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Sorex trowbridgii.
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Sorex trowbridgii Baird, 1857
Trowbridge’s Shrew


S. montereyensis Merriam, 1895:79. Type locality “Monterey [Monterey Co.], California.”


S. t. humboldtensis Jackson, 1922:264. Type locality “Carson’s Camp, Mad River, Humboldt Bay, Humboldt County, California.”

S. t. mariposae Grinnell, 1913:189. Type locality “Yosemite Valley at 4000 feet altitude, Mariposa County, California.”

S. t. montereyensis Merriam, 1895:79, see above.

S. t. trowbridgii Baird, 1857:13, see above.

DIAGNOSIS. Externally, S. trowbridgii may be distinguished from other species in the genus by its sharply bicolorad tail and the dark venter that is almost concolor with the dorsum (Jackson, 1928). As with other members of the subgenus Sorex, the ridge extending from the apex of the uncus toward the interior edge of the cingulum is only slightly pigmented and almost never pigmented to the cingulum, separated from the cingulum by an anter-posterior groove, never ending in a distinct cusp. The third uncusp is smaller than the fourth; it is the only member of the subgenus with this character (Jackson, 1928; Junge and Hoffmann, 1979). Trowbridge’s shrews usually possess a post-mandibular foramen; the orbit is placed relatively far back at the level of the metastylose of M2; the laceral foramen is at the interface of M1 and M2; and the border of the infraorbital foramen is on a line between the mesostyle and metastylose of M1 (Carraway, 1987; Junge and Hoffmann, 1979; van Zyll de Jong, 1983).

GENERAL CHARACTERS. Sorex trowbridgii is a medium-sized, long-tailed shrew (Fig. 1; Jackson, 1928). The species has a dark brown pelage slightly more brownish in summer than in winter. whiskers are numerous and moderately long. The ears are almost hidden by the pelage. The tail is hairy in young animals, becoming naked as individuals age. The feet are pentadactylyous, as in all Sorex, and vary in color “from whitish to very light tan” (Maser et al., 1981:61). There are five uncusipate teeth in the upper jaw, one incisor with two cusps, and four molariform teeth; the lower jaw possesses one incisor, two uncusipate teeth, and three molariform teeth (Fig. 2). The teeth are pigmented a dark reddish-brown. The skull is medium-sized for Sorex and moderately depressed (Baird, 1857; Jackson, 1928; Maser et al., 1981; Repenning, 1967; van Zyll de Jong, 1983).

Means (in mm) and ranges (in parentheses) of five samples representing Canadian S. t. trowbridgii (van Zyll de Jong, 1983), American S. t. trowbridgii, S. t. humboldtensis, S. t. montereyensis, and S. t. mariposae (Jackson, 1928) are as follows: total length, 113.0 (104 to 124), 119.2 (113 to 130), 131.2 (129 to 133), 122.5 (114 to 131), 118.5 (116 to 121); length of tail, 54.3 (50 to 59), 55.6 (52 to 59), 60.8 (60 to 62), 52.2 (48 to 56), 50.5 (50 to 51); length of hind foot, 13.1 (12.1 to 14.5), 13.5 (13 to 14), 14.5 (14 to 15), 14.4 (13.5 to 15), 14.2 (14 to 15); condylobasal length, 17.2 (16.8 to 17.5), 17.4 (17.1 to 17.6), 18.1 (17.8 to 18.3), 18.2 (18.0 to 18.4), 18.6 (18.4 to 18.8); cranial breadth, 8.6 (8.3 to 8.9), 8.7 (8.3 to 8.9), 9.0 (8.9 to 9.1), 9.0 (8.7 to 9.2), 9.3 (9.2 to 9.4); interorbital width, 3.8 (3.7 to 3.9), 3.8 (3.6 to 3.9), 4.0 (3.9 to 4.1), 4.2 (4.0 to 4.3), 4.2 (4.1 to 4.3); maxillary width, 4.9 (4.9 to 5.1), 4.9 (4.8 to 5.0), 5.3 (5.3 to 5.4), 5.6 (5.4 to 5.7), 5.6 (5.5 to 5.7).

