A NEW SPECIES OF SHREW (SORICIDAE, INSECTIVORA) FROM ALASKA

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A new species of shrew from Alaska is described. Specimens of this shrew were compared with a large series of *Sorex minutissimus* from eastern Siberia. Description of this species is based on univariate and multivariate analyses of 23 morphological characters and qualitative comparison of the unicuspid teeth.

Key words: *Sorex*, shrew, taxonomy, Alaska, Beringia

The Eurasian tiny shrew, *Sorex minutissimus*, is known to be widespread, but scarce, from Scandinavia to the Bering Strait. In September 1993, a single specimen of tiny shrew from Alaska was found in the collection at the University of Alaska Museum and identified as *S. minutissimus* (Dokuchaev, 1994). Six additional specimens from Alaska have been identified, thus permitting a morphological comparison of the specimens from Alaska with *S. minutissimus* in several Russian collections. The results of this analysis indicate that this shrew is a distinct species.

While it was surprising that a species of mammal remained undetected in northern North America, it was not surprising to find a species with an Eurasian affiliation on the eastern side of the Bering Strait. The recent biota on either side of the Bering Strait, originating in the Pleistocene glacial refugium known as Beringia (Chernyavsky, 1984; Hopkins, 1967; Kontrimavichus, 1984), comprises a large number of closely related taxa. Some forms on both continents are considered to be conspecific, while others constitute distinct, but closely related species, depending, among other things, on the timing of vicariance events and the period of isolation.

MATERIALS AND METHODS

In addition to the seven specimens of the tiny shrew from Alaska, 122 specimens from seven regions in eastern Russia were examined (Appendix I). The Eurasian sample contained two subspecies; *S. minutissimus tschuktschorum* and *S. m. ussuriensis* (Yudin, 1989). Only specimens that had not overwintered, as determined by slightly or moderately worn teeth, were included. Age variation, thus, was eliminated from the analysis. Males and females were combined; significant sexual dimorphism has been shown to be absent in young *Sorex* (Carraway, 1990; Dokuchaev, 1990; Stroganov, 1957; Yudin, 1989).

Seventeen cranial and dental measurements, and four external measurements from specimen labels (Table 1) were used in the analyses. In addition, length of tail and hind foot were standardized as proportions of body length (i.e., relative lengths; Table 1). Cranial and dental measurements were made with an ocular micrometer in a stereomicroscope, except condylobasal length, which was measured with calipers. Cranial breadth, palatal length, interorbital breadth, width across second upper molars, length of the molariform toothrow, and length of the unicuspid toothrow were as described in Junge and Hoffmann (1981; figure 3). Facial length is measured from the anterior medial point of the premaxillary bones to the posterior-most point on the infraorbital foramen.

Differences between means of the Alaska tiny shrew and the Asian *S. minutissimus* were tested by means of Student's *t*-test with a Bonferroni correction (Neter et al., 1985). A probability level of $P < 0.05$ was accepted as statistically significant.

TABLE 1.—*Descriptive statistics (means ± 1 SE), sample sizes (*n*), and ranges (in parentheses) of external, cranial, and dental characters in* Sorex minutissimus *and in the Alaska tiny shrew from eastern Siberia. Measurements are given in millimeters, except for weight, which is in grams, and relative length, which is in percentages.* P*-values with an asterisk are individually significant at* P *< 0.01, but not significant using the Bonferroni adjustment.*

