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A Key to Recent Soricidae of the Western United States and Canada Based Primarily on Dentaries

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ABSTRACT Dentaries of *Notiosorex crawfordii*, *Cryptotis parva*, three species of *Blarina*, and 26 species of *Sorex* from west of the Mississippi River (U.S.) and 94°W (Canada) were examined for distinguishing characters. Additionally, subspecies of four species of *Sorex* that exhibited sufficient morphological differences were considered separately. Twenty quantitative characters and states for 12 qualitative characters were used to develop a key that can resolve the identifications of the 35 taxa under consideration primarily by use of the dentaries.

Key words: Soricidae; *Blarina; Cryptotis; Notiosorex; Sorex;* Dentary; Mandible; Identification; Western North America.

In the western United States and Canada, most soricid remains in fossil matrix, raptor pellets, and carnivore droppings are dentaries (and some rostral elements). However, few species-specific characters for dentaries have been described, and skin characteristics often are the primary basis by which some species of shrews are distinguished. Therefore, when the skin is missing or deteriorated beyond use, identification to species is difficult. Ognev (1962) and Gureev (1971) used a combination of nearly equal numbers of dentary and cranial characters to describe and distinguish taxa of fossil and Recent Palearctic soricids. In describing the subfamilies and

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genera of soricids, Repenning (1967) considered a combination of characters of the mandible and rostrum. Subsequently, application of dentary characters to separate species of soricids was limited and sporadic (Butler et al., 1989; Carraway, 1990; Diersing, 1980; Foresman and Jensen, 1992; Handwerk, 1987; Harris and Carraway, 1993; Hausser and Jammot, 1974; Jammot, 1972*a*, *b*; Junge and Hoffmann, 1981; Junge et al., 1983; Mullican and Carraway, 1990; Ruprecht, 1971; Schaefer, 1975; Vesmanis et al., 1980; Wilson, 1985; Woodman and Timm, 1992). The purpose of this paper is to provide a means of identifying soricids from western North America, north of Mexico, to species based primarily on features of the dentary. Identification of soricid species should facilitate a better understanding of the diet composition of predators and the structure of fossil and Recent small-mammal communities.

MATERIALS AND METHODS

Specimens of *Notiosorex crawfordi*, *Cryptotis parva*, three species of *Blarina*, and 26 species of *Sorex* from west of the Mississippi River (United States) and 94°W (Canada) were identified by use of published cranial and skin characteristics (Carraway, 1987, 1990; Diersing, 1980; Hall, 1981; Hennings and Hoffmann, 1977; van Zyll de Jong, 1980, 1982). *Blarina brevicauda* also was distinguished by use of morphological characters, but specimens of *B. carolinensis* (2n = 37–39, 46, FN = 44–45) and *B. hylophaga* (2n = 52, FN = 60–62) were those for which diploid number and fundamental number had been determined (George et al., 1982). Subspecies of *S. bendirii*, *S. monticolus*, *S. sonomae*, and *S. trowbridgii* that exhibited sufficient morphological differences were considered separately.

Complete dentaries for each taxon were examined for distinguishing characters. Specimens of taxa examined were selected from throughout their western distributions and included all age classes (Jackson, 1928). Nevertheless, it is possible to encounter individuals that exceed the range of variation of these samples. Only one karyotyped *Blarina carolinensis* from west of the Mississippi River was available; consequently, 15 from elsewhere in the range were used to verify identifying characteristics.

For each dentary, states for 12 qualitative characters (Fig. 1) were evaluated and 20 quantitative characters (Fig. 2; Tables 1, 2) were measured by use of an ocular micrometer and ocular protractor mounted in a Bausch and Lomb binocular microscope. Terminology for tooth morphology follows that of Butler et al. (1989), Choate (1970), Dannelid (1989), and Hershkovitz (1971). Dentary tooth nomenclature follows that of Hall (1981): *i1*, *c1*, *p4*, *m1*, *m2*, and *m3*.

Some characters in the key were used previously (Butler et al., 1989; Carraway, 1987; Carraway and Verts, 1994; Dannelid, 1989; Harris and

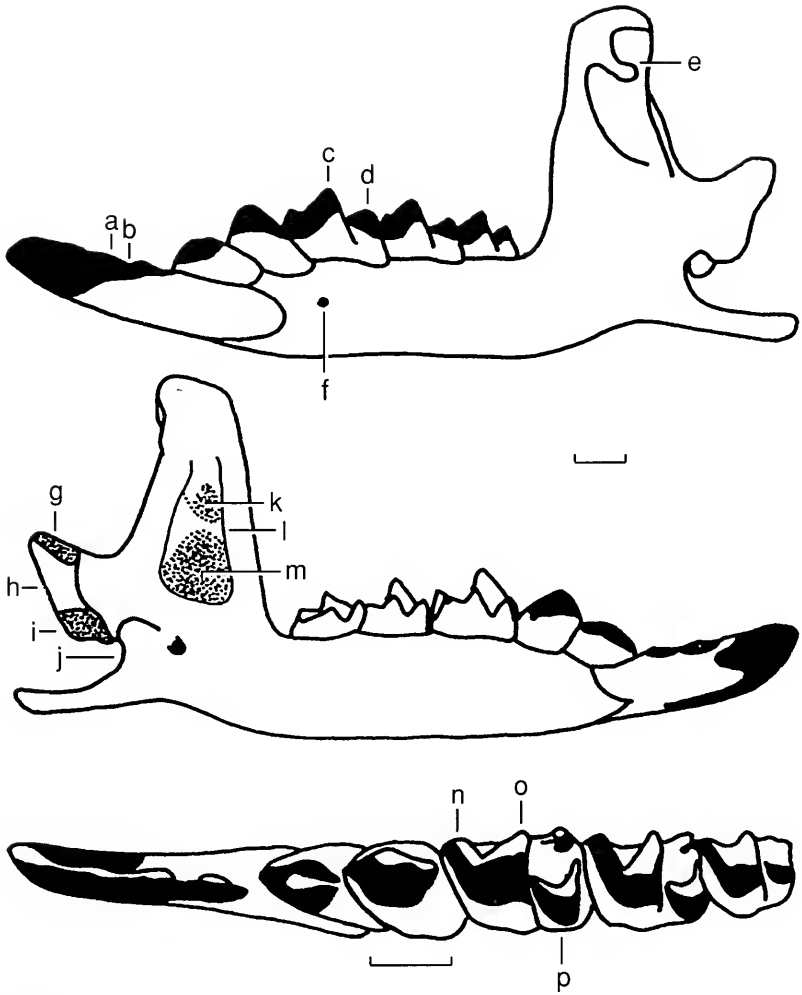


Fig. 1. Labial (top) and lingual (middle) views of dentary, and occlusal (bottom) view of mandibular tooth row of *Sorex* to illustrate qualitative characters examined. Key to characters: a = denticle; b = interdenticular space; c = paraconid; d = hypoconid; e = coronoid spicule; f = mental foramen; g = superior condylar process; h = interarticular area; i = inferior condylar process; j = lower sigmoid notch; k = superior opening of temporal fossa; l = internal temporal fossa; m = inferior opening of temporal fossa; n = paraconid; o = protoconid; and p = hypoconid. Scales in this and all other figures are 1 mm.

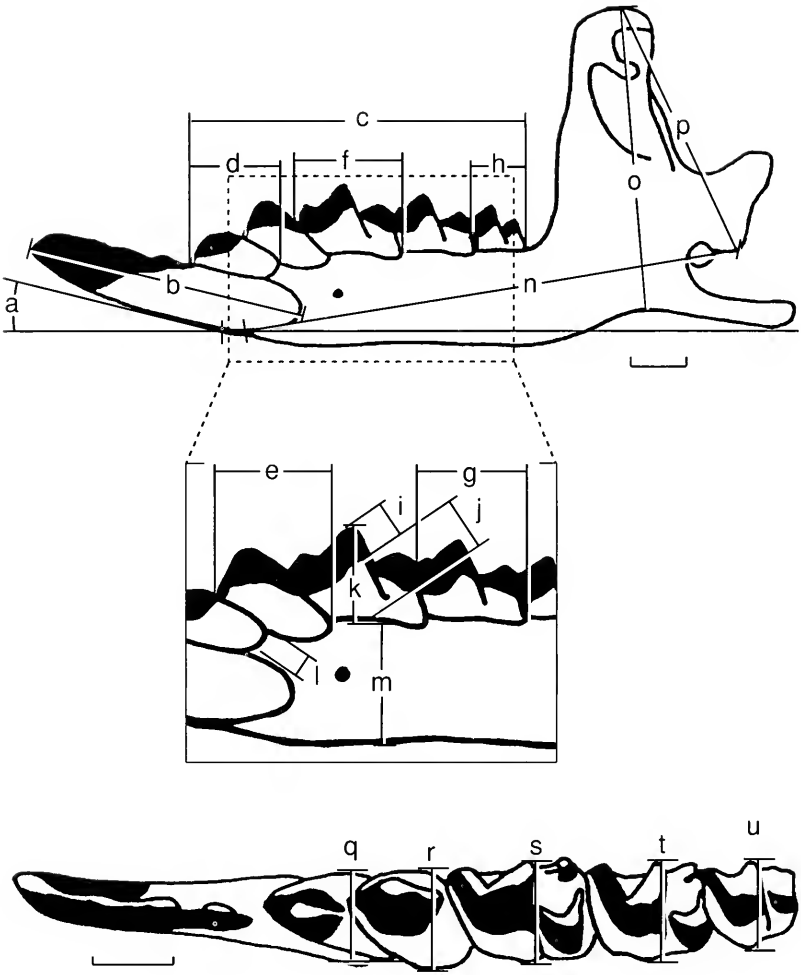


Fig. 2. Labial (top) and occlusal (bottom) views of a *Sorex* dentary to illustrate quantitative characters measured. Key to characters: a = angle e (i.e., *i1* set at an angle e from the horizontal ramus of the dentary); b = length of *i1* (used only with *Sorex hendirii);* c = length of mandibular tooth row (i.e., *c1–m3*); d = length of *c1;* e = length of *p4;* f = length of *m1;* g = length of *m2;* h = length of *m3;* i = height of pigmented portion of *m1;* j = height of unpigmented portion of *m1;* k = height of *m1;* l = distance between *i1* and *p4;* m = depth of dentary below *m1;* n = length of dentary; o = height of coronoid process; p = length of coronoid-condyloid processes; q = width of *c1;* r = width of *p4;* s = width of *m1;* t = width of *m2;* and u = width of *m3*. Note that the length of the dentary is measured from the pericentral margin of the alveolus of *i1* to the labial edge of the inferior condylar process, and that the horizontal line at the base of the dentary presents the orientation for the determination of angle e.

Carraway, 1993; Handwerk, 1987; Hausser, 1984; Repenning, 1967). For dimensions in which tooth designations are separated by a dash (e.g., *c1–m3*), the specified teeth were measured as a unit from the most anterior point to the most posterior point. For dimensions in which tooth designations are separated by a plus (+), the length of each tooth was measured individually and the values summed. This distinction is necessary, because unlike the mandibular teeth of most mammals, soricid mandibular teeth overlap one another to a considerable extent.

The key is dichotomous. Because some species are composed of geographic races of disparate sizes, it is possible for a species to be identified in more than one couplet. Camera-lucida tracings illustrate states of the qualitative characters examined and various views of the dentaries. Figures of the dentaries are drawn to the same scale and in the same orientation; however, they are not all printed to the same scale because of publishing constraints. All scale bars represent 1 mm.

Species comparisons of taxa of similar size or close geographic proximity either now or possibly during the Pleistocene follow the key. In a few instances in which no quantitative or qualitative dentary characters could be discerned, rostral characters were used. Species are listed in alphabetical order.

KEY TO THE DENTARIES

1. In labial view, alveolus of *i1* extending posteriorly beneath at least part of paraconid of *m1* (Fig. 3, left) 2

   In labial view, alveolus of *i1* not extending posteriorly beneath paraconid of *m1* (Fig. 3, right) 7

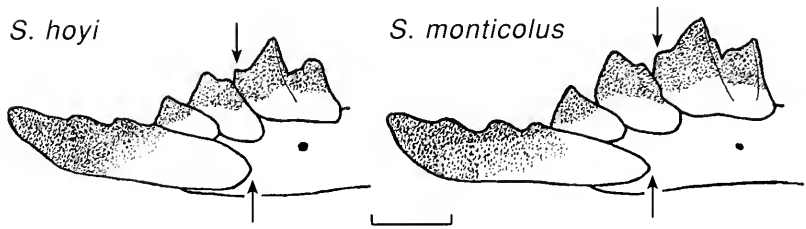


Fig. 3. Labial view of the anterior half of dentaries to illustrate *Sorex hoyi* (KU 37149) with the alveolus of *i1* (lower arrow) extending beneath *m1* (upper arrow), and *S. monticolus* (OSUFW 4747) with the alveolus of *i1* not extending beneath *m1*.