DISTRIBUTION. Sorex trowbridgii occurs from coastal southwestern British Columbia south of Barrand Inlet, through western Washington and Oregon to northwestern California; from there, south through the coast ranges to Santa Barbara County, California, and east to the Warner Mountains of northeastern California and south through the Sierra Nevada to Kern County, California (Fig. 3; Cowan and Guiguet, 1960; Dalquest, 1948; Hall, 1981; Verner and Bass, 1980).

FOSSIL RECORD. Sorex trowbridgii is known only from one site, an asphalt trap at Carpinteria, California, dated from the Wisconsinan (late Rancholabrean); this site is at the extreme southern edge of the species’ present distribution (Kurten and Anderson, 1980; Lundelius et al., 1983). The lack of fossils may be because there are few late Cenozoic deposits from the Pacific Coast north of San Francisco Bay (Lundelius et al., 1983). George (1988) speculated that the lineage is considerably older than late Pleistocene, possibly diverging from its ancestral stock in the early Pliocene.

FORM AND FUNCTION. There are two molts each year. Autumn molt occurs from September to early November, but a few specimens have been found molting to winter pelage as early as late July and August (Jackson, 1928; Jameson, 1955). In spring, a few animals molt to a brown summer coat; this occurs from late April to June, but takes place as late as July and August in the Sierra Nevada. The winter coat is thicker, longer, and paler in color than the summer coat (Jackson, 1928). Before their first molt, juveniles are more brownish than adults (van Zyll de Jong, 1983).

Like all Sorex, the separate cranial bones anastomose into one “compact whole” while the shrews are still juvenile, making comparison of individual bones of the skull impossible (Jackson, 1928: 1). Food consumption is high (0.91 g food g body mass<sup>-1</sup> day<sup>-1</sup> for breeding individuals; 1.43 g food g body mass<sup>-1</sup> day<sup>-1</sup> for non-breeding individuals), presumably to maintain a high metabolic rate (Rust, 1978; Terry, 1978).

ONTOGENY AND REPRODUCTION. Pregnant female Trowbridge’s shrews have been found from March to May in Washington, carrying three to four embryos (Dalquest, 1941; Scheffer and Dalquest, 1942). An average of 3.89 embryos was found in a sample of 463 Oregon females (Gashwiler, 1976). In the Sierra Nevada, S. trowbridgii breeds from February until early June, and the mean number of embryos carried is five (varying from three to six, with one occurrence of one; Jackson, 1928; Jameson, 1955).

![Photograph of Sorex t. trowbridgii from Washington.](image)

Fig. 1. Photograph of Sorex t. trowbridgii from Washington. Photograph courtesy of V. B. Scheffer.
Twelve percent of gravid females in the Sierra Nevada were lactating, suggesting that post-partum pregnancies are probably frequent (Jameoson, 1955).

Onset of sexual maturity in the Sierra Nevada is accompanied by increased mass and testis size in males and increased mass and width of the uterine horns in females. This may be affected by local conditions and variability in climate from year to year, with populations in warmer sites and during warmer years attaining maturity at earlier dates (Jameoson, 1955). Females appear to mature about 2 weeks later than males. After the conclusion of the breeding season, the reproductive structures shrink and become non-functional. Mass of breeding individuals averages 5 g, whereas mass of non-breeding individuals averages 3.8 g (van Zyll de Jong, 1983).

ECOLOGY. Predators of S. trowbridgii include barred owl (Strix varia—Leder and Walters, 1980), Pacific giant salamander (Dicamptodon ensatus—Maser et al., 1981). Domestic cats will kill Trowbridge’s shrews, but usually refuse to eat them (Maser et al., 1981).