Character	*Sorex minutissimus*	*n*	*Sorex* n. sp.	*n*	*t (d.f.)*	*P*
Condylobasal length	13.2 ± 0.04 (12.4–14.2)	122	13.3 ± 0.07 (13.1–13.6)	6	0.56 (126)	n.s.
Cranial breadth	6.32 ± 0.02 (5.92–7.04)	122	6.29 ± 0.08 (5.98–6.56)	6	0.38 (126)	n.s.
Facial length	6.27 ± 0.03 (5.75–7.06)	122	6.23 ± 0.04 (6.10–6.35)	6	0.31 (126)	n.s.
Palatal length	5.25 ± 0.02 (4.80–5.83)	122	5.25 ± 0.03 (5.15–5.35)	6	0.00 (126)	n.s.
Palatal breadth	1.39 ± 0.006 (1.22–1.58)	122	1.30 ± 0.016 (1.26–1.36)	6	3.22 (126)	<0.01*
Interorbital breadth	2.62 ± 0.010 (2.29–2.85)	122	2.41 ± 0.024 (2.32–2.49)	6	4.84 (126)	<0.001
Width across second upper molars	3.33 ± 0.008 (3.09–3.52)	122	2.99 ± 0.018 (2.93–3.03)	6	8.80 (126)	<0.001
Width across second upper unicuspids	1.46 ± 0.005 (1.35–1.63)	122	1.26 ± 0.014 (1.22–1.30)	6	8.50 (126)	<0.001
Length of upper molariform toothrow	3.29 ± 0.009 (3.09–3.50)	122	3.06 ± 0.020 (2.99–3.11)	6	5.56 (126)	<0.001
Length of upper unicuspid toothrow	1.73 ± 0.009 (1.55–2.00)	122	1.78 ± 0.015 (1.72–1.82)	6	1.23 (126)	n.s.
Length of first upper incisor	1.35 ± 0.006 (1.20–1.53)	122	1.10 ± 0.017 (1.05–1.15)	6	8.74 (126)	<0.001
Length between first upper incisor and fourth upper premolar	1.46 ± 0.009 (1.26–1.74)	122	1.59 ± 0.015 (1.54–1.63)	6	3.06 (126)	<0.01*
Height of upper first unicuspids	0.65 ± 0.003 (0.56–0.75)	122	0.52 ± 0.017 (0.46–0.55)	6	8.11 (126)	<0.001
Height of second unicuspid	0.53 ± 0.003 (0.45–0.61)	122	0.43 ± 0.017 (0.36–0.47)	6	7.49 (126)	<0.001
Height of third unicuspid	0.54 ± 0.004 (0.43–0.65)	122	0.43 ± 0.013 (0.38–0.47)	6	6.18 (126)	<0.001
Height of fourth unicuspid	0.41 ± 0.004 (0.27–0.50)	122	0.33 ± 0.019 (0.26–0.38)	6	4.75 (126)	<0.001
Height of fifth unicuspid	0.29 ± 0.005 (0.17–0.42)	122	0.25 ± 0.017 (0.21–0.32)	6	1.53 (126)	n.s.
Weight	1.9 ± 0.03 (1.4–2.9)	111	1.6 ± 0.05 (1.5–1.7)	5	3.08 (124)	<0.01*
Length of head and body	47.2 ± 0.31 (39.0–55.0)	121	46.2 ± 0.58 (45.0–48.0)	5	0.63 (124)	n.s.
Length of tail	25.4 ± 0.31 (20.0–35.0)	121	25.8 ± 0.74 (23.0–27.0)	5	0.29 (124)	n.s.
Length of hind foot	8.6 ± 0.05 (7.2–10.0)	121	8.5 ± 0.16 (8.0–9.0)	5	0.48 (124)	n.s.
Relative length of tail	54.0 ± 0.69 (39.6–72.9)	121	55.8 ± 1.51 (51.1–60.0)	5	0.55 (124)	n.s.
Relative length of hind foot	18.3 ± 0.13 (14.7–23.1)	121	18.4 ± 0.50 (16.7–19.6)	5	0.18 (124)	n.s.

TABLE 2.—*Character loadings on the first two principal components for 11 cranial and dental characters of* Sorex *n.sp. and* S. minutissimus.

