibular canal open in deeper portion of mandibular fossa than in superspecies *caecutiens*. First 4

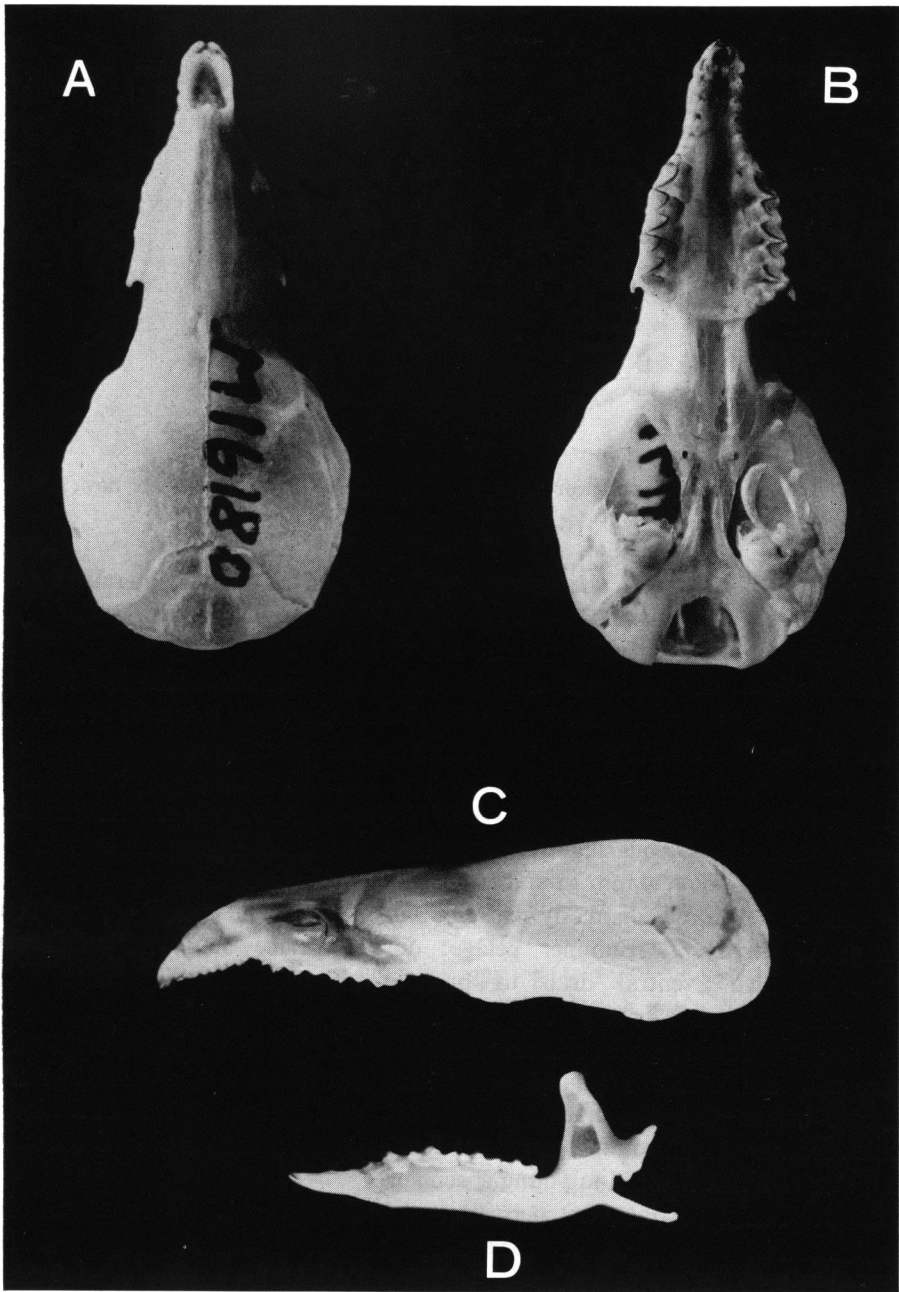


Fig. 1. Skull of *Sorex sardonis* sp. nov., holotype, NSMT-M16180, adult, ♀. A, Dorsal aspect of cranium; B, Ventral aspect of cranium; C, Lateral aspect of cranium; D, Lateral aspect of mandible.