Ticks found on S. trowbridgii include Isodes angustus and I. soricis (Bishop and Trembly, 1945; Easton and Goulding, 1974). Mites include the laelapid species Hirstionyssus obsOLEtus, H. utahensis (Herrin, 1970), Haemogamasus keegani (Whitaker and Wilson, 1974), H. occidentalis, H. reidi, Androlaelaps fahrenholzi, A. cassius, Eulaelaps stubularis, Eubrachylaelaps dehita, and Alpholaelaps apodontiae, the myobiid Protomobius brevetosus, glycyphagid species Orycterosenus soricus and Glycyphagus hypudaei, the cheyletid Euchelletia hishoppi, pygmyhordan species Pygmehorus horridus, P. designatus, P. sp., and Bakerdania sp., plus Eurytarasites sp., Cyrtolaelaps sp., Pseudoparasitus sp., Proctolaelaps sp., an unidentified aneotid (Whitaker et al., 1980), and the tarnenemid Pygmehorus plurispinosus (Mahunka, 1975). The chigger, Comasaccerus americanus, attaches in or around the ear canal of shrews, not in the paws (Easton, 1975). The only coleopteran recorded from S. trowbridgii is Leptinus testaceus (Gould and Bean, 1952; Maser and Hooven, 1971). Fleas include Neorotopsylla princeci and Corypsylla kohls (Lewin, 1974). Hertel and Danyszki (1987) found 10 to 48 (21%) individuals infected with coccidia; coccidian species included Eimeria palustris, E. vaGranit, and Isospora palustris.

Jameson (1955:340) characterized the habitat of S. trowbridgii throughout its range as “mature forest type with an abundant
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ground litter.” Dalquest (1948) stated that Trowbridge’s shrews are most common over dry ground beneath forest, are abundant in ravines and swampy woods when other shrews are absent, but avoid open meadows and marshes. Habitat at Deer Island, off the Pacific coast of Washington, is characterized by grass and tall brush, with highest abundances of shrews in “deep, rank, grass at the border of salmon-berry thickets” (Scheffer and Dalquest, 1942:333). Jackson (1928:4) stated that S. trowbridgi could be found in the “regulation” damp, mousy, shrewy habitat, but that it “displays a marked preference for the drier woods.” This preference might be explained by Dalquest’s (1941) work in western Washington demonstrating that the removal of S. vagnus from a wet ravine bottom resulted in the invasion of S. trowbridgi from surroun- dung areas (Jackson, 1928:4). Removal of populations of Peromyscus maniculatus resulted in greatly inflated numbers of both species of Sorex (Dalquest, 1941). Whitaker and Maser (1976) suggested that in densely forested areas of western Oregon where S. trowbridgi is found sympatric with other species of Sorex, S. trowbridgi is found in the greatest numbers because it possesses the least specialized diet.

The habitat of S. trowbridgi has been quantified as having a relatively thick organic layer, low water table, and large amounts of ground cover or canopy. The species is more a burrower in organic layers of soils than in the sympatric S. monticolus, which is found more often in surface debris. These two species probably are separated by micro-habitat rather than by competition; this is supported by the fact that the species are similarly distributed in all areas where they are found, sympatrically or not. In contrast, the burrowing activity of S. trowbridgi is restricted to the upper non-burrowing S. vagnus, which is displaced in drier, more friable soils (Terry, 1981).

In the Oregon Cascade Mountains, significantly more S. trowbridgi were caught in riparian fringe habitat (15 to 25 m from streamside) than in understory forest (within 3 m of streamside) (Terry, 1981). Chi-square contingency test, P < 0.05. More Trowbridge’s shrews were captured in mature forest than in old-growth or young forest, however, small samples precluded significance testing (Anthony et al., 1987).

In the central and southern Sierra Nevada, S. trowbridgi is limited to the western slope (Verner and Boss, 1980). There, the species is found from 1,230 m elevation in the upper ponderosa pine (Pinus ponderosa) forest, through the mixed conifer zone where it was most abundant, up to 2,300 m on dry slopes among Ceanothus clumps in red fir (Abies magnifica) forest (Williams, 1904, in press). At the southwestern limits of its range, Grinnell (1933:80) stated that S. trowbridgi inhabits dry hillside chapparal, as well as moist forest-shaded cañon bottoms.”

In Oregon, population densities of S. trowbridgi are greatest in uncut, mature forest, less in clear-cut forest, and the least in stands of young growth (Moore and Black, 1976; Moore, 1942). Gashwiler (1970) noted that 6 years passed before population densities on a clear-cut area approached densities in virgin forest. In contrast, Gunther et al. (1983) found the highest abundances of Trowbridge’s shrews on clear-cut plots in the Cascade Mountains of north-central Washington. They attributed this difference to a higher percentage of ground cover in Washington clear-cuts, providing a more favorable microhabitat, higher invertebrate populations than in uncut forest, and better protection from predators. Current timber-management activities of clear-cutting forest should benefit S. trowbridgi by maintaining areas with good ground cover (Silovsky and Pinto, 1974). Shrew densities do decline, however, after forest wildfires (Black and Hooven, 1974; Hooven, 1974; Hooven, 1969).