2(1). Internal temporal fossa composed of an inferior triangular opening leading directly into a superior depression; *i1* with three denticulations (Fig. 4); length of dentary usually ≤ 6.1 mm; length of *c1–m3* ≤ 4.2 mm; height of coronoid process usually ≤ 3.4 mm ..... *Sorex hoyi*, Pygmy shrew (Fig. 4)

Internal temporal fossa composed of an inferior round opening separated from a superior depression by a bar (Fig. 4); *i1* with one or two denticulations (Fig. 4); length of dentary > 6.1 mm; length of *c1–m3* > 4.2 mm; height of coronoid process ≥ 3.4 mm 3

3(2). Area between condylar processes deeply emarginate—i.e., breadth of interarticular area markedly less than that of superior condylar process (Fig. 5); internal temporal fossa characterized by small, inferior round opening separated from a superior depression by a wide bar (Fig. 4); no pigment present on *m2* and *m3;* height of unpigmented portion of *m1* ≥ 0.9 mm ..... *Notiosorex crawfordi*, Desert shrew (Fig. 4)

Area between condylar processes shallowly emarginate—i.e., breadth of interarticular area approximately equal to that of superior condylar process (Fig. 5); internal temporal fossa characterized by a large, inferior round opening separated from a superior depression by a narrow bar (Fig. 6); pigment present on *m2* and *m3;* height of unpigmented portion of *m1* ≤ 0.8 mm 4

4(3). Inferior condylar process not completely obscured in labial view (no groove separating process from lower sigmoid notch); coronoid spicule small, not extending beyond posterior edge of coronoid process in lingual view (Fig. 6); no basin in lingual side of interarticular area (Fig. 5); length of dentary ≤ 7.1 mm; length of *c1–m3* ≤ 4.9 mm; length of coronoid-condyloid processes ≤ 3.5 mm; height of coronoid process ≤ 4.1 mm; width of *m2* ≤ 1.0 mm ..... *Cryptotis parva*, Least shrew (Fig. 6)

Inferior condylar process obscured in labial view (Figs. 7); coronoid spicule large, usually extending beyond posterior edge of coronoid process in lingual view; basin may be present in lingual side of interarticular area (Fig. 5); length of dentary ≥ 8.3 mm; length of *c1–m3* ≥ 5.8 mm; length of coronoid-condyloid processes ≥ 4.3 mm; height of coronoid process ≥ 5.0 mm; width of *m2* ≥ 1.1 mm 5

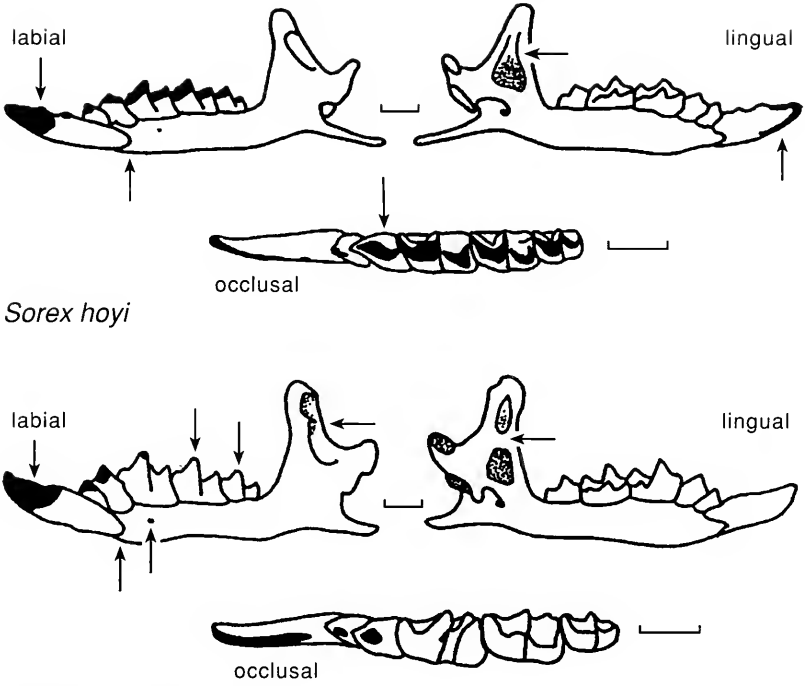


Fig. 4. Dentaries of *Sorex hoyi* (ROM 10736) and *Notiosorex crawfordi* (MSB 47947). In both taxa, note number of denticulations, relationship of posterior edge of *i1* to *m1*, and structure of internal temporal fossa. *Sorex hoyi* has pigment on posterior portion of ventromedial edge of *i1* and one posterolingually directed ridge on *p4*. *Notiosorex crawfordi* lacks pigment on *m2* and *m3*.

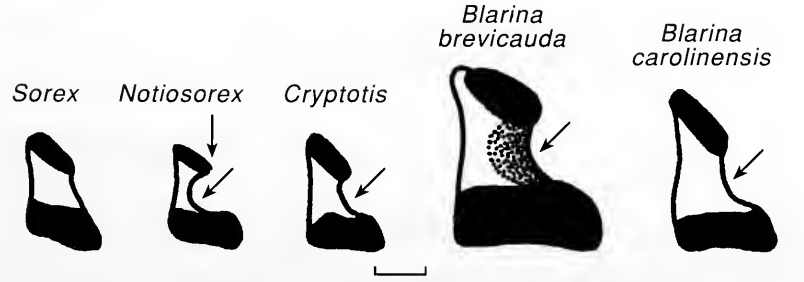
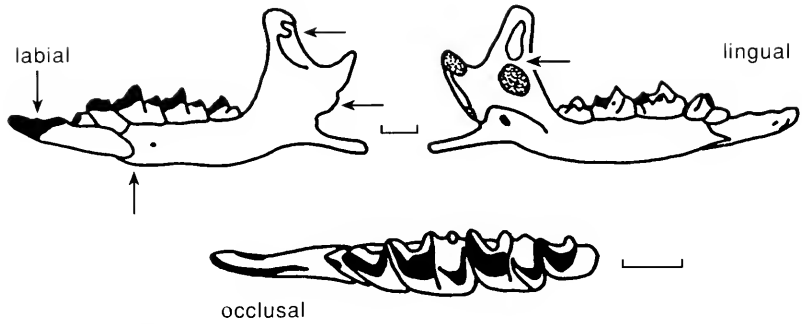


Fig. 5. Posterior views (labial to left) of condylar processes of soricids. Note the differences in the relative widths of the superior and inferior condylar processes, the amount of emargination in the lingual side of interarticular areas, and the presence or absence of a basin in the lingual side of interarticular areas.



Cryptotis parva

Fig. 6. Dentary of *Cryptotis parva* (OSUFW 4475). Note the numbers of denticulations, the relationship of the posterior edge of *il* to *m1*, size of the coronoid spicule, and structure of the internal temporal fossae.

5(4). Height of coronoid process usually ≥ 6.0 mm; length of *c1–m3* usually ≥ 6.5 mm; length of coronoid-condyloid processes usually ≥ 5.2 mm; mental foramen positioned beneath hypoconid of *m1;* basin in lingual side of interarticular area (Fig. 5) .... *Blarina brevicauda,* Northern short-tailed shrew (Fig. 7)

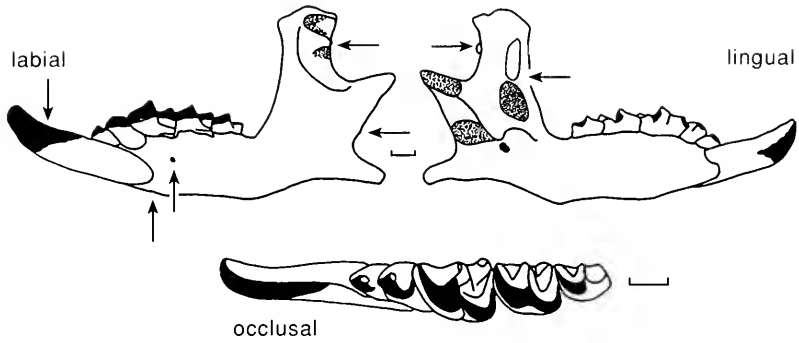
Height of coronoid process ≤ 6.0 mm; length of *c1–m3* ≤ 6.5 mm; length of coronoid-condyloid processes usually < 5.0 mm; mental foramen positioned beneath midpoint between protoconid and hypoconid of *m1;* no basin in lingual side of interarticular area (Fig. 5) 6

6(5). First lower incisor set at an angle ≤ 17° from the horizontal ramus of the dentary (Fig. 7) ....*Blarina carolinensis,* Southern short-tailed shrew (Fig. 7)

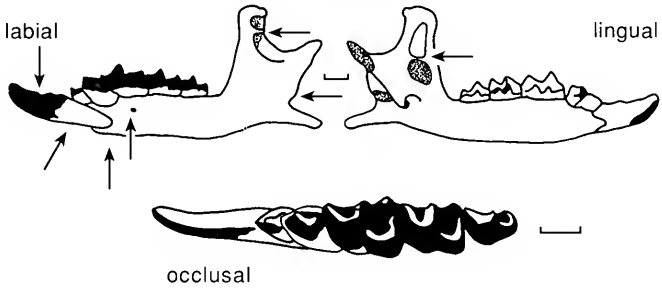
First lower incisor set at an angle ≥ 18° from the horizontal ramus of the dentary (Fig. 7) .... *Blarina hylophaga,* Elliot's short-tailed shrew (Fig. 7)

7(1). Length of dentary usually ≥ 7.7 mm; height of coronoid process ≥ 4.0 mm; length of *c1–m3* ≥ 4.9 mm 8

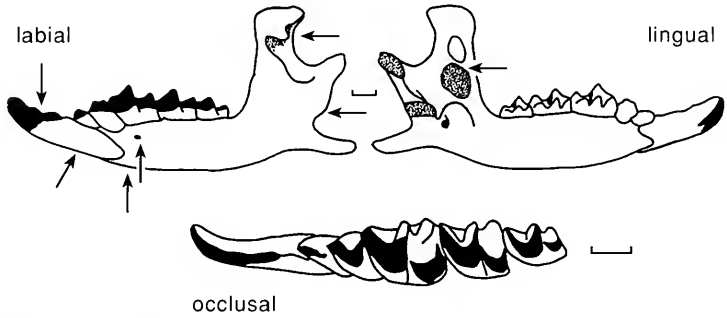
Length of dentary usually ≤ 7.7 mm; height of coronoid process ≤ 4.0 mm; length of *c1–m3* < 5.0 mm 22



Blarina brevicauda



Blarina carolinensis



Blarina hylophaga

Fig. 7. Dentaries of *Blarina brevicauda* (OSUFW 7777), *B. carolinensis* (OSUFW 3325), and *B. hylophaga* (FHSU 10166). In all taxa, note the numbers of denticulations, the relationship of the posterior edge of *il* to *m1*, the sizes of the coronoid spicules, the structures of the internal temporal fossae, and the obscured inferior condylar process in labial view. The mental foramen is located beneath the hypoconid of *m1* in *B. brevicauda*, whereas it lies beneath the midpoint between the protoconid and hypoconid of *m1* in *B. carolinensis* and *B. hylophaga*. Note angle of *il* relative to horizontal ramus of dentary in *B. carolinensis* and *B. hylophaga*.

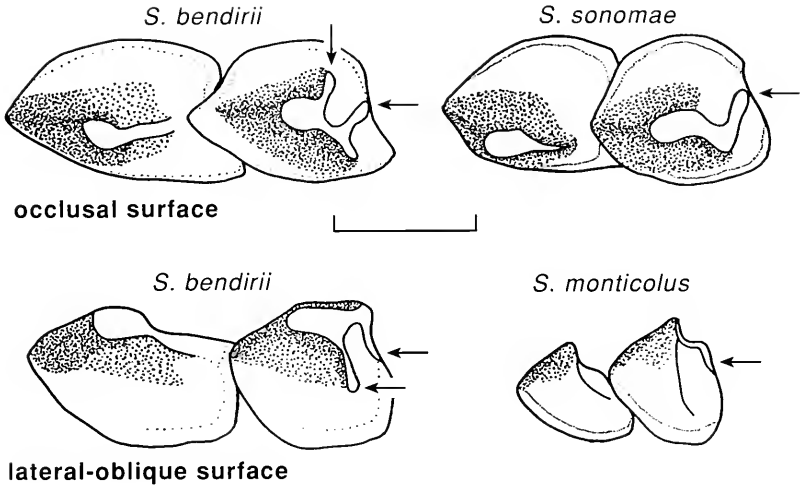


Fig. 8. Views of *c1* and *p4* (anterior to left) to show posterolingually directed ridges on the occlusal surface of *p4* of *Sorex bendirii* (OSUFW 4873), *S. sonomae* (KU 145866), *S. bendirii* (OSUFW 4873), and *S. monticolus* (OSUFW 4815). Note the presence of two ridges in *S. bendirii* and only one ridge in the other *Sorex*.

8(7). Two posterolingually directed ridges on occlusal surface of *p4* (Fig. 8); length of *c1* > length of *p4* 9

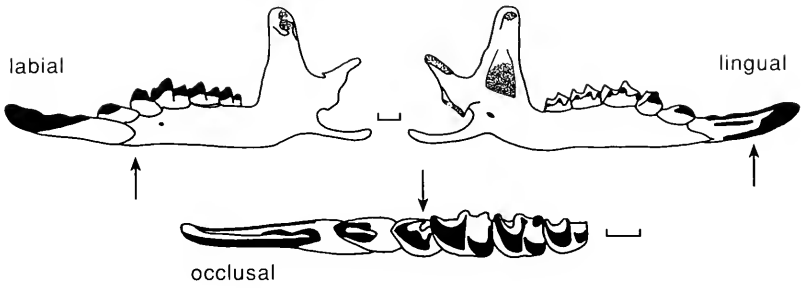
One posterolingually directed ridge on occlusal surface of *p4* (Fig. 8); length of *c1* ≤ length of *p4* 10

9(8). Width of *c1* + width of *p4* usually ≥ 1.8 mm; length of *i1* usually ≥ 5.4 mm ($\bar{x}$ = 5.85, SE = 0.07, *n* = 29, range 5.2–6.5, CV = 0.06) ..... *Sorex bendirii palmeri*, Pacific water shrew (Fig. 9)

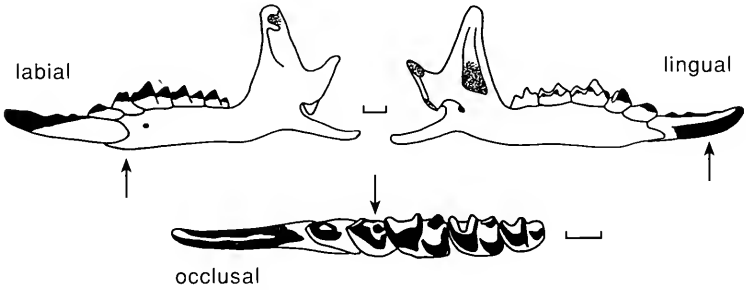
Width of *c1* + width of *p4* usually ≤ 1.8 mm; length of *i1* usually ≤ 5.4 mm ($\bar{x}$ = 5.16, SE = 0.05, *n* = 29, range 4.7–5.7, CV = 0.05) ..... all other *Sorex bendirii*, Pacific water shrew (Fig. 9)

10(8). No strip of pigment on inside of ventromedial edge of *i1s* where they meet (Fig. 10) 11

Strip of pigment on inside of ventromedial edge of *i1s* where they meet (Fig. 10) 13



Sorex bendirii palmerii



Sorex bendirii (other subspecies)

Fig. 9. Dentaries of *Sorex bendirii palmeri* (OSUFW 1483) and other subspecies of *S. bendirii* (represented by USNM 233594). Note the relationship of the posterior edge of *i1* to *m1*, the presence of pigment on the posterior portion of the ventromedial edge of *il*, and the two posterolingually directed ridges on *p4*.