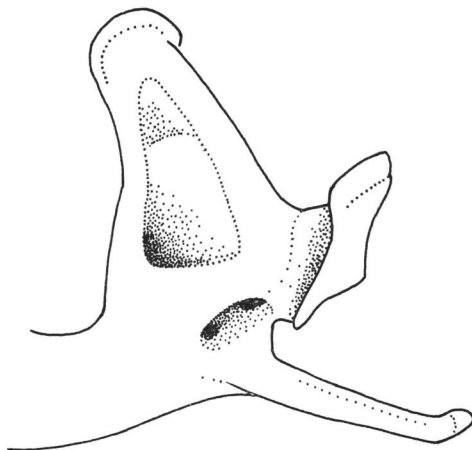


Fig. 2. Lateral aspect of posterior portion of mandible of *Sorex sadonis* sp. nov., NSMT-M16180, ♀, adult, holotype.

unicuspids not in pairs with the points forming a convex line in lateral aspect, 1st nearly equal or higher than 2nd, latter subequal to or higher than 3rd, 4th much higher than 5th, but clearly lower than 3rd.

Description: Ear moderate, projecting slightly above fur, which is soft but not as smooth as that of *shinto*, *saevus*, *shikokensis* and *caecutiens* in winter pelage. Rhinarium larger, blackish brown in color, much darker than that of superspecies *caecutiens* group. Front and hind feet sine unguis, slightly larger than typical *shinto*, but not larger than *saevus* and *shikokensis* (ABE, 1967). Tail evidently shorter than *shinto*, *saevus* and *shikokensis*, but slightly longer than *caecutiens* from Khabarovsk.

Fur of back about 4 mm in summer pelage, and about 6 mm in winter pelage. Pelage faintly 3-colored, distinctly darker both in dorsal and lateral regions than in superspecies *caecutiens*. Summer pelage: dorsal surface between "olivebrown*" and "clove brown"; ventral "drab" to "buffy brown" except for "light drab" throat; lateral surface "Prout's brown" with a clear line of demarcation on flank. Winter pelage: slightly darker, dorsal surface "sepia," ventral "drab" to "light drab," lateral surface "Saccardo's umber" "changing to "snuff brown" on side of neck just behind ears, also with a clear line of demarcation on flank. Back of front and hind feet blackish brown. Tail 2-colored, upper surface dark brown and ventral surface whitish, with a blackish brown pencil in young specimens.

Skull: Facial portion very massive and braincase relatively large and broad. Nare, infraorbital foramen and foramen magnum larger than in *caecutiens* and *shinto*. Posterior margin of nare extending to level of middle of 4th unicuspid. Postglenoid process well developed. Mandible large and massive, especially in ramus. Angular process long postero-ventrally. Coronoid fossa deep and wide in lower portion,

* Color names in quotation marks are of RIDGWAY, 1912.

Table 3. Cranial and dental measurements (in mm) of *Sorex sadoensis* sp. nov. from Sado Island.

Collection no.	Greatest length of skull with I	Greatest length of skull without I	Condylbasal length of skull with I	Condylbasal length of skull without I	Cranial breadth	Maxillary width	Interorbital width	Incisor width	Width across M2-M2	Length of the upper unicuspid tooth row	Length of the upper tooth row	P4-M3 length	Length of mandible	Height of coronoid process	Coronoid process-condyle length	Length of mandibular toothrow
NSMT-M16180 ♀ adult (Holotype)	18.36	17.94	18.16	17.78	8.67	4.91	3.59	1.57	4.42	2.50	7.80	4.47	8.48	4.38	3.15	5.17
NSMT-M26602 ♀ subadult	18.50	17.92	—	—	8.77	4.95	3.36	1.57	4.36	2.50	7.80	4.43	7.99	3.81	2.94	4.98
NSMT-M26593 ♂ old	17.46	17.40	17.50	17.25	8.03	4.76	3.59	1.53	4.35	2.50	7.30	4.10	8.10	4.00	3.03	5.09
NSMT-M26601 ♀ adult	17.01	16.59	16.40	16.35	7.75	4.47	3.46	1.07	4.23	2.30	7.70	4.36	7.46	3.38	2.82	4.92
NSMT-M26600 ♂ adult	16.57	16.42	16.45	16.13	8.12	4.31	3.24	1.39	4.08	2.20	7.30	4.16	8.46	3.85	3.14	4.78
OB 2309 ♂ subadult	19.15	18.57	—	—	9.06	5.00	3.35	1.64	4.49	2.70	7.90	4.36	9.33	4.61	3.40	5.08
SM81-9.1 ♂ adult	18.35	17.81	18.03	17.61	8.64	4.87	3.35	1.49	4.26	2.75	8.00	4.44	8.39	4.23	3.09	5.03