Character	Principal component I	Principal component II
Palatal length	0.947	0.096
Length between the first incisor and the fourth upper premolar	0.927	−0.201
Facial length	0.926	0.143
Length of upper unicuspid toothrow	0.917	−0.045
Condylobasal length	0.823	0.224
Length of upper molariform toothrow	0.620	0.602
Palatal breadth	0.569	0.557
Width across second upper unicuspids	−0.194	0.859
Width across second upper molars	0.380	0.825
Length of first upper incisor	−0.239	0.787
Interorbital breadth	0.496	0.627
Percentage of variance explained	48.4	29.3

Principal-components analysis, factor analysis, and discriminant analysis were used to analyze cranial variation among eight geographical samples. Eleven cranial and dental characters that showed high loadings (Table 2) were used in the principal-components analysis.

RESULTS

Cranial, dental, and external measurements for the new species and *S. minutissimus* are listed in Table 1. Most cranial differences between *S. minutissimus* and the new species are in width of rostrum and shape and size of unicuspids and first incisor (Fig. 1; Table 1). There were significant differences in five cranial measurements and in height of the first four upper unicuspids (Table 1). Furthermore, width across second upper molars, across second unicuspids, and length of first upper unicuspid do not overlap. None of the external measurements differed significantly between *S. minutissimus* and the new species (Table 1).

The first principal component reflects overall size of skull (Table 2, Fig. 2) and does not distinguish *S. minutissimus* from the Alaska tiny shrew. However, the second principal component (Fig. 2) does indicate differences in shape of skull. The highest loadings onto the second principal component were mostly from width of the rostral part of the skull and size of the first upper incisor.

Three unstandardized discriminant coefficients distinguish the new species from *S. minutissimus*:

a

b

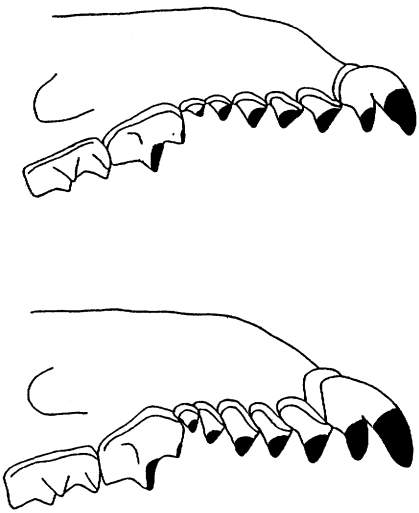

FIG. 1.—Rostra of a) *Sorex* n. sp. (UAM 19268) and b) *S. minutissimus* from coast of Okhotsk Sea, northeastern Asia (IBPN 6006).

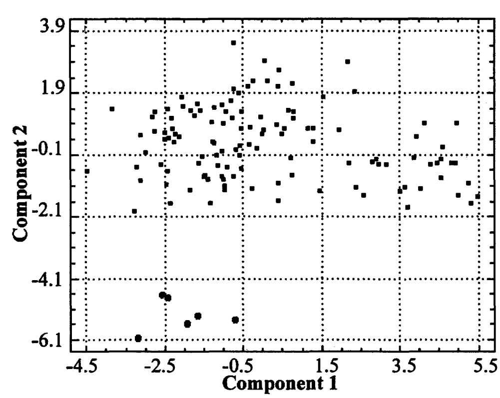

FIG. 2.—Multivariate relationships of specimens of *Sorex* n. sp. (stars) and *S. minutissimus* (squares). Projections of scores extracted from correlations of 11 cranial and dental characters are depicted.

$$Z = -23.16 - 1.75\ (CBL) + 10.56\ (M2\text{-}M2) + 8.38\ (IL)$$

(where CBL = condylobasal length, M2-M2 = width across second upper molars, and IL = length of first upper incisor). The group centroid is −5.55 for the new species and 0.27 for *S. minutissimus*. All specimens were correctly classified. These analyses indicate that the Alaska tiny shrew is a distinct taxon representing a new species.

Sorex yukonicus, new species

Holotype.—University of Alaska Museum (UAM) 19268, a subadult with the sex indicated as "male?;" skin and skull collected by Timothy O. Osborne 2 September 1987. The external measurements are given as: total length = 74 mm; length of tail = 26 mm; length of hind foot = 8.5 mm; length of hind foot (*sine unguis*) = 8 mm; weight = 1.5 g.