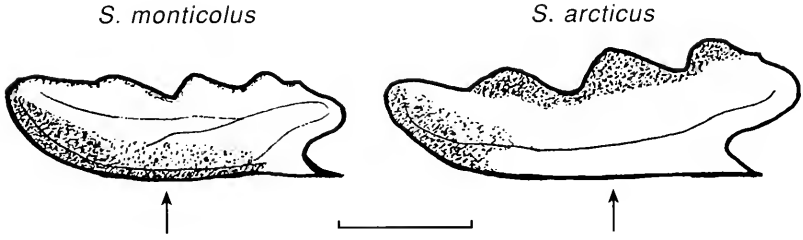


Fig. 10. Lingual views (anterior to the left) of *i1* of *Sorex monticolus* (OSUFW 4747) and *S. arcticus* (KU 45299) to show differences in the posterior extent of the pigment on the ventromedial edge of *i1*.

11(10). Length of *c1–m3* ≤ 2.7 mm; length of dentary ≤ 6.0 mm; depth of dentary below *m1* ≤ 0.6 mm; height of coronoid process ≤ 2.7 mm ..... *Sorex minutissimus*, Holarctic least shrew (Fig. 11)

Length of *c1–m3* ≥ 4.5 mm; length of dentary > 6.8 mm; depth of dentary below *m1* ≥ 1.0 mm; height of coronoid process ≥ 3.7 mm 12

12(11). Pigment on *i1* in two or three sections (Fig. 11); height of coronoid process ≥ 4.4 mm; length of coronoid-condyloid processes ≥ 3.8 mm; length of dentary ≥ 7.9 mm; depth of dentary below *m1* + height of coronoid process ≥ 5.6 mm ..... *Sorex arcticus*, Arctic shrew (Fig. 11)

Pigment on *i1* in one section (Fig. 11) may be obscured in old adults; height of coronoid process ≤ 4.2 mm; length of coronoid-condyloid processes ≤ 3.6 mm; length of dentary ≤ 7.9 mm; depth of dentary below *m1* + height of coronoid process ≤ 5.2 mm ..... *Sorex tundrensis*, Tundra shrew (Fig. 11)

13(10). Height of coronoid process ≤ 4.2 mm; length of coronoid-condyloid processes usually ≤ 3.6 mm; depth of dentary below *m1* + height of coronoid process usually ≤ 5.2 mm 14

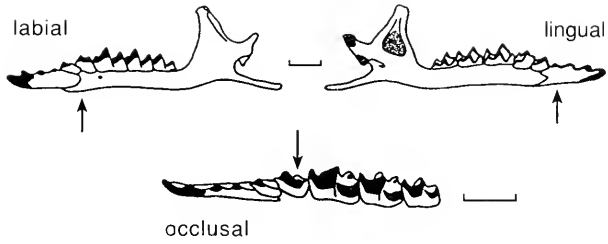
Height of coronoid process ≥ 4.3 mm; length of coronoid-condyloid processes ≥ 3.6 mm; depth of dentary below *m1* + height of coronoid process usually ≥ 5.3 mm 16

14(13). Mental foramen usually positioned beneath posterior half of *m1* (Fig. 12) ..... *Sorex monticolus*, Dusky or Montane shrew (Fig. 12)

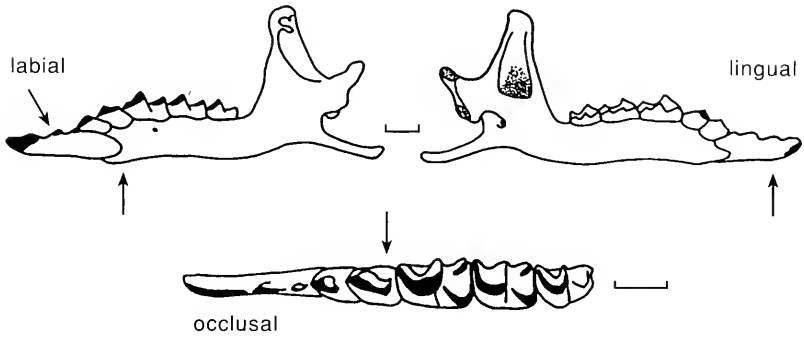
Mental foramen usually positioned beneath anterior half of *m1* (Fig. 12) 15

15(14) First lower incisor set at an angle 8–10° from the horizontal ramus of the dentary (Fig. 12); distance between *i1* and *p4* ≤ 0.3 mm. . ..*Sorex trowbridgii montereyensis*, Trowbridge's shrew (Fig. 12)

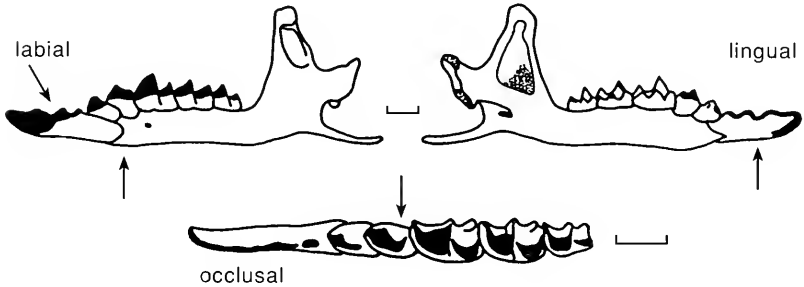
First lower incisor set at an angle 10–15° from the horizontal ramus of the dentary (Fig. 12); distance between *i1* and *p4* ≥ 0.4 mm ..... all other *Sorex trowbridgii*, Trowbridge's shrew (Fig. 12)



Sorex minutissimus

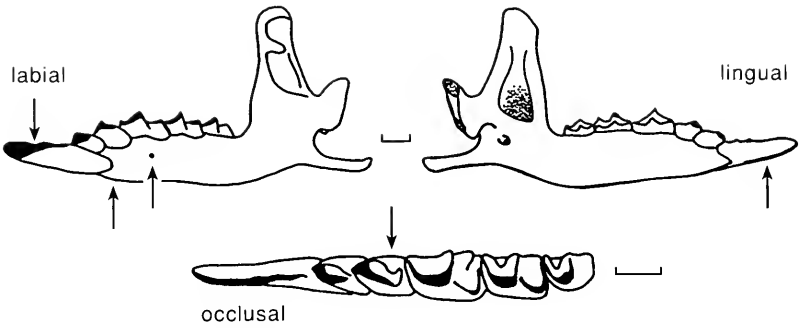


Sorex arcticus

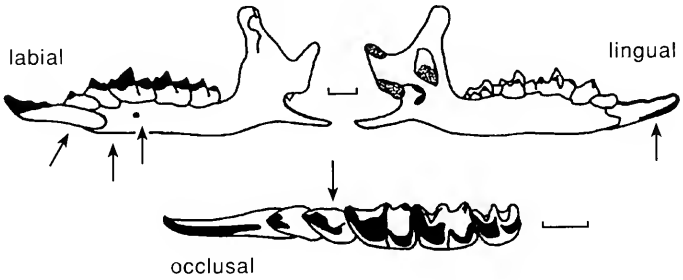


Sorex tundrensis

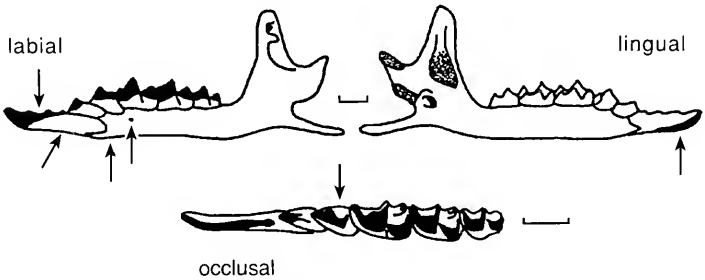
Fig. 11. Dentaries of *Sorex minutissimus* (UAM 19268), *S. arcticus* (ROM 11622), and *S. tundrensis* (UAM 13561) showing relationship of posterior edge of *i1* to *m1*, the lack of pigment on the posterior portion of the ventromedial edge of *i1*, and one posterolingually directed ridge on *p4*. Note number of pigment sections on *i1* of *S. arcticus* and *S. tundrensis*.



Sorex monticolus (other subspecies)



Sorex trowbridgii montereyensis



Sorex trowbridgii (other subspecies)

Fig. 12. Dentaries of *Sorex monticolus* (OSUFW 6055), *S. trowbridgii montereyensis* (KU 68098), and other subspecies of *S. trowbridgii* (represented by OSUFW 6111). Note the relationship of the posterior edge of *i1* to *m1*, the position of the mental foramen relative of *m1*, one posterolingually directed ridge on *p4*, and the presence of pigment on the posterior portion of the ventromedial edge of *i1*. In *S. monticolus* and other subspecies of *S. trowbridgii* note the very deep interdenticular space. In all *S. trowbridgii* note the angle of *i1* relative to the horizontal ramus of the dentary.

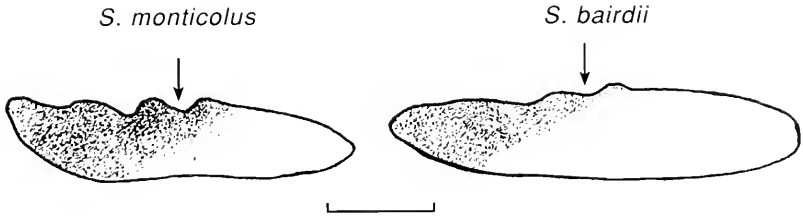


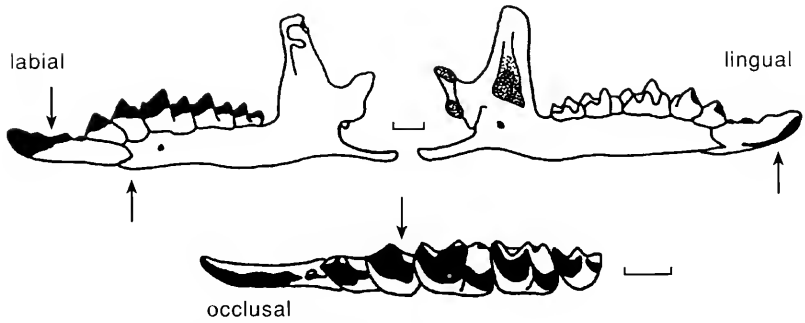
Fig. 13. Labial views (anterior to the left) of the *ils* of *Sorex monticolus* (OSUFW 4747) to show the deep interdenticulations and of *S. bairdii* (OSUFW 7261) to show the shallow interdenticulations.

16(13). Interdenticular space very deep (Fig. 13), may be obscure in old adults; length of coronoid-condyloid processes usually < 4.1 mm 17

Interdenticular space shallow (Fig. 13); length of coronoid-condyloid processes ≥ 4.1 mm 19

17(16). Height of coronoid process usually ≥ 4.5 mm; width of *c1* + width of *p4* usually > 1.4 mm ..... *Sorex monticolus neomexicanus* Dusky or Montane shrew (Fig. 14)

Height of coronoid process usually ≤ 4.5 mm; width of *c1* + width of *p4* usually ≤ 1.4 mm 18



Sorex monticolus neomexicanus

Fig. 14. Dentary of *Sorex monticolus neomexicanus* (MSB 37345) showing very deep interdenticular space, relationship of posterior edge of *i1* to *m1*, one posterolingually directed ridge on *p4*, and presence of pigment on the posterior portion of ventromedial edge of *il*.

18(17). No dentary characters discerned, but prominent inframaxillary ridge (Fig. 15) .... *Sorex alaskanus*, Glacier Bay water shrew (Fig. 15)

No inframaxillary ridge, only a depression (Fig. 15) .... *Sorex palustris*, Water shrew (Fig. 15)

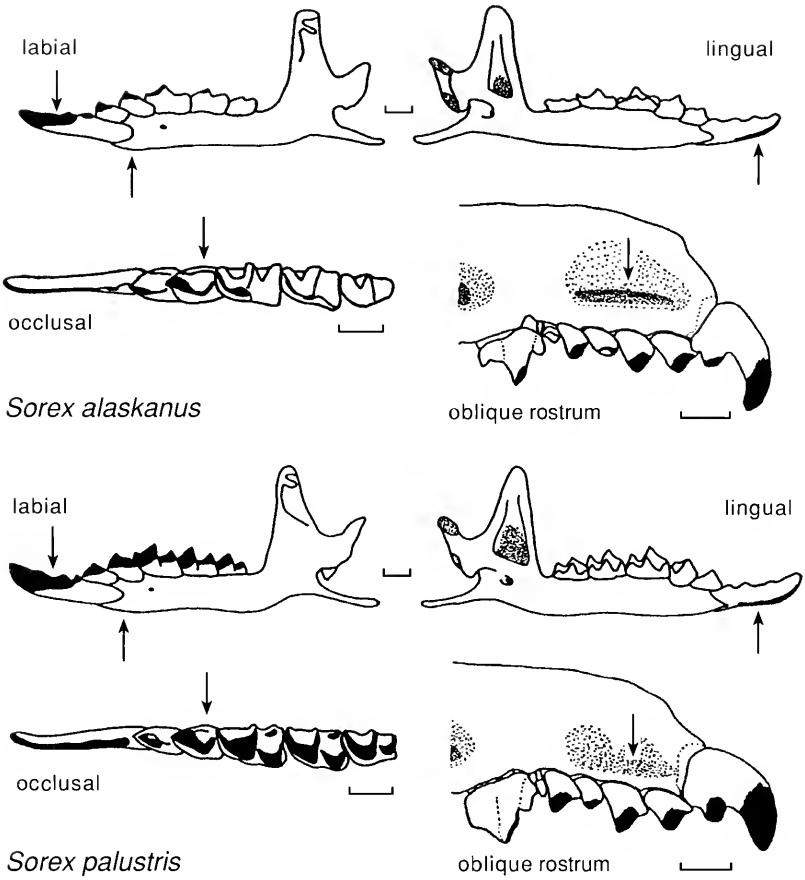


Fig. 15. Dentaries and rostrums (in oblique view at lower right) of *Sorex alaskanus* (USNM 97712) and *S. palustris* (OSUFW 4857). Note in the dentaries of both taxa the very deep interdenticular space, the relationship of the posterior edge of *i1* to *m1*, and one posterolingually directed ridge on *p4*, and presence of pigment on the posterior portion of the ventromedial edge of *i1*. The rostrum of *S. alaskanus* has a prominent inframaxillary ridge, whereas that of *S. palustris* has a depression.