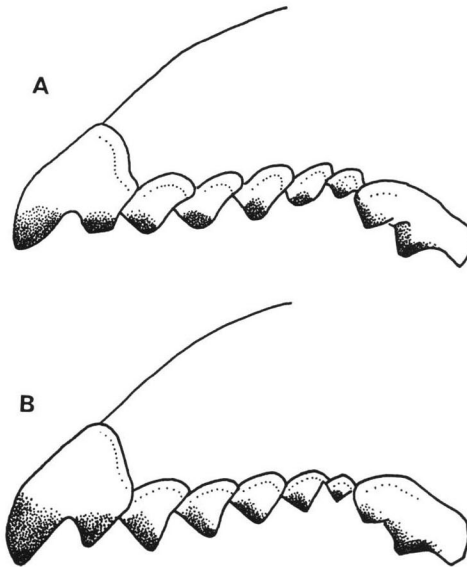


Fig. 3. Lateral aspect of anterior portion of tooththrow of *Sorex sadonis* sp. nov. A. NSMT-M16180, ♀, adult, holotype; B, NSMT-M26602, ♀, subadult.

antero-lower corner in particular roundish not angular mandibular in *shino*. Mandibular fossa also deep, posterior and anterior mandibular canals open in relatively deep portion, the posterior one linking mandibular and coronoid fossae.

Teeth: Teeth not so heavily pigmented, and pigment not extending to basins of molariform teeth as in *daphaenodon*. First 4 unicuspid not in pairs with the points forming a convex line in lateral view; 5th is lowest, not extending to the line of points, 4th much higher than 5th and distinctly lower than 3rd, 1st subequal to or higher than 2nd which is subequal to or slightly higher than 3rd. Posterior cusp of upper I 1 distinctly lower than 1st unicuspid as in *daphenodon*. When viewed from below, the crowns are squarish in outline, as broad as long except for 1st; crown area of 1st is triangular, much longer than broad, gradually diminishing in breadth to pointed anterior end, each crown area gradually reduced from 1st to 4th, 4th and 5th subequal. Upper 4th premolar with a shallow posterior concavity and distinct and more lingual protocone, which is vestigial and nearer to main cusp in *shinto*, *saevus*, *shikokensis* and *caecutiens*. Lower 2nd and 3rd teeth larger than in *shinto*, *saevus*, *shikokensis* and *caecutiens*, 2nd with a secondary cusp.

Remarks

This new species, *Sorex sadonis*, undoubtedly belongs to the *caecutiens-arcticus* section of the *minutus* group but is unique among the members of this section in its fairly big claws, almost blackish-brown dorsal surface and clearly 3-colored pelage.

The *caecutiens-arcticus* section of the *minutus* group as here understood contains such East Asiatic middle-sized forms as *S. caecutiens* LAXMANN, 1788, *S. shinto* THOMAS, 1905 with its subspecies, and *S. arcticus* KERR, 1792. They are generally 2-colored with light brown back both in summer and winter pelages and rather small claws. The hind claws of *S. sadonis* are fairly long, 1.5 to 2.2 mm, clearly exceeding the range of $M \pm 2SD$, 1.3 to 2.3 mm, of *S. shinto shinto* (N=30) and slightly but evidently longer than the 1.5 to 2.0 mm, of a large-clawed subspecies of the latter, *S. shinto shikokensis* ABE, 1967.

In its 3-colored pelage with dark dorsal surface and big claws, *S. sadonis* is rather similar to *S. daphaenodon* THOMAS, 1907, *S. unguiculatus* DOBSON, 1890, and some forms of *S. arcticus* KERR, 1792 which is characterized by a 2nd lower tooth (C) with a simple cone.

As shown in the following key which is only slightly modified from the useful key for the Palearctic species of CORBET (1978), *S. sadonis* falls into *arcticus* section, but it is clearly distinguished by several characters.