Paratypes.—UAM 22599, preserved in alcohol with extracted skull, collected 23 August 1982, upper Susitna River (62°49′10″N, 149°8′25″W), sex unknown; UAM 29829, skin and skeleton, collected 2 September 1993, Little Mud River drainage in Nowitna National Wildlife Refuge (64°45′N, 153°50′W), subadult female; UAM 29830, skin and skeleton, collected 26 August 1993, Yukon River 2.25 miles S, 5 miles E Bishop Rock (64°47′N, 157°11′W), female; University of Washington Burke Museum (UWBM) 39045, skull, collected 16 September 1991, Nowitna Wildlife Refuge, 43.5 miles E, 8 miles S Ruby, subadult male; UWBM 39046, skin and skeleton, collected 31 August 1991, Nowitna Wildlife Refuge, subadult female; UWBM 39047, skin and skeleton, collected 29 August 1992, 45 miles E, 4 miles S Ruby, subadult male.

Type locality.—Crow Creek, 1¾ miles N, 2¼ miles W Beaver Creek (64°44′N, 156°50′W) near Galena, Alaska.

Distribution.—Known from essentially three localities in Alaska (Fig. 3); the type locality at Galena on the Yukon River; ca. 140 km east of the type locality near the Yukon River; from the upper Susitna River, in southcentral Alaska. This last locality is in a separate major river drainage and suggests that *S. yukonicus* is widespread, albeit scarce, in subarctic Alaska.

Etymology.—Named for the Yukon River. Most of the specimens have been found along this River, which is believed to have provided a refugium of riparian forest (Hopkins, 1972) during Pleistocene glaciations.

Diagnosis.—*Sorex yukonicus* is a small shrew of the subgenus *Sorex*. Although similar to *S. minutissimus* it can be distinguished from *S. minutissimus* by its narrower rostrum, its smaller upper first incisor, and its smaller, more widely spaced, unicuspid teeth. The breath of the rostrum across the second molars is <3.10 mm and across the second unicuspids is <1.31 mm. The length of the first upper incisor is <1.16 mm. Unicuspids two, three, and four are isosceles triangles in profile, with their peaks about symmetrical to their bases (Fig. 1a). In contrast, the first four unicuspids of *S. minutissimus* are asymmetric with their peaks anterior to center (Fig. 1b).

Description.—A member of the subgenus *Sorex*. The post-mandibular canal on the jaw is well developed and the upper unicuspid teeth lack a pigmented ridge on the lingual side from apex to the cingulum. Size small (Table 1) with young-of-the-year specimens weighing from 1.5–1.7 g. The length of body is 45–48 mm, length of tail is 23–27 mm, and length of hind foot is 8.0–9.0 mm (without nail). Condylobasal length is 13.1–13.6 mm. In the one overwintered specimen (UAM 29830), all measurements are within the range of the non-overwintered specimens except for the breadth of the second upper molars (3.09 mm), which is slightly greater. The pelage is slightly tricolored with the dorsum being nearest fuscous, the flanks near hair gray, and the ventrum pale smoke gray (Ridgway, 1912). The tail is bicolored with the dorsal side being the same color as the dor-