19(16). No dentary characters discerned, but no projection on medial edge of *i1s* (Fig. 16); body of *i1s* completely abutting for length of pigment or at least at dorsal aspect of pigment (Fig. 16); maxillary and mandibular unicuspids robust for skull size; zygomatic processes of maxilla rounded 20

Projection present within the pigment on the medial edge of *i1s* (Fig. 18); maxillary and mandibular unicuspids quite small for skull size; zygomatic processes of maxilla pointed 21

20(19). Length *m1* usually ≥ 1.8 mm; width of *c1* + width of *p4* usually ≥ 1.9 mm .....*Sorex sonomae sonomae*, Fog shrew (Fig. 16)

Length of *m1* usually ≤ 1.7 mm; width of *c1* + width of *p4* usually ≤ 1.8 mm ..... *Sorex sonomae tenelliodus*, Fog shrew (Fig. 17)

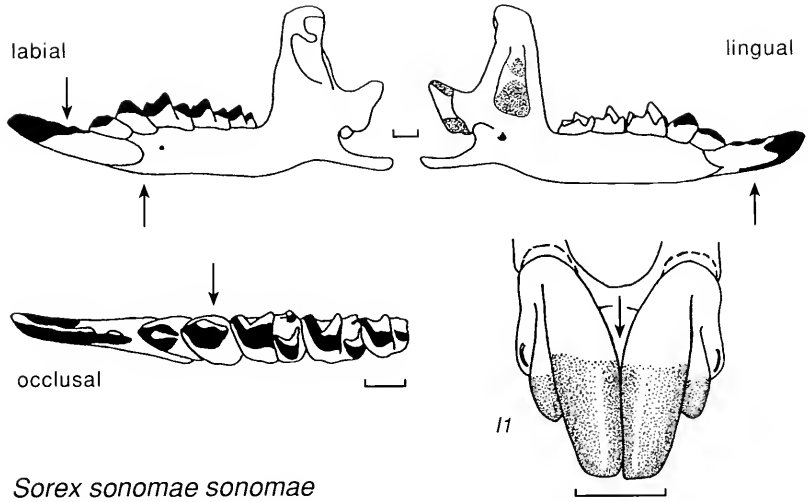
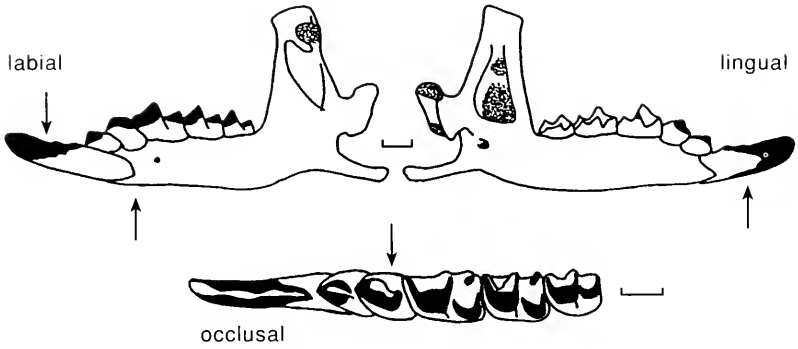


Fig. 16. Dentary and anterior view of *i1* (at lower right) of *Sorex sonomae sonomae* (OSUFW 8876). In the dentary note the shallow interdenticular space, the relationship of the posterior edge of *i1* to *m1*, one posterolingually directed ridge on *p4*, and presence of pigment on the posterior portion of the ventromedial edge of *il*. The medial edge of each *i1* lacks a projection.



Sorex sonomae tenelliodus

Fig. 17. Dentary of *Sorex sonomae tenelliodus* (OSUFW 7206) showing the shallow interdenticular space, the relationship of the posterior edge of *i1* to *m1*, one posterolingually directed ridge on *p4*, and presence of pigment on the posterior portion of the ventromedial edge of *i1*.

21(19). No dentary characters discerned, but small median tine present on *I1s* (Fig. 18) ..... *Sorex bairdii*, Baird's shrew (Fig. 18)

Ridge present at posteromedial edge of *I1s* (Fig. 18) .... *Sorex pacificus*, Pacific shrew (Fig. 18)

22(7). Length of dentary usually ≤6.5 mm; length of *c1–m3* usually < 4.1 mm; height of coronoid process ≤ 3.2 mm 23

Length of dentary usually ≥ 6.5 mm; length of *c1–m3* ≥ 4.1 mm; most with height of coronoid process > 3.2 mm 25

23(22). Pigment on *i1* in one or two sections (Fig. 19), rarely three as a result of wear; dentary below *m1* shallower than height of *m1* ... .*Sorex nanus*, Dwarf shrew (Fig. 19)

Pigment on *i1* usually in three sections (Fig. 19); dentary below *m1* as deep as or deeper than height of *m1* 24

24(23). First lower incisor set at an angle ≤ 8° from the horizontal ramus of the dentary (Fig. 19); width of *m1* ≤ 0.8 mm; width of *m2* ≤ 0.8 mm ..... *Sorex preblei*, Preble's shrew (Fig. 19)

First lower incisor set at an angle ≥ 8° from the horizontal ramus of the dentary (Fig. 19); width of *m1* ≥ 1.1 mm; width of *m2* ≥ 0.9 mm ..... *Sorex longirostris*, Southeastern shrew (Fig. 19)

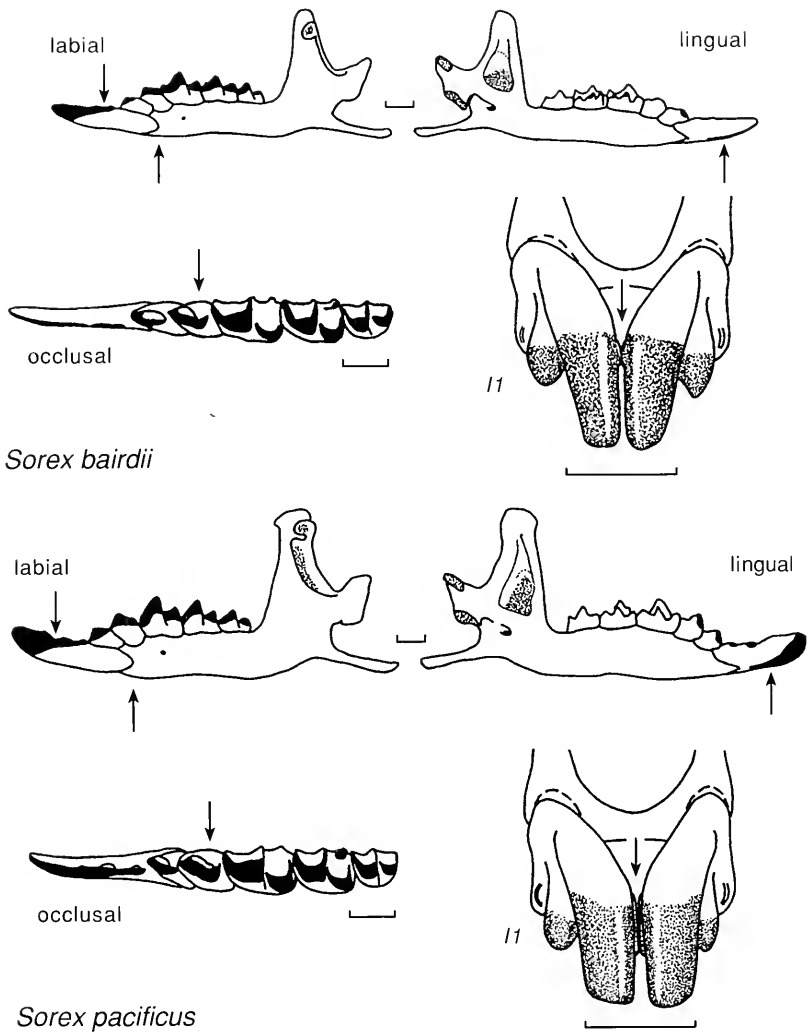


Fig. 18. Dentaries and anterior views of *i1s* (at lower right) of *Sorex bairdii* (OSUFW 6111) and *S. pacificus* (OSUFW 8306). In the dentaries of both taxa note the shallow interdenticular space, the relationship of the posterior edge of *i1* to *m1*, one posterolingually directed ridge on *p4*, and presence of pigment on the posterior portion of the ventromedial edge of *i1*. Each *i1* of *S. bairdii* bears a small median tine, whereas each *i1* of *S. pacificus* bears a ridge along the posteromedial edge.

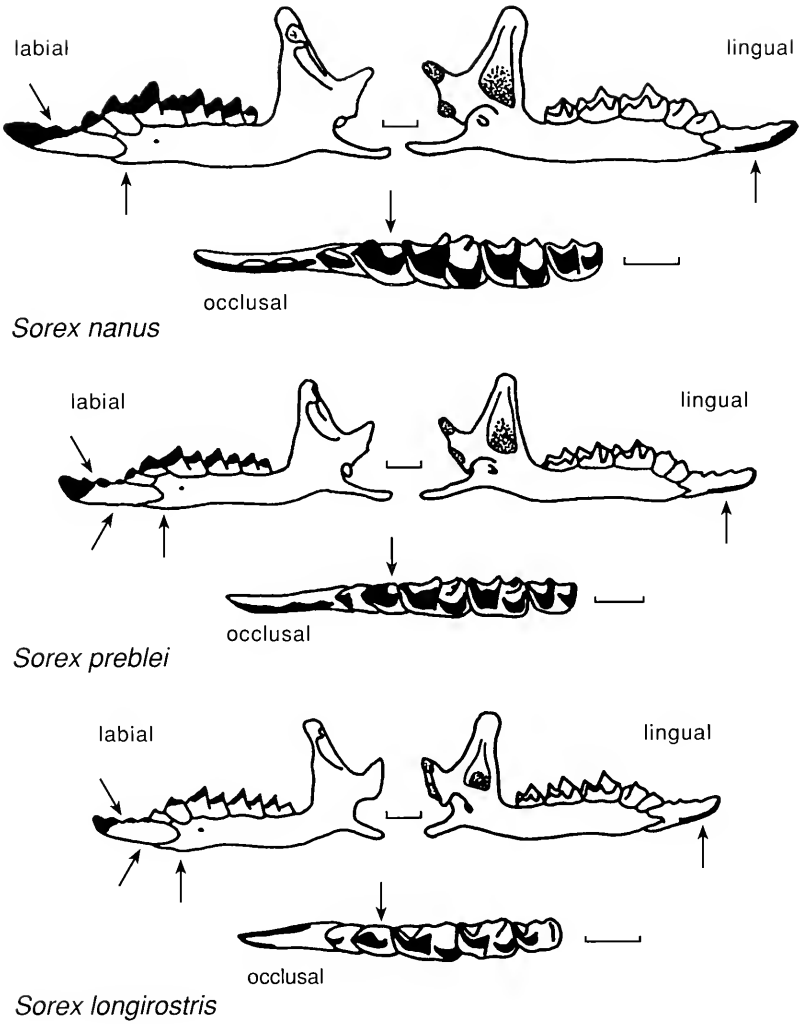


Fig. 19. Dentaries of *Sorex nanus* (MSB 59339), *S. preblei* (OSUFW 4435), and *S. longirostris* (MSUMZ 24168). Note the number of pigment sections on *i1*, the relationship of the posterior edge of *i1* to *m1*, and one posterolingually directed ridge on *p4*, and presence of pigment on the posterior portion of the ventromedial edge of *i1* in all taxa. In *S. preblei* and *S. longirostris* note the angle of *i1* relative to the horizontal ramus of the dentary.