At upper elevations on the west slope of the Sierra Nevada, insectivores associated with S. trowbridgi are S. monticolus and S. palustris, and at lower elevations, S. ornatatus and S. palustris (Williams, in press). Species found with S. trowbridgi in the Trinity region of northern California include S. vagnus, Scapanus latimanus, and S. ornatatus. In the Siskiyous, S. latioralis, Tamiocetus douglassi, Glaucomys sabrinus, Tho- momys monticolus, Peromyscus maniculatus, Neotoma cinerea, N. fuscipes, Micrurus longicaudus, Clethrionomys californicus, Zapus trinitatus, Martes americana, Mustela erminea, M. fren- ata, M. vison, Procyon lotor, Urocitellus americanus, and Odoscelus hemionus (Grinnell, 1916; Kellogg, 1916). In the Cascade Moun- tains of western Oregon, S. trowbridgi is found in association with S. benditii, S. vagnus [this probably includes S. monticolus], Neotrichus gibbsii, Scapanus ornatatus, Ochotona princeps, Leptos americanus, Apodona tundri, Spermophilus beecheyi, Eutamias townsendii, Tamiasciurus douglassi, Glaucomys sabrinus, Peromyscus maniculatus, Neotoma cinerea, Clethrionomys californi- cus, Sorex arborius, S. ornatatus, S. trinitatus, Erethizon dorsatum, Mustela erminea, M. fennata, and Spilogale putorius (Hooven and Black, 1976). Sign of Thomomys mazama, Canis latrans, Procyon lotor, Lynx rufus, Ursus americ- anus, Cercus canadensis, and Odobenus hemionus has also been found in the area where Trowbridge’s shrews are caught. In the Coast Range of Oregon, S. trowbridgi has been found in association with S. pacificus, Eutamias townsendii, Peromyscus maniculatus, Microtus oregoni, M. longicaudus, Arboriris albipes, Mustela erminea, and Sylemus bachmani (Maser and Hooven, 1969), plus S. vagnus, Tamiasciurus douglassi, Glaucomys sabrinus, Ne- otoma cinerea, Clethrionomys californicus, Mustela erminea, and Leo- pus americanus (Gashwiler, 1959). In Washington, mammals associated with S. trowbridgi are S. vagnus, S. monticolus, and Neurotrichus gibbsii (Terry, 1981), plus Scapanus ornatatus, Aplo- donia rufa, Eutamias townsendii, Peromyscus maniculatus, Mi- crotus oregoni, and Zapus trinitatus (Dalquest, 1941). In studies to determine the effects of herbicides (2,4-D, atrazine, dalapon, silvex) on small mammal populations, S. trowbridgi is found in significantly greater numbers on herbicide-treated plots than on untreated plots (Black and Hooven, 1974; Boracco et al., 1979). This is interpreted as a response to the decrease of herbaceous cover and the corresponding increase in tree cover on the treated plots. Seventeen months is probably the maximum life span of S. trowbridgi, as most adults that survive a winter disappear rapidly in the dry soils of Douglas fir (Abies grandis) forest (Maser, 1968). S. trowbridgi is disappeared by the subsequent November (Jameson, 1955). Because of high spring and summer recruitment, populations in the autumn tend to be double the size of spring populations (Gashwiler, 1970).

Terry (1978:43) stated that Trowbridge’s shrews were “generalists with regard to food.” As an example, 480 stomachs of S. trowbridgi from the Sierra Nevada indicated that the diet was primarily small arthropods, including Neopterina, Coleoptera, Dip- tera, Lepidoptera, Hemiptera, and Hymenoptera, plus Archippus, Chlopoidea, Arachnida, and Planaria (Jameson, 1953). In Oregon, results of a study of 158 stomachs of wild-caught shrews found 47 types of food; the most common foods were Chilopoda (15.4%), Arachnida (11.6%), internal organs of Coleoptera (10.5%), and Mollusca (9.4%); Whittaker and Maser, 1976).