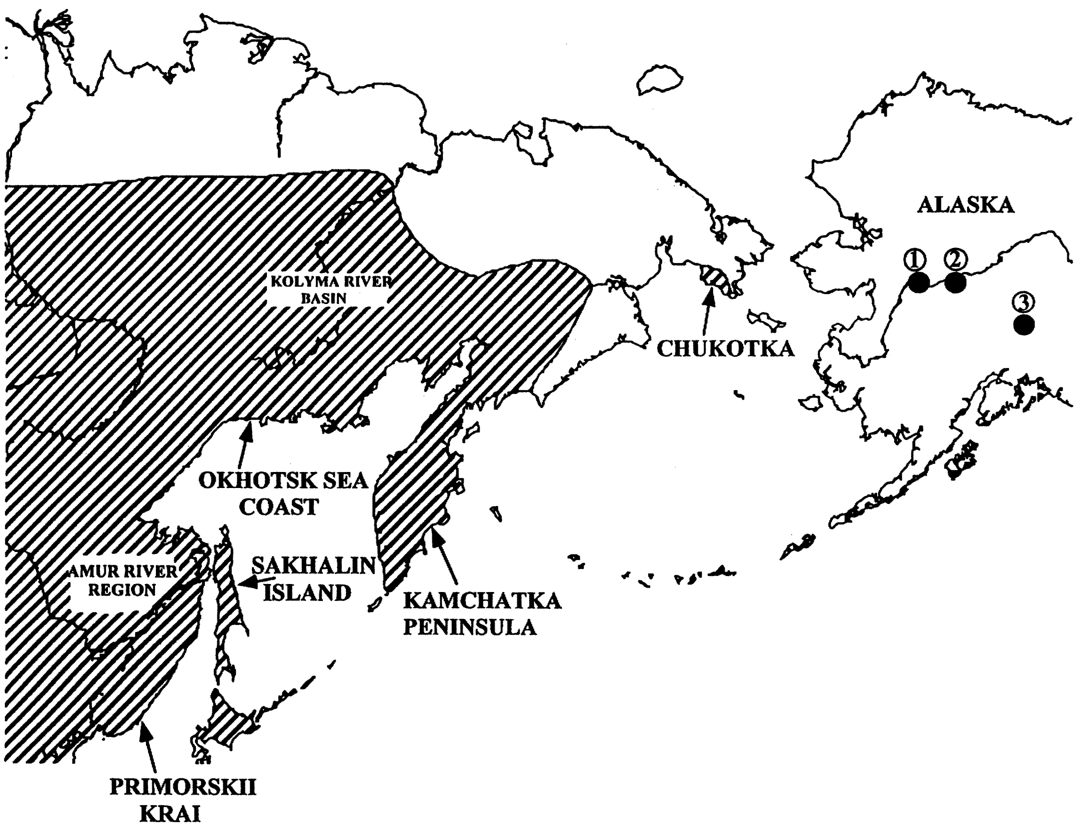

FIG. 3.—Localities for *Sorex yukonicus* in Alaska and the distribution of *S. minutissimus* in northeastern Asia (shading); an isolated locality of *S. minutissimus* is shown in eastern Chukotka; 1) the type locality and locality of paratype UAM 29830 at Galena; 2) the locality of the four specimens from the Nowitna National Wildlife Refuge, east of Ruby; 3) the upper Susitna River site. Detailed localities are given in the text.

sum, and the ventral side more white than the ventrum.

Comparisons.—*Sorex yukonicus* is probably the sister taxon of *S. minutissimus*. The latter has a vast range, from Scandinavia east to the Chukotsk and Kamchatka peninsulas, and Sakhalin and Hokkaido islands (Fig. 3). The two species are similar except for characters of the rostrum and teeth noted above. Unicuspids and the first upper incisor of *S. yukonicus* are smaller than *S. minutissimus* (Figs. 1a and 1b; Table 1). The order of size of unicuspids in *S. yukonicus* is the same as in *S. minutissimus*. The first unicuspid is largest, the second and third are, generally, equal and smaller than the first, the fourth unicuspid is smaller than the third, and the fifth is the smallest.

Sorex yukonicus may be distinguished from *S. minutissimus* by less-compact placement of the upper unicuspids and peaks of the upper unicuspids that are symmetrical to their base (Fig. 1a). A lateral view of the skull of *S. minutissimus* (Fig. 1b) shows that the upper unicuspids are relatively compressed in the toothrow; the first upper unicuspid overlaps the first upper incisor and each successive upper unicuspid overlaps previous upper unicuspid. While size and configuration of the unicuspids in *S. minutissimus* are variable (Dolgov, 1985; Yudin, 1989), none of the *S. yukonicus* examined have unicuspids like those of *S. minutissimus.*

Other small shrews in Alaska belong to the subgenus *Otisorex* (including *Sorex hoyi*, which is easily distinguished by its tiny third unicuspid).