25(22). Height of coronoid process ≤ 3.2 mm; *c1* with two cusps. .... *Sorex ugyunak*, Barren ground shrew (Fig. 20)

Height of coronoid process usually ≥ 3.2 mm; *c1* usually with one cusp, but if with two cusps, height of coronoid process ≥ 3.4 mm 26

26(25). Length of coronoid-condyloid processes usually ≤ 3.1 mm; length of *m1* + length of *m2* usually ≤ 2.4 mm 27

Length of coronoid-condyloid processes usually ≥ 3.1 mm; length of *m1* + length of *m2* usually ≥ 2.4 mm 32

27(26). Pigment on *i1* distributed in one section (Fig. 20) .... *Sorex tenellus*, Inyo shrew (Fig. 20)

Pigment on *i1* distributed in two or three sections (Figs. 20, 21, 22) 28

28(27). Present geographic range limited to Sierra Nevada mountains, Mono Co., California (Williams, 1984); pelage bicolored .... *Sorex lyelli*, Mt. Lyell shrew (Fig. 20)

Present geographic range not including California; pelage bicolored or tricolored 29

29(28). Present geographic range limited to Pribliof Islands, Alaska; pelage tricolored 30

Present geographic range other than Pribliof Islands, Alaska; pelage bicolored 31

30(29). Pigment on *i1* distributed in two sections (Fig. 21); *i1* set at an angle ≥ 8° from the horizontal ramus of the dentary (Fig. 21) .... *Sorex hydrodromus*, Pribilof Island shrew (Fig. 21)

Pigment on *i1* distributed in three sections (Fig. 21); *i1* set at an angle ≤ 8° from the horizontal ramus of the dentary (Fig. 21) .... *Sorex jacksoni*, St. Lawrence Island shrew (Fig. 21)

31(29). No dentary characters discerned, but maxillary breadth < 4.15 mm (Jackson, 1928; zygomatic processes commonly broken in specimens of old adults) ..... *Sorex cinereus*, Masked shrew (Fig. 21)

Maxillary breadth ≥ 4.15 mm (Jackson, 1928; zygomatic processes commonly broken in specimens of old adults) .... *Sorex haydeni*, Hayden's shrew (Fig. 22)

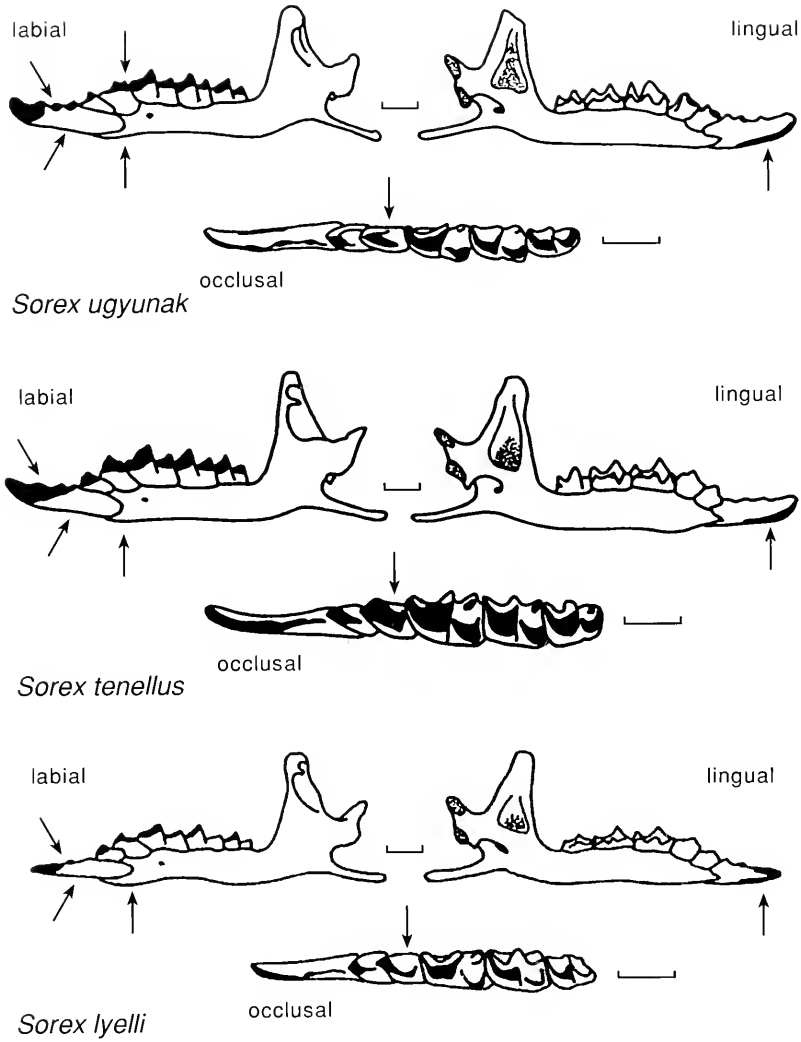
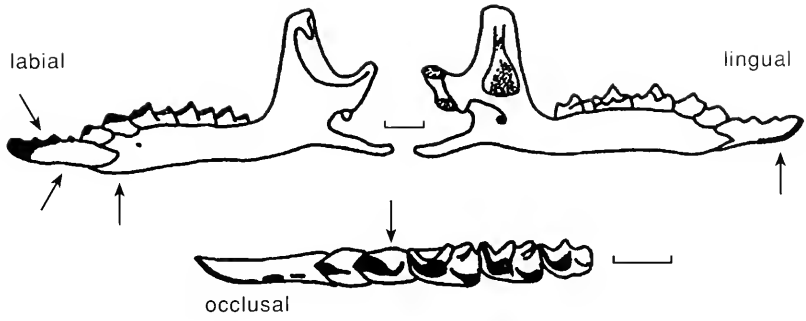
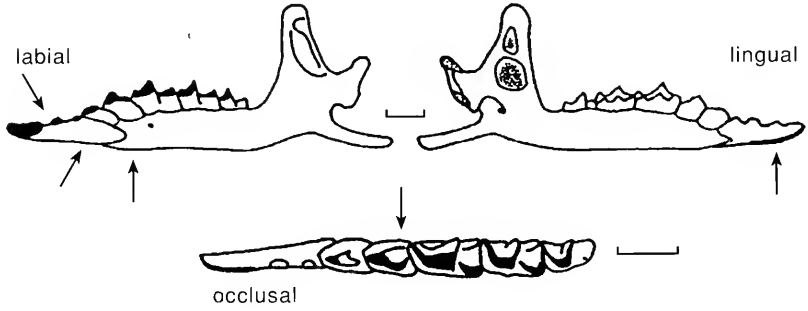


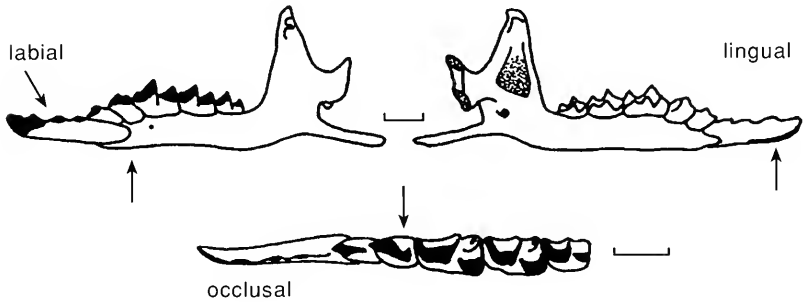
Fig. 20. Dentaries of *Sorex ugyunak* (KU 43166), *S. tenellus* (LACM 85713), and *S. lyelli* (LACM 85453). In all taxa note the number of pigment sections on *i1*, the angle of *i1* relative to the horizontal ramus of the dentary, the relationship of the posterior edge of *i1* to *m1*, one posterolingually directed ridge on *p4*, and presence of pigment on the posterior portion of the ventromedial edge of *i1*. In *S. ugyunak*, *c1* bears two cusps.



Sorex hydrodromus



Sorex jacksoni



Sorex cinereus

Fig. 21. Dentaries of *Sorex hydrodromus* (UAM 13562), *S. jacksoni* (UAM 7794), and *S. cinereus* (OSUFW 7796). In all taxa note the number of pigment sections on *i1*, the relationship of the posterior edge of *i1* to *m1*, one posterolingually directed ridge on *p4*, and presence of pigment on the posterior portion of the ventromedial edge of *i1*. In *S. hydrodromus* and *S. jacksoni* note the angle of *i1* relative to the horizontal ramus of the dentary.

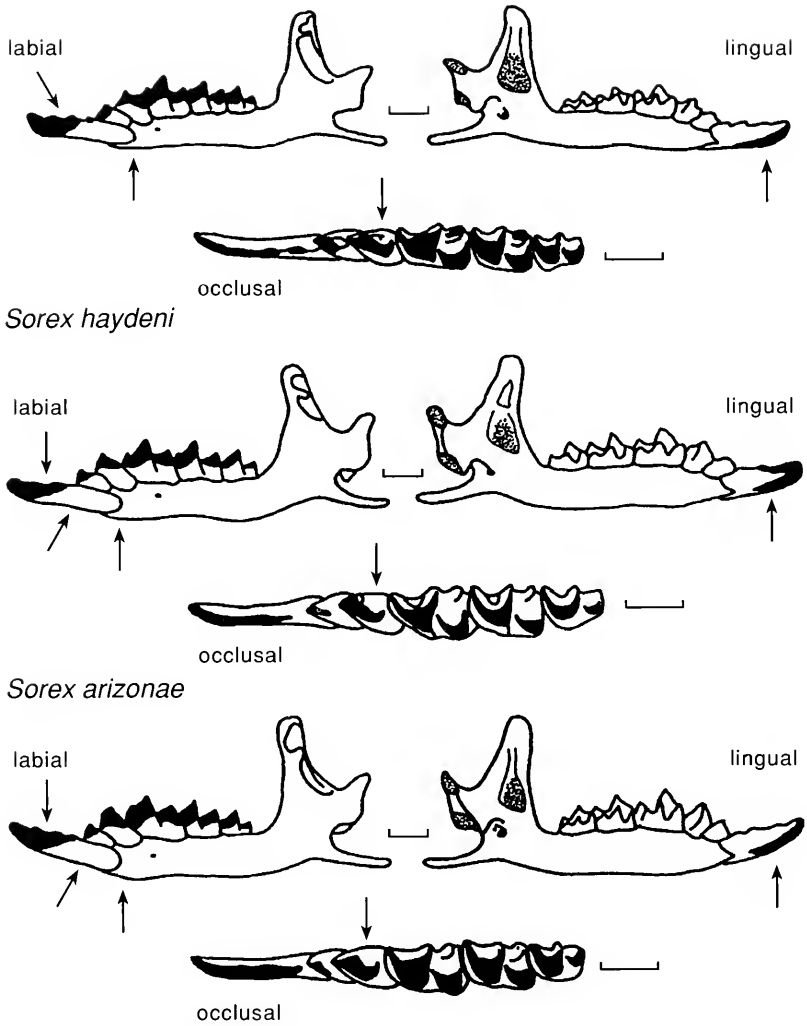


Fig. 22. Dentaries of *Sorex haydeni* (OSUFW 3278), *S. arizonae* (UIMNH 49494), and *S. merriami* (OSUFW 3348). In all taxa note the relationship of the posterior edge of *i1* to *m1*, one posterolingually directed ridge on *p4*, and presence of pigment on the posterior portion of the ventromedial edge of *i1*. In *S. haydeni* note the number of pigment sections on *i1*. In *S. arizonae* and *S. merriami* note the very shallow interdenticular space and the angle of *i1* relative to the horizontal ramus of the dentary.

32(26). First lower incisor set at an angle ≥ 13° from the horizontal ramus of the dentary; interdenticular space very shallow (Fig. 13).... 33

First lower incisor set at an angle ≤ 13° from the horizontal ramus of the dentary; interdenticular space very deep (Fig. 13), may be obscured in old individuals 34

33(32). Height of coronoid process ≤ 3.8 mm; ratio of height of coronoid process:length of dentary ≤ 0.54; ratio of distance between *i1* and *p4* : length of dentary ≥ 0.04 .....
..... *Sorex arizonae*, Arizona shrew (Fig. 22)

Height of coronoid process usually ≥ 3.9 mm; ratio of height of coronoid process:length of dentary ≥ 0.55; ratio of distance between *i1* and *p4* : length of dentary ≤ 0.04 .....
..... *Sorex merriami*, Merriam's shrew (Fig. 22)

34(32). No dentary characters discerned, but median tines on *I1s* set at or above the pigment on the body of the *I1s* (Fig. 23) 35

Median tines on *I1s* set within the pigment on the body of the *I1s* (Fig. 23) 36

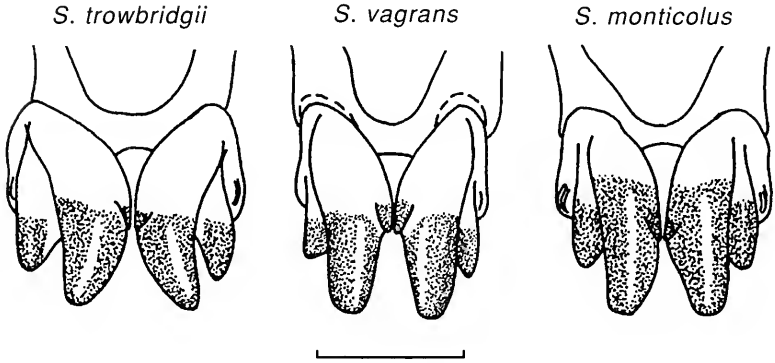
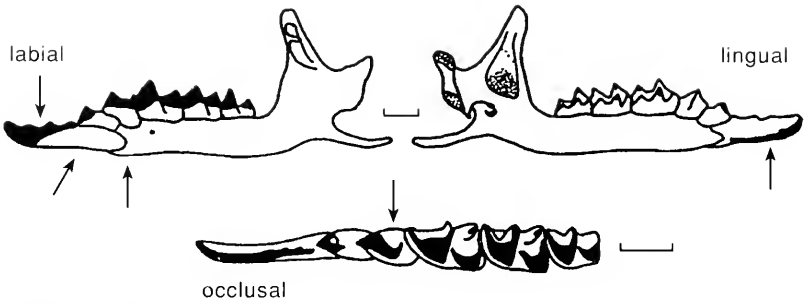


Fig. 23. Anterior views of *i1s* of *Sorex trowbridgii* (PSM 5892), *S. vagrans* (SDMNH 16971), and *S. monticolus* (KU 146134). Notice that in *S. trowbridgii* and *S. vagrans* the tines are above the level of the pigment; however, in *S. trowbridgii* the medial edges of the *i1s* are curved and flaring, whereas they are straight and minimally divergent in *S. vagrans*. In *S. monticolus* the median tines are set within the pigment.



Sorex vagrans

Fig. 24. Dentary of *Sorex vagrans* (OSUFW 6821) showing the very deep interdenticular space, the angle of *i1* relative to the horizontal ramus of the dentary, the relationship of the posterior edge of *i1* to *m1*, one posterolingually directed ridge on *p4*, and presence of pigment on the posterior portion of the ventromedial edge of *i1*.