- 1a. Tail over 90% of head and body; 5th unicuspid tooth usually well developed, almost as large as 4th
 - S. alpinus* SCHINZ, 1837 (St. Gothard Pass, Uri Canton, Switzerland)
 - S. cylindricaudata* MILNE-EDWARDS, 1872 (Darin, 40 km N. W. Korsakoff, Sakhalin)
 - S. bedfordiae* THOMAS, 1911 (Omisan, 2896 m, Szechaun, China)
- 1b. Tail under 90% of head and body: 5th unicuspid usually very small.....(2)
- 2a. 2nd unicuspid smaller than 3rd which is equal to 1st.....
 - S. buchariensis* OGNEV, 1921 (River Davan-su, Peter the Great Ridge, N. W. Russian Pamir Mtns.)
 - S. minutus* LINNAEUS, 1766 (Altaisky Krai, near Barnaul, West Siberia)
- 2b. 2nd unicuspid equal to or larger than 3rd.....(3)
- 3a. Claws of front feet very large, over 3 mm, condylobasal length 18.4–21 mm..
 - S. unguiculatus* DOBSON, 1890 (Sakhalin)
- 3b. Claws of front feet not over 3 mm.....(4)
- 4a. Very large; hind feet over 16 mm, condylobasal length over 22 mm; posterior cusp of upper 1st tooth small, scarcely projecting beyond cingulum of 1st unicuspid; 4th unicuspid larger than 3rd
 - S. mirabilis* OGNEV, 1937 (Kishinka River, Primorsky Krai, Eastern Siberia)
- 4b. Smaller; hind feet under 16 mm, condylobasal length under 22 mm, posterior cusp of upper 1st tooth exceeding cingulum of 1st unicuspid; 4th unicuspid not larger than 3rd.....(5)
- 5a. Pelage uniformly dark, ventral surface only slightly lighter than dorsal, without a clear line of demarcation on flank
 - S. sinalis* THOMAS, 1912 (72 km S. E. of Fenghsiang-fu, 3150 m, Shensi, China)
 - S. gravesi* GOODWIN, 1933 (Monoma River, 128.7 km E. of Troitskov,

- Maritime Province, Eastern Siberia)
- S. isodon* TUROV, 1924 (N. E. corner of Lake Baikal, Sosnovki, Barguzin Ridge, Buryat-Mongolsk U.S.S.R.)
- S. ruthenus* STROGANOV, 1936 (Lake Seliger, Kalini district, Russia)
- S. raddei* SATUNIN, 1895 (Georgian S.S.R., near Kutais, U.S.S.R.)
- 5b. Ventral pelage distinctly lighter than dorsal.....(6)
- 6a. Teeth heavily pigmented, pigment extending into basins of molariform teeth....
S. daphaenodon THOMAS, 1907 (Darine 40.2 km N. W. of Korsakoff, Sakhalin)
- 6b. Teeth not so heavily pigmented.....(7)
- 7a. Larger; condylobasal length 18.3–20.3 mm.....
S. vir G. M. ALLEN, 1914 (Nizhne Kolymsk, N. E. Yakutia, U.S.S.R.)
S. asper THOMAS, 1914 (Tekes Vallery, Tien Shan Mts.)
S. araneus LINNAEUS, 1758 (Uppsala, Sweden)
S. caucasicus SATUNIN, 1913 (Bakuryani, Tbilisi, Georgian S.S.R., U.S.S.R.)
- 7b. Smaller; condylobasal length 12.0–18.3 mm.....(8)
- 8a. First 4 unicuspid in pairs, in lateral aspect 1st equal in size to 2nd, 3rd smaller and equal to 4th, 5th very small
S. caecutiens LAXMANN, 1788 (Lake Baikal, Siberia)
S. shinto THOMAS, 1905 (Makado, Aomori Ken, N. Hondo, Japan) (including *S. s. saevus* THOMAS, 1907, *S. s. shikokensis* ABE, 1967)
S. cinereus KERR, 1792 (At mouth of Severn River, Ft. Severn, Ontario, Canada)
- 8b. Unicuspid not grouped in this was.....(9)
- 9a. Smaller; condylobasal length 12.0–15.9 mm, first 4 unicuspid with the points forming an almost straight line
S. minutissimus ZIMMERMANN, 1780 (Bank of Kiiia River, Mariinsk, Kemerovsk, Obl., U.S.S.R.)
- 9b. Larger, condylobasal length 15.7–18.4 mm, first 4 unicuspid with the points forming a convex line.....(10)
- 10a. Posterior cusp of 1st upper tooth as high as or higher than 1st unicuspid, 2nd lower tooth without a secondary cusp; pelage light, lateral surface not markedly darker than ventral
S. arcticus KERR, 1792 (Hudson Bay, Ontario, Canada)
- 10b. Posterior cusp of 1st upper tooth lower than 1st unicuspid, 2nd lower tooth with a secondary cusp; pelage dark, lateral surface much darker than ventral
S. sadonis sp. nov. (Sado, Japan)

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