Habitat.—All seven specimens of *S. yukonicus* were collected in riparian habitat.

Remarks.—*Sorex yukonicus*, like *S. minutissimus* in Eurasia, is either uncommon or difficult to detect by present sampling methods. All known specimens were collected using pitfall traps, a method that has been employed extensively only relatively recently by North American mammalogists. The earliest specimen was collected in 1982 during an inventory of mammals for the Susitna Hydroelectric Project; this was probably the first small-mammal survey in Alaska to employ pitfall traps extensively.

The vernacular name Alaska tiny shrew stems from the Russian common name for *Sorex minutissimus*, kroshechnaya burozubka (tiny shrew). The English name for *S. minutissimus*, least Siberian shrew, (e.g., Corbet, 1978) seems inappropriate because in North America least shrew refers to *Cryptotis parva.*

Sorex minutissimus possibly invaded Alaska as a woodland form prior to the Illinois Glaciation at the same time that the American *S. cinereus*, a woodland form as well, spread to Asia (Dokuchaev, in press). During the Illinoian glaciation, *S. yukonicus* diverged from *S. minutissimus* in Beringia. *S. yukonicus* is therefore an autochthon of Beringia.

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Appendix I

The following specimens of *Sorex minutissimus* were examined. Abbreviations are: MSU, Zoological Museum of Moscow State University; ZIN, Zoological Institute of the Russian Academy of Sciences, Saint Petersburg; ISE, Institute for Systematics and Ecology, Novosibirsk; IBPN, Institute of Biological Problems of the North, Magadan. Chukotka (3): Nunlingran (ZIN 2465, 2466, 2469). Kamchatka (28): Esso (ZIN 3710); Malki, 10 km N (ZIN 3967, 3968, 3988, 4009, 4010, 4041, 4060, 4085, 4102); Ossora (ZIN 5450); Milkovo (MSU S-91266, S-91267, S-91798, S-93453, S-93454, S-93459, S-93460, S-93462, S-93465, S-93468, S-93469, S-93471, S-93472, S-93473, S-93474, S-93475, S-93476). Kolyma River basin (21): Ust-Srednekan (ZIN 1939); Omolon River, Kegali (ISE 2821, 2824, 2826, 2827, 2829, 2830, 2831, 2832, 2833, 27874, MSU S-89059); Jack London Lake (IBPN 5998, 5999, 6000, 6001, 6002, 6003); Omolon River, 50 km S of Ust-Oloy (IBPN 6004, 6005); Seymchan (ISE 32778). Okhotsk Sea coast (12): Source of Yama River (ZIN 1881); Stekolnyi (IBPN 5995); Olomdzha River (IBPN 5996); Ul'beya River (IBPN 5997), Chelomdzha River (IBPN 6006, 6007, 6008, 6009, 6010, 6011, 6012, 6013). Amur River region (21): Selemdzha River; (ZIN 5944); Tynda (ZIN 6590, 6603); Zeyskyi Preserve (ZIN 6640, 6657); Dipkun (ZIN 7011); Erakingra River (ZIN 6880, 12841, 12848); Giluy River (ISE 12842, 12843, 12845, 12852, 12853, 12855); Amgun' River (ISE 16770, 16786, 16801); Solov'evsk (ISE 26918, 32780); Pivan' (MSU S-131742). Primorskii Krai (22): Kedrovaya Pad' Preserve (ISE 2837, 2838, 8408, 32795); Tordoki-Yani (ZIN 7168, 7171); Ussuriiskii Preserve (ISE 32796); Khrustalnyi (MSU S-118136, S-118138, S-118139, S-118141, S-118144, S-118145, S-118152, S-118156, S-118157, S-118161, S-118162, S-118164, S-118170, S-118174, S-145609). Sakhalin Island (15): (ISE 32783, 32790, 32791, 32792, MSU S-77782, S-77784, S-77788, S-77789, S-77792, S-77794, S-77797, S-77798, S-77799, S-77800, S-77801).