Trowbridge’s shrews often eat Douglas fir seed and other plants as well (Moore, 1942). In seed selection experiments, S. trowbridgi is restricted to smaller food items (seeds <35 mg), seemingly because of the inability to penetrate heavy seed coats and capsules, and thick exoskeletons in the case of insects. Seeds of Pseudotsuga menziesii, Pinus monticola, and Picea sitchensis are selected over those of Abies and the only seed that was rejected by S. trowbridgi is that of Digitalis purpurea (Terry, 1978). Of two stomachs ex- amined for spores, 10% of the volume of one stomach was hypogeous Endogonaceae only, with no basidiomycetes or ascomycetes (Maser et al., 1978).

Trapping for S. trowbridgi is most effective when using pitfall traps (Williams and Braun, 1983). In the Oregon Cascade mountains, significantly more shrews are caught with Museum Special snap traps than with Victor rat traps (Chi-square, P < 0.001; Anthony et al., 1987). When compared, significantly more of the “newer model” of Museum Special snap traps catch Trowbridge’s shrews than the “older” model (G-test, P < 0.001; West, 1985). In Oregon, S. trowbridgi is usually the most common shrew, and often the most common mammal collected in coniferous forest (Bailey, 1936; Maser et al., 1981).

BEHAVIOR. Hoarding behavior, wherein Trowbridge’s shrews carry seeds away from the source and bury them, has been noted in captivity (Terry, 1978). To identify whether a Douglas fir seed contains a kernel, it is necessary for S. trowbridgi to sample each seed individually, whereas mice evidently can determine this by simply picking up the seed (Moore, 1942).

Sorex trinitatus is active for 39% of a 24-hour period, in “short bursts at regularly spaced intervals followed by periods of quies- cence”; the short-lomtom cycles have an average periodicity of ap- proximately 1 h (Rust, 1978). Although Whitaker and Maser (1976) stated that S. trowbridgi is nocturnal, both Rust (1978) and Terry (1978) found that in captivity, the species was active at all times of the day and night (although more active in hours of darkness),
with no long rest periods. Old adults tend to be more active in the spring than in the winter, and young adults tend to be more active in the autumn than in the late summer; these levels of activity correspond to breeding seasons (Rust, 1978). Breeding individuals are more active than non-breeding individuals, but their food consumption is significantly less (Student’s t-test, P < 0.001; Rust, 1978).

Dudk (1948) and Maser et al. (1981) found S. truohbridgii to be the most difficult shrew to maintain in captivity. Terry (1978) was successful with a diet of canned dogfood, insect larvae, conifer seeds, and mushrooms.

**GENETICS.** *Sorex truohbridgii* from Oregon and California had diploid numbers of 34 chromosomes with 2 metacentric, 4 submetacentric, and 26 acrocentric autosomes (Brown, 1974). In an examination of allomorphic variability among 10 individuals of Trowbridge’s shrews from Oregon and Washington, 5 of 26 presumptive loci were polymorphic, and average individual heterozygosity was 0.02 (George, 1988).

**REMARKS.** The genus name *Sorex* is a Latin word meaning “shrew-mouse.” The species name *truohbridgii* is a patronym honoring Lt. W. P. Trowbridge, the collector of the type specimen. Subgenus classification of *S. truohbridgii* has been equivocal; Findley (1955) and Junge and Hoffmann (1979) assigned *S. truohbridgii* to the subgenus *Sorex* on the basis of the post-mandibular foramen, whereas van Zy lde de Jong (1983) pointed out that the structure of the unicuspids, the reduced size of the third unicusp, and the presence of 13 pairs of ribs link it to the subgenus *Olessorex*. Based on allomorphic characters and the retention of a number of ancestral morphologic characters, George (1988) suggested that *S. truohbridgii* should be classified in a third, yet unnamed subgenus along with *S. merriami* and *S. arizone*. Subspecific designations are based on variations in relative size of the tail, palate, and molarse teeth, as well as differences in coloration (Jackson, 1928).

**LITERATURE CITED**


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