35(34). No dentary characters discerned, but medial edge of *I1s* curved and flaring (Fig. 23); least interorbital breadth ≥ 3.5 mm (Carraway, 1987) .... *Sorex trowbridgii*, Trowbridge's shrew (Fig. 12)

Medial edge of *I1s* straight and minimally divergent (Fig. 23); least interorbital breadth < 3.5 mm (Carraway, 1987) .... *Sorex vagrans*, Vagrant shrew (Fig. 24)

36(34). No dentary characters discerned, but paracrista not pigmented on *P4* (Fig. 25) ..... *Sorex ornatus*, Ornate shrew (Fig. 26)

Paracrista partially to completely pigmented on *P4* (Fig. 25) .... *Sorex monticolus*, Dusky or Montane shrew (Fig. 12)

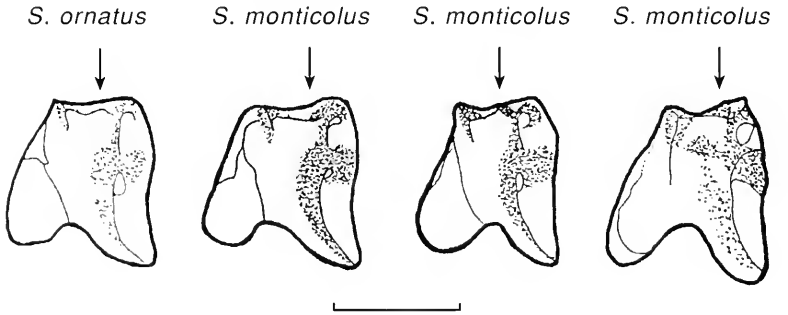
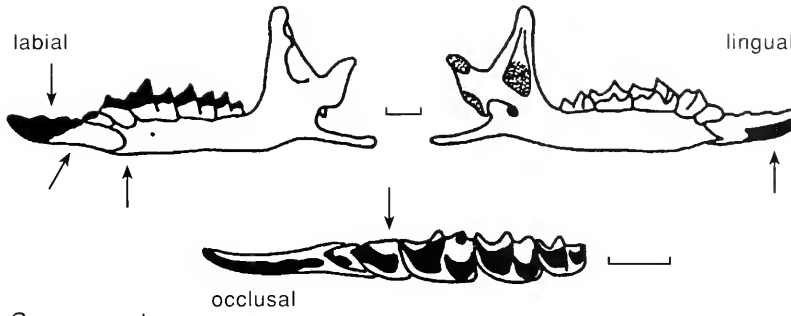


Fig. 25. Occlusal views (lingual to the left) of upper *P4* of *Sorex ornatus* (KU 50218) and three specimens of *S. monticolus* (left to right: OSUFW 4798, 4799, and 4815) to show the absence of pigment on the paracrista in *S. ornatus* and the variable amounts of pigment on the paracrista in *S. monticolus*.



Sorex ornatus

Fig. 26. Dentary of *Sorex ornatus* (UCD 4688) showing the very deep interdenticular space, the angle of *i1* relative to the horizontal ramus of the dentary, the relationship of the posterior edge of *i1* to *m1*, one posterolingually directed ridge on *p4*, and presence of pigment on the posterior portion of the ventromedial edge of *i1*.

COMPARISONS OF SOME SPECIES OF SORICIDAE

Selected species not in direct line in the key are compared in the following annotations of aspects of their morphology.

Notiosorex crawfordi (**Desert shrew**)

Notisorex crawfordi can be distinguished from all other soricids in the western United States and Canada by possession of the following combination of characters: alveolus of *i1* extending posteriorly beneath at least part of *m1* (Figs. 3, 4); no pigment on *m2* and *m3* (Fig. 4); and deeply emarginate interarticular area (Fig. 5). However, these three characters may not be sufficient to identify to species old individuals with excessively worn teeth or a damaged dentary. The desert shrew can be separated from *Sorex hoyi*, *S. merriami*, *S. ornatus*, and *S. preblei* by height of the unpigmented portion of *m1* ≥ 0.9 mm; from *S. hoyi*, *S. nanus*, and *S. preblei* by height of the coronoid process ≥ 3.5 mm and length of *c1–m3* ≥ 4.5 mm; and from *S. hoyi* and *S. ornatus* by *i1* set at an angle ≥ 15° from the horizontal ramus of the dentary. Additionally, *N. crawfordi* differs from *S. hoyi* by the width of *m1* ≥ 0.8 mm, width of *m2* ≥ 0.8 mm, and length of the dentary ≥ 6.1 mm, and from *S. preblei* by length of the coronoid-condyloid processes ≥ 3.0 mm.

Sorex alaskanus (**Glacier Bay water shrew**)

The Glacier Bay water shrew differs from *Sorex arcticus*, *S. monticolus*, and *S. ugyunak* by length of *c1–m3* ≥ 5.4 mm. Also, it differs from *S. arcticus* by presence of a strip of pigment on the inside ventromedial edge

of the *i1s* (Figs. 10, 15) and by the length of the coronoid-condyloid processes ≤ 3.7 mm, and from *S. ugyunak* > 3.5 mm. *Sorex alaskanus* is distinguished from *S. monticolus* and *S. ugyunak* by length of the dentary ≥ 8.6 mm. Additionally, it can be distinguished from *S. ugyunak* by height of the coronoid process ≥ 4.2 mm, depth of the mandible at *m1* ≥ 1.3 mm, by pigment on *i1* in one section, and *c1* with one cusp.

Sorex arcticus (**Arctic shrew**)

Sorex arcticus differs from *S. alaskanus, S. cinereus, S. jacksoni, S. hydrodromus, S. monticolus,* and *S. ugyunak* by length of the coronoid-condyloid processes ≥ 3.8 mm and lack of a strip of pigment on the inside ventromedial edge of the *i1s* (Figs. 10, 11). Additionally, it can be distinguished from *S. alaskanus* by length of *c1–m3* ≤ 5.3 mm and from *S. jacksoni, S. hydrodromus,* and *S. ugyunak* ≥ 4.8 mm; from *S. cinereus, S. jacksoni, S. hydrodromus, S. monticolus,* and *S. ugyunak* by height of the coronoid process ≥ 4.4 mm; from *S. cinereus, S. jacksoni, S. hydrodromus,* and *S. ugyunak* by length of the dentary ≥ 7.9 mm; from *S. jacksoni, S. hydrodromus,* and *S. ugyunak* by width of *p4* ≥ 0.7 mm; from *S. cinereus* and *S. ugyunak* by width of *c1* ≥ 0.6 mm; and from *S. jacksoni* and *S. ugyunak* by depth of the dentary below *m1* ≥ 1.1 mm. Also, from *S. jacksoni* by width of *m2* ≥ 0.7 mm and from *S. ugyunak* by *c1* with one cusp.

Sorex arizonae (**Arizona shrew**)

This species can be distinguished from *Sorex hoyi* and *S. nanus* by height of the coronoid process ≥ 3.5 mm, and from *S. merriami* ≤ 3.8 mm, and from *S. hoyi* and *S. nanus* by length of *c1–m3* ≥ 4.7 mm and length of the dentary ≥ 7.1 mm. Additionally, *S. arizonae* differs from *S. hoyi* by length of *m3* ≥ 0.8 mm and the alveolus of *i1* not extending posteriorly beneath part of *m1* (Figs. 3, 22), and from *S. nanus* by depth of the dentary below *m1* ≥ 1.0 mm, length of the coronoid-condyloid processes ≥ 3.1 mm, length of *c1* ≥ 0.9 mm, length of *p4* ≥ 1.0 mm, length of *m2* ≥ 1.2 mm, and width of *p4* ≥ 0.7 mm.

Sorex bairdii (**Baird's shrew**)

Sorex bairdii can be distinguished from *S. monticolus* by height of the coronoid process usually ≥ 4.3 mm and length of *c1–m3* usually ≥ 5.2 mm.

Sorex bendirii (**Pacific water shrew**)

The condition of two posterolingually directed ridges (Fig. 8) on the occlusal surface of *p4* of the Pacific water shrew is unique among shrews in the western United States and Canada. Also, *Sorex bendirii* can be distin-

guished from all other *Sorex* by length of *c1* greater than length of *p4*. Differences in pattern of pigmentation on the *i1s* of specimens of *S. b. bendirii* and *S. b. palmeri* in Figure 9 are the result of individual variation and are not of taxonomic value.

Sorex cinereus (**Masked shrew**)

Sorex cinereus differs from *S. arcticus, S. monticolus, S. m. neomexicanus, S. palustris, S. tundrensis,* and *S. vagrans* by length of the coronoid-condyloid processes usually ≤ 3.2 mm; from *S. hydrodromus* and *S. palustris* by *i1* set at an angle ≤ 8° from the horizontal ramus of the dentary; and from *S. arcticus* and *S. tundrensis* by presence of a strip of pigment on the inside ventromedial edge of the *i1s* (Figs. 10, 21). No single qualitative or quantitative character, or combination of characters recorded for this study, distinguish *S. cinereus* from *S. jacksoni*. However, van Zyll de Jong (1982; in litt., 30 January 1995) could distinguish *cinereus* and *jacksoni* by the following discriminant-function equation: discriminant score = 2.751 (length of mandible) + 3.633 (height of the coronoid process) + 6.189 (length of coronoid-condyloid processes) + 11.68 (greatest condylar depth) + 14.53 (width of lower condylar facet) – 5.923 (width of upper condylar facet) – 3.874 (length of *c1–m3*) – 17.54496. Those specimens with a score ≤ – 0.293 are *S. cinereus*. Additionally, the masked shrew can be separated from *S. arcticus* and *S. palustris* by length of the dentary ≤ 7.6 mm and height of the coronoid process ≤ 3.9 mm and from *S. ugyunak* usually ≥ 3.2 mm; from *S. arcticus* by width of *c1* ≤ 0.5 mm; from *S. palustris* by length of *c1–m3* ≤ 4.9 mm; from *S. monticolus* by length of *m1* ≤ 1.4 mm; from *S. m. neomexicanus* by length of *m1* ≤ 1.4 mm, length of *m2* ≤ 1.2 mm, and height of the unpigmented portion of *m1* ≤ 0.6 mm; from *S. palustris* by length of *m3* ≤ 0.9 mm; and from *S. ugyunak* by *c1* usually with one cusp.

Sorex haydeni (**Hayden's shrew**)

Hayden's shrew differs from *Sorex hoyi* by the alveolus of *i1* not extending posteriorly beneath at least part of *m1* (Figs. 3, 22) and length of the dentary ≥ 6.2 mm; from *S. monticolus* by length of *m1* usually ≤ 1.3 mm and length of *c1–m3* ≤ 4.4 mm; and from *S. preblei* by height of the coronoid process ≥ 3.2 mm and length of *c1–m3* usually ≥ 4.1 mm.

Sorex hoyi (**Pygmy shrew**)

This species is unique within the genus *Sorex* because the alveolus of *i1* extends posteriorly beneath at least part of *m1* (Figs. 3, 4). *Sorex hoyi* can be distinguished from *Notiosorex crawfordi, S. arizonae,* and *S. merriami* by height of the coronoid process ≤ 3.4 mm and from *S. nanus* ≥ 3.1 mm;

from *N. crawfordi* and *S. preblei* by *i1* set at an angle ≤ 13° and ≥ 10° from the horizontal ramus of the dentary, respectively; from *N. crawfordi* and *S. arizonae* by width of *m1* ≤ 0.8 mm and width of *m2* ≤ 0.8 mm; and from *S. haydeni* and *S. merriami* by length of the dentary ≤ 6.1 mm. Additionally, it differs from *N. crawfordi* by height of the unpigmented portion of *m1* ≤ 0.7 mm; from *N. crawfordi*, *S. arizonae*, and *S. merriami* by length of *c1–m3* ≤ 4.2 mm; from *S. arizonae* and *S. merriami* by length of *m3* ≥ 0.9 mm and ≤ 0.8 mm, respectively; and from *S. merriami* by length of the coronoid-condyloid processes ≤ 3.1 mm.

Sorex hydrodromus (**Pribilof Island shrew**)

The Pribilof Island shrew differs from *Sorex arcticus*, *S. monticolus*, and *S. tundrensis* by length of the coronoid-condyloid processes usually ≤ 3.1 mm and length of *c1–m3* ≤ 4.5 mm, and from *S. cinereus*, *S. jacksoni*, and *S. ugyunak* by *i1* set at an angle ≥ 8° from the horizontal ramus of the dentary. Additionally, *S. hydrodromus* can be distinguished from *S. arcticus* and *S. tundrensis* by presence of a strip of pigment on the inside ventromedial edge of the *i1s* (Figs. 10, 21) and height of the coronoid process ≤ 3.6 mm and from *S. ugyunak* ≥ 3.3 mm; from *S. arcticus* by width of *p4* ≤ 0.6 mm and length of the dentary ≤ 7.7 mm; from *S. monticolus* by length of *m1* ≤ 1.3 mm; and from *S. ugyunak* by presence of pigment on *i1* in two sections and *c1* usually with one cusp.

Sorex jacksoni (**St. Lawrence Island shrew**)

Sorex jacksoni can be distinguished from *S. arcticus*, *S. monticolus*, and *S. tundrensis* by length of *c1–m3* ≤ 4.4 mm; from *S. arcticus*, *S. monticolus*, and *S. tundrensis* by length of the coronoid-condyloid processes ≤ 3.0 mm; from *S. hydrodromus* and *S. monticolus* by *i1* set at an angle ≤ 7° from the horizontal ramus of the dentary; and from *S. ugyunak* by *c1* usually with one cusp. No single qualitative or quantitative character, or combination of characters recorded for this study, separates *S. jacksoni* from *S. cinereus*. However, van Zyll de Jong (1982; in litt., 30 January 1995) could distinguish *jacksoni* and *cinereus* by the following discriminant-function equation: discriminant score = 2.751 (length of mandible) + 3.633 (height of the coronoid process) + 6.189 (length of coronoid-condyloid processes) + 11.68 (greatest condylar depth) + 14.53 (width of lower condylar facet) – 5.923 (width of upper condylar facet) – 3.874 (length of *c1–m3*) – 17.54496. Those specimens with a score ≥ 0.460 are *S. jacksoni*. Further, it differs from *S. arcticus* and *S. tundrensis* by height of the coronoid process ≤ 3.5 mm and from *S. ugyunak* ≥ 3.2 mm; from *S. arcticus* and *S. monticolus* by width of *p4* ≤ 0.5 mm and width of *m2* ≤ 0.6 mm; from *S. arcticus* by depth of the dentary below *m1* ≤1.0 mm and length of the dentary ≤ 7.0 mm; and from *S. arcticus* and *S. tundrensis* by presence of a strip of pigment on the inside of the ventromedial edge of the *i1s* (Figs. 10, 21).

Sorex longirostris (**Southeastern shrew**)

This species can be distinguished from *Sorex hoyi*, *S. merriami*, and *S. nanus* by width of *m1* ≥ 1.1 mm and from *S. hoyi* and *S. nanus* by width of *m2* ≥ 0.9 mm. Also, it differs from *S. hoyi* by the alveolus of *i1* not extending posteriorly beneath part of *m1* (Figs. 3, 19), and from *S. merriami* by length of *c1–m3* ≤ 4.2 mm, height of the coronoid process ≤ 3.3 mm, and length of the coronoid-condyloid processes ≤ 2.9 mm.

Sorex lyelli (**Mt. Lyell shrew**)

The Mt. Lyell shrew differs from *Sorex ornatus* and *S. vagrans* by length of the coronoid-condyloid processes ≤ 3.0 mm; from *S. nanus* and *S. ornatus* by height of the coronoid process ≥ 3.1 mm and ≤ 3.4 mm, respectively; and from *S. tenellus* and *S. vagrans* by *i1* set at an angle ≤ 6° from the horizontal ramus of the dentary. Additionally, *S. lyelli* can be distinguished from *S. nanus* by length of *m1* ≥ 1.3 mm, length of *c1–m3* ≥ 4.2 mm, and length of dentary ≥ 6.5 mm.

Sorex merriami (**Merriam's shrew**)

Sorex merriami can be distinguished from *S. arizonae*, *S. hoyi*, *S. longirostris*, *S. nanus*, and *S. preblei* by height of the coronoid process usually ≥ 3.9 mm; from *Notiosorex crawfordi* by height of the unpigmented portion of *m1* ≤ 0.7 mm; and from *S. vagrans* by the interdenticular space very shallow (Figs. 13, 22) and *i1* set at an angle ≥ 13° from the horizontal ramus of the dentary (Fig. 22). It differs from *S. hoyi*, *S. longirostris*, *S. nanus*, and *S. preblei* by length of *c1–m3* ≥ 4.3 mm and length of the coronoid-condyloid processes ≥ 3.2 mm, and from *S. nanus* and *S. preblei* by depth of the dentary below *m1* ≥ 0.95 mm. Additionally, Merriam's shrew can be distinguished from *S. hoyi* by length of *m3* ≥ 0.9 mm, length of the dentary ≥ 6.4 mm, and the alveolus of *i1* not extending posteriorly beneath part of *m1* (Figs. 3, 22); from *S. longirostris* by width of *m1* ≤ 1.0 mm; and from *S. preblei* by length of *m1* ≥ 1.3 mm and length of the dentary usually ≥ 6.6 mm.

Sorex monticolus (**Dusky** or **Montane shrew**)

Sorex monticolus can be distinguished from *S. arcticus* and *S. m. neomexicanus* by length of the coronoid-condyloid processes ≤ 3.6 mm and from *S. cinereus*, *S. jacksoni*, *S. hydrodromus*, and *S. ugyunak* ≥ 3.2 mm; from *S. alaskanus*, *S. bairdii*, and *S. m. neomexicanus* by length of *c1–m3* ≤ 5.2 mm and from *S. jacksoni*, *S. hydrodromus*, and *S. monticolus* ≥ 4.5 mm; and from *S. arcticus* and *S. tundrensis* by presence of a strip of pigment on the inside of the ventromedial edge of the *i1s* (Figs. 10, 12).

Additionally, it differs from *S. alaskanus* by length of the dentary ≤ 8.1 mm; from *S. arcticus, S. bairdii,* and *S. m. neomexicanus* by height of the coronoid process ≤ 4.2 mm and from *S. ugyunak* ≥ 3.5 mm; from *S. cinereus, S. haydeni, S. hydrodromus, S. jacksoni,* and *S. ugyunak* by length of *m1* ≥ 1.4 mm; from *S. jacksoni* by *i1* set at an angle usually ≥ 8° from the horizontal ramus of the dentary, width of *p4* ≥ 0.6 mm, and width of *m2* ≥ 0.7 mm; and from *S. ugyunak* by *i1* set at an angle usually ≥ 8° from the horizontal ramus of the dentary, pigment on *i1* usually in one section, and *c1* usually with one cusp.

Sorex monticolus neomexicanus (**Dusky** or **Montane shrew**)

This taxon can be distinguished from *Sorex cinereus,* other *S. monticolus,* and *S. palustris* by height of the coronoid process usually ≥ 4.5 mm. Additionally, this taxon differs from *S. cinereus* and other *S. monticolus* by length of *c1–m3* ≥ 5.0 mm and usually ≥ 5.3 mm, respectively, and length of the coronoid-condyloid processes ≥ 3.7 mm; from *S. cinereus* and *S. palustris* by height of the unpigmented portion of *m1* ≥ 0.65 mm; from *S. cinereus* by length of *m1* ≥ 1.6 mm, length of *m2* ≥ 1.3 mm, and length of the dentary ≥ 7.6 mm; and from *S. palustris* by widths of *c1* + *p4* usually > 1.4 mm.

Sorex nanus (**Dwarf shrew**)

With exception of *Sorex minutissimus,* the dwarf shrew is the smallest shrew in North America (Tables 1, 2). *Sorex nanus* can be distinguished from *Notiosorex crawfordi, S. hoyi, S. lyelli, S. merriami,* and *S. arizonae* by height of the coronoid process usually ≤ 3.1 mm. Also, it differs from *S. hoyi* by the alveolus of *i1* not extending posteriorly beneath part of *m1* (Figs. 3, 19); from *S. preblei* by *i1* set at an angle usually ≥ 8° from the horizontal ramus of the dentary; from *S. longirostris* by width of *m1* ≤ 0.8 mm and width of *m2* ≤ 0.8 mm; and from *S. tenellus* by length of the dentary ≤ 6.5 mm and length of *c1–m3* usually ≤ 4.1 mm. Additionally, it can be distinguished from *N. crawfordi* by length of *c1–m3* ≤ 4.2 mm and pigment present on *m2* and *m3;* from *S. merriami* and *S. arizonae* by length of the coronoid-condyloid processes ≤ 3.0 mm, depth of the dentary below *m1* ≤ 0.95 mm, and length of *c1–m3* ≤ 4.1 mm; from *S. arizonae* by length of *c1* ≤ 0.8 mm, length of *p4* ≤ 0.9 mm, length of *m2* ≤ 1.1 mm, width of *p4* ≤ 0.6 mm, and length of the dentary ≤ 6.7 mm; and from *S. lyelli* by length of *m1* ≤ 1.3 mm, length of *c1–m3* ≤ 4.1 mm, and length of the dentary usually ≤ 6.5 mm.

Sorex ornatus (**Ornate shrew**)

Sorex ornatus can be distinguished from *Notiosorex crawfordi* by *i1* set at an angle usually ≤ 13° from the horizontal ramus of the dentary, height

of the unpigmented portion of *m1* ≤ 0.7 mm, and pigment present on *m2* and *m3;* from *S. lyelli* by height of the coronoid process usually ≥ 3.4 mm and length of the coronoid-condyloid processes ≥ 3.0 mm; and from *S. trowbridgii* by length of *c1–m3* usually ≤ 4.8 mm. No quantitative or qualitative characters of the dentary could be discerned to distinguish *S. ornatus* from *S. vagrans.*

Sorex pacificus (**Pacific shrew**)

This species can be distinguished from *Sorex bendirii* by one posterolingually directed ridge (Figs. 8, 18) on the occlusal surface of *p4* and length of *c1* ≤ length of *p4.*

Sorex palustris (**Water shrew**)

This species differs from *Sorex bendirii* by one posterolingually directed ridge (Figs. 8, 15) on the occlusal surface of *p4* and length of *c1* < length of *p4;* from *S. cinereus* and *S. ugyunak* by height of the coronoid process ≥ 4.0 mm and from *S. m. neomexicanus* usually ≤ 4.5 mm. Additionally, the water shrew differs from *S. cinereus* and *S. ugyunak* by length of *m3* ≥ 0.95 mm, length of *c1–m3* ≥ 5.2 mm, *i1* set at an angle usually ≥ 8° from the horizontal ramus of the dentary, length of the coronoid-condyloid processes ≥ 3.2 mm, and length of the dentary ≥ 8.0 mm; from *S. m. neomexicanus* by height of the unpigmented portion of *m1* ≤ 0.65 mm and widths of *c1* + *p4* ≤ 1.4 mm; and from *S. ugyunak* by pigment on *i1* in one section, length of *p4* ≥ 1.1 mm, width of *m2* ≥ 0.8 mm, and *c1* usually with one cusp.

Sorex preblei (**Preble's shrew**)

Sorex preblei can be distinguished from *Notiosorex crawfordi* and *S. merriami* by height of the coronoid process ≤ 3.3 mm, length of the coronoid-condyloid processes ≤ 2.9 mm, and length of *c1–m3* ≤ 4.2 mm, and from *S. hoyi* and *S. nanus* by *i1* set at an angle ≤ 8° from the horizontal ramus of the dentary. Additionally, Preble's shrew can be distinguished from *N. crawfordi* by height of the unpigmented portion of *m1* ≤ 0.65 mm and pigment present on *m2* and *m3;* from *S. hoyi* by the alveolus of *i1* not extending posteriorly beneath part of *m1* (Figs. 3, 19); from *S. merriami* by depth of dentary below *m1* ≤ 0.9 mm, length of *m1* ≤ 1.3 mm, and length of dentary usually ≤ 6.6 mm; and from *S. haydeni* by height of the coronoid process usually ≤ 3.2 mm and length of *c1–m3* usually ≤ 4.1 mm.

Sorex sonomae (**Fog shrew**)

This species can be distinguished from *Sorex bendirii* by one posterolingually directed ridge (Fig. 8) on the occlusal surface of *p4* and length of *c1* < length of *p4.*

Sorex tenellus (**Inyo shrew**)

The Inyo shrew can be distinguished from *Sorex lyelli* by *i1* set at an angle ≥ 8° from the horizontal ramus of the dentary (Fig. 20), and from *S. nanus* by length of *c1–m3* ≥ 4.2 mm and length of the dentary usually ≥ 6.4 mm.

Sorex trowbridgii (**Trowbridge's shrew**)

This species can be distinguished from *Sorex ornatus* by length of *c1–m3* usually ≥ 5.0 mm.

Sorex tundrensis (**Tundra shrew**)

Sorex tundrensis differs from *S. hydrodromus*, *S. jacksoni*, and *S. ugyunak* by height of the coronoid process ≥ 3.7 mm, length of the coronoid-condyloid processes ≥ 3.1 mm, and length of *c1–m3* ≥ 4.5 mm; from *S. cinereus*, *S. jacksoni*, *S. monticolus*, and *S. ugyunak* by lack of a strip of pigment on the inside of the ventromedial edge of the *i1s* (Figs. 10, 11). Additionally, it differs from *S. cinereus* by length of the coronoid-condyloid processes usually ≥ 3.3 mm and from *S. ugyunak* by pigment on *i1* in one or two sections, *c1* with one cusp, and depth of the dentary below *m1* + height of the coronoid process ≥ 4.7 mm.

Sorex ugyunak (**Barren ground shrew**)

The barren ground shrew can be distinguished from all other *Sorex* by a combination of height of the coronoid process ≤ 3.2 mm and *c1* with two cusps. Additionally, it differs from *Sorex alaskanus*, *S. arcticus*, and *S. palustris* by length of *c1–m3* ≤ 4.5 mm, length of the coronoid-condyloid processes ≤ 2.9 mm, and length of the dentary ≤ 6.9 mm; from *S. alaskanus* and *S. arcticus* by depth of the dentary below *m1* ≤ 1.0 mm; from *S. alaskanus*, *S. hydrodromus*, *S. palustris*, and *S. tundrensis* by pigment on *i1* in three sections; and from *S. hydrodromus*, *S. monticolus*, and *S. palustris* by *i1* set at an angle ≤ 5° from the horizontal ramus of the dentary. Additionally, *S. ugyunak* can be distinguished from *S. arcticus* and *S. tundrensis* by presence of a strip of pigment on the inside ventromedial edge of the *i1s* (Figs. 10, 20); from *S. arcticus* and *S. palustris* by length of *p4* ≤ 0.9 mm; from *S. monticolus* and *S. tundrensis* by length of the coronoid-condyloid processes ≤ 2.9 mm; and from *S. tundrensis* by length of *c1–m3* ≤ 4.5 mm.

Sorex vagrans (**Vagrant shrew**)

Sorex vagrans can be distinguished from *S. cinereus* and *S. lyelli* by length of the coronoid-condyloid processes ≥ 3.1 mm; from *S. lyelli* by *i1* set at an angle ≥ 8° from the horizontal ramus of the dentary (Fig. 24); and

from *S. merriami* by the interdenticular space very deep (Figs. 13, 24) and *i1* set at an angle ≤ 13° from the horizontal ramus of the dentary (Fig. 24). No quantitative or qualitative dentary characters could be discerned to distinguish *S. vagrans* from *S. ornatus*.

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Table 1. Means (±SE), ranges, and CVs of measurements (in mm) and angular mean and deviation of angle e[a] (in degrees) of dentaries of of *Cryptotis*, *Notiosorex*, and three species of *Blarina* from west of the Mississippi River (United States) and 94°W (Canada). Characters referred to contributed to the separation of taxa in the key. Taxa are arranged alphabetically.

Taxon	*n*	Length of dentary	Height of coronoid process	Length of coronoid-condyloid processes	Length of *c1-m3*	Height of *m1*	Height of unpigmented portion of *m1*	Depth of mandible below *m1*
Blarina								
brevicauda	30	9.70 ± 0.09	6.75 ± 0.09	5.70 ± 0.08	6.74 ± 0.06	1.46 ± 0.04	0.56 ± 0.02	2.17 ± 0.05
		8.8–11.2	5.7–7.9	5.0–6.9	5.8–7.3	0.8–1.9	0.4–0.7	1.7–3.0
		0.05	0.08	0.07	0.05	0.15	0.16	0.12
carolinensis	1	8.3	5.0	4.3	5.8	1.2	0.4	1.6
hylophaga	26	9.57 ± 0.08	5.90 ± 0.06	4.98 ± 0.06	6.34 ± 0.04	1.52 ± 0.04	0.59 ± 0.01	2.15 ± 0.03
		8.81–10.2	5.48–6.56	4.60–5.66	6.00–6.83	1.0–1.7	0.4–0.7	1.7–2.4
		0.04	0.05	0.06	0.03	0.14	0.10	0.08
Cryptotis								
parva	30	6.56 ± 0.05	3.72 ± 0.04	3.24 ± 0.04	4.47 ± 0.05	1.04 ± 0.02	0.43 ± 0.02	1.24 ± 0.03
		6.0–7.1	3.2–4.1	2.7–3.5	4.2–4.9	0.7–1.3	0.3–0.6	1.1–1.7
		0.04	0.05	0.06	0.06	0.13	0.22	0.12
Notiosorex								
crawfordi	29	6.86 ± 0.06	4.00 ± 0.07	3.47 ± 0.04	4.84 ± 0.03	1.19 ± 0.02	1.14 ± 0.02	1.14 ± 0.02
		6.1–7.3	3.3–4.7	3.0–3.9	4.5–5.1	0.9–1.3	0.9–1.3	0.9–1.4
		0.05	0.09	0.06	0.04	0.09	0.09	0.11

Table 1. Continued.

Taxon	*n*	Angle e	Distance of *i1* to *p4*	Width of *c1*	Width of *p4*	Width of *m1*	Width of *m2*	Length of *m1*	Length of *m2*
Blarina									
brevicauda	30	16.9 ± 3.4	0.19 ± 0.01	0.92 ± 0.01	1.18 ± 0.03	1.46 ± 0.02	1.31 ± 0.03	2.21 ± 0.03	1.79 ± 0.02
		13–28	1–3	0.8–1.1	0.9–1.6	1.2–1.7	1.0–1.6	1.7–2.5	1.6–2.0
			0.36	0.06	0.14	0.09	0.11	0.07	0.05
carolinensis	1	15	0.2	0.8	1.0	1.3	1.2	1.7	1.5
hylophaga	26	18.8 ± 2.6	0.21 ± 0.02	0.90 ± 0.01	1.20 ± 0.01	1.54 ± 0.01	1.38 ± 0.02	2.09 ± 0.02	1.69 ± 0.01
		14–25	0.1–0.4	0.8–1.0	0.9–1.4	1.3–1.7	1.1–1.7	1.9–2.4	1.6–1.9
			0.39	0.08	0.06	0.05	0.06	0.06	0.04
Cryptotis									
parva	30	17.7 ± 3.0	0.20 ± 0.01	0.53 ± 0.01	0.65 ± 0.01	0.82 ± 0.02	0.77 ± 0.02	1.36 ± 0.01	1.18 ± 0.01
		13–28	0.1–0.3	0.4–0.6	0.6–0.8	0.7–1.1	0.7–1.0	1.2–1.5	1.0–1.3
			0.25	0.10	0.10	0.13	0.14	0.56	0.05
Notiosorex									
crawfordi	29	19.1 ± 3.7	0.14 ± 0.01[b]	0.60 ± 0.01[c]	0.75 ± 0.02[b]	0.98 ± 0.02	0.99 ± 0.02	1.45 ± 0.03	1.33 ± 0.02
		15–28	0.07–0.23	0.5–0.7	0.4–1.0	0.8–1.1	0.8–1.1	0.9–1.7	0.8–1.5
			0.39	0.09	0.14	0.09	0.09	0.09	0.09

[a]Summary statistics based on a circular distribution (Zar, 1984:428–432).
[b]Sample size one less than *n*.
[c]Sample size three less than *n*.

Table 2. Means (±SE), ranges, and CVs of measurements (in mm) and angular mean and deviation of angle e[a] (in degrees) of dentaries of 30 taxa of *Sorex* from west of the Mississippi River (United States) and 94°W (Canada). Characters listed were used to separate taxa in the key. Taxa are arranged alphabetically.

Taxon	*n*	Length of dentary	Height of coronoid process	Length of coronoid-condyloid processes	Length of *c1-m3*	Height of *m1*	Height of unpigmented portion of *m1*	Depth of mandible below *m1*
S. alaskanus	2	8.65 ± 0.09 8.55–8.74 0.02	4.36 ± 0.13 4.23–4.49 0.04	3.64 ± 0.07 3.57–3.70 0.03	5.51 ± 0.07 5.43–5.58 0.02	0.8[b] 1.27–1.30 0.02	0.6[b]	1.29 ± 0.02
S. arcticus	30	8.31 ± 0.06 7.9–9.2 0.04	4.71 ± 0.03 4.4–5.0 0.03	4.04 ± 0.02 3.8–4.3 0.03	5.03 ± 0.02 4.8–5.2 0.02	1.01 ± 0.02 0.75–1.2 0.13	0.62 ± 0.02 0.5–1.0 0.14	1.33 ± 0.02 1.1–1.5 0.08
S. arizonae	6	7.22 ± 0.05[b] 7.1–7.4 0.02	3.68 ± 0.05 3.5–3.8 0.03	3.32 ± 0.03 3.1–3.3 0.03	4.80 ± 0.04[b] 4.7–4.9 0.02	0.96 ± 0.06 0.8–1.2 0.16	0.56 ± 0.02 0.5–0.6 0.09	1.13 ± 0.04 1.0–1.3 0.09
S. bairdii	30	8.18 ± 0.06 7.9–9.2 0.04	4.59 ± 0.06 4.1–5.2 0.07	4.01 ± 0.05 3.8–4.3 0.07	5.42 ± 0.05 5.0–5.7 0.05	1.09 ± 0.03 0.8–1.4 0.14	0.67 ± 0.01 0.6–0.8 0.10	1.32 ± 0.03 1.1–1.5 0.12
S. bendirii palmeri	29	10.11 ± 0.05 9.4–10.5 0.03	5.72 ± 0.05 5.2–6.3 0.05	5.09 ± 0.05 4.5–5.5 0.05	6.62 ± 0.03 6.2–7.0 0.02	1.19 ± 0.04 0.8–1.5 0.17	0.67 ± 0.01 0.5–0.8 0.12	1.93 ± 0.04 1.5–2.4 0.12

Table 2. Continued.

S. bendirii	51	9.40 ± 0.05[b]	5.27 ± 0.03	4.65 ± 0.03	6.25 ± 0.03	1.23 ± 0.02	0.60 ± 0.01	1.68 ± 0.02
other		8.8–10.3	4.8–5.9	4.1–5.0	5.7–6.6	0.8–1.5	0.5–0.8	1.4–2.1
subspecies		0.03	0.04	0.04	0.03	0.13	0.12	0.08
S. cinereus	33	6.79 ± 0.06[b]	3.26 ± 0.03	2.94 ± 0.03	4.43 ± 0.03[b]	0.89 ± 0.02	0.54 ± 0.01	0.88 ± 0.02
		6.5–7.6	3.0–3.9	2.7–3.4	4.2–4.9	-0.7–1.1	0.5–0.6	0.7–1.4
		0.05	0.05	0.07	0.04	0.15	0.07	0.15
S. haydeni	30	6.44 ± 0.04	3.29 ± 0.02	2.89 ± 0.03	4.23 ± 0.02	1.10 ± 0.17	0.52 ± 0.01	0.85 ± 0.01
		6.2–7.0	3.1–3.5	2.5–3.2	3.9–4.4	0.6–1.1	0.45–0.6	0.7–1.0
		0.03	0.03	0.05	0.03	0.84	0.09	0.09
S. hoyi	30	5.63 ± 0.04	3.24 ± 0.02	2.87 ± 0.02	3.95 ± 0.02	1.00 ± 0.02	0.58 ± 0.01	0.87 ± 0.01
		5.3–6.1	3.1–3.4	2.6–3.1	3.7–4.2	0.8–1.2	0.4–0.7	0.7–1.0
		0.04	0.03	0.04	0.03	0.09	0.10	0.09
S. hydrodromus	30	7.01 ± 0.04	3.39 ± 0.02	2.98 ± 0.02	4.39 ± 0.01	0.80 ± 0.02	0.49 ± 0.01	1.02 ± 0.01
		6.7–7.7	3.0–3.6	2.9–3.4	4.2–4.5	0.7–1.0	0.4–0.5	0.9–1.2
		0.03	0.04	0.04	0.02	0.12	0.06	0.07
S. jacksoni	20	6.59 ± 0.04	3.33 ± 0.02	2.91 ± 0.02	4.37 ± 0.02	0.86 ± 0.02	0.51 ± 0.01	0.97 ± 0.01
		6.2–7.0	3.2–3.5	2.8–3.0	4.2–4.6	0.7–1.0	0.5–0.6	0.9–1.0
		0.03	0.03	0.02	0.02	0.09	0.01	0.05
S. longirostris	34	6.11 ± 0.04	3.13 ± 0.02	2.76 ± 0.02	4.02 ± 0.02	0.89 ± 0.02	0.62 ± 0.01	0.85 ± 0.01
		5.5–6.5	2.9–3.2	2.5–2.9	3.8–4.1	0.7–1.0	0.4–0.7	0.7–0.9
		0.04	0.03	0.03	0.02	0.11	0.11	0.08

Table 2. Continued.

Taxon	*n*	Length of dentary	Height of coronoid process	Length of coronoid-condyloid processes	Length of *c1-m3*	Height of *m1*	Height of unpigmented portion of *m1*	Depth of mandible below *m1*
S. lyelli	6	6.97 ± 0.18 6.4–7.5 0.06	3.25 ± 0.05 3.1–3.4 0.04	2.88 ± 0.06 2.7–3.0 0.05	4.38 ± 0.09 4.2–4.7 0.05	0.83 ± 0.08 0.6–1.1 0.23	0.51 ± 0.02 0.45–0.6 0.09	0.88 ± 0.08 0.5–1.0 0.23
S. merriami	30	6.87 ± 0.05 6.4–7.6 0.04	4.03 ± 0.02 3.8–4.2 0.02	3.47 ± 0.02 3.2–3.8 0.03	4.69 ± 0.03 4.3–5.1 0.04	1.13 ± 0.04 0.65–1.45 0.18	0.63 ± 0.01 0.5–0.7 0.08	1.13 ± 0.02 0.95–1.4 0.09
S. minutissimus	2	5.85 ± 0.15 5.7–6.0 0.04	2.30 ± 0.00 2.3–2.3 0.00	2.80 ± 0.70 2.1–3.5 0.35	2.85 ± 0.75 2.1–3.6 0.37	0.85 ± 0.08 0.8–0.9 0.08	0.50 ± 0.00 0.5–0.5 0.00	0.50 ± 0.00 0.5–0.5 0.00
S. monticolus neomexicanus	20	7.82 ± 0.06 7.22–8.24 0.03	4.46 ± 0.02 4.32–4.68 0.02	3.81 ± 0.03 3.50–3.95 0.03	5.45 ± 0.02 5.28–5.60 0.02	1.25 ± 0.05 0.6–1.5 0.19	0.70 ± 0.01 0.65–0.75 0.04	1.29 ± 0.02 1.09–1.59 0.08
S. monticolus other subspecies	30	7.39 ± 0.05 6.8–8.1 0.04	3.93 ± 0.02 3.5–4.2 0.03	3.47 ± 0.02 3.2–3.6 0.03	4.93 ± 0.03 4.5–5.2 0.03	1.15 ± 0.03 0.8–1.3 0.13	0.57 ± 0.01 0.45–0.7 0.09	1.04 ± 0.02 0.8–1.3 0.10

Table 2. Continued.

S. nanus	30	6.12 ± 0.06 5.5–6.7 0.05	2.88 ± 0.03 2.6–3.2 0.05	2.53 ± 0.04 2.1–3.0 0.08	4.03 ± 0.02 3.8–4.2 0.03	0.89 ± 0.02 0.65–1.0 0.15	0.48 ± 0.01 0.35–0.6 0.13	0.74 ± 0.02 0.6–0.95 0.12
S. ornatus	30	6.94 ± 0.06 6.3–7.7 0.05	3.67 ± 0.04 3.0–4.0 0.05	3.31 ± 0.03 3.0–3.6 0.05	4.63 ± 0.03 4.4–4.9 0.03	1.02 ± 0.03 0.7–1.2 0.14	0.59 ± 0.01 0.3–0.7 0.13	0.99 ± 0.02 0.9–1.3 0.09
S. pacificus	30	8.64 ± 0.07 8.0–9.2 0.04	5.01 ± 0.04 4.3–5.4 0.05	4.37 ± 0.03 4.0–4.7 0.04	5.65 ± 0.04 5.1–6.1 0.04	1.26 ± 0.03 1.0–1.5 0.13	0.71 ± 0.01 0.6–0.8 0.09	1.35 ± 0.03 1.1–1.7 0.13
S. palustris	31	8.50 ± 0.05 8.0–9.0 0.03	4.31 ± 0.03 4.0–4.6 0.03	3.85 ± 0.04 3.2–4.2 0.05	5.54 ± 0.03[b] 5.2–5.8 0.03	1.16 ± 0.03 0.75–1.4 0.14	0.58 ± 0.01 0.4–0.65 0.09	1.26 ± 0.02 1.1–1.6 0.11
S. preblei	33	6.16 ± 0.04 5.6–6.6 0.03	3.09 ± 0.02 2.9–3.3 0.03	2.74 ± 0.02 2.6–3.2 0.04	3.99 ± 0.02 3.8–4.2 0.03	0.89 ± 0.02 0.6–1.0 0.15	0.49 ± 0.01 0.4–0.65 0.11	0.80 ± 0.01 0.7–0.9 0.08
S. sonomae sonomae	30	9.59 ± 0.09 8.8–11.1 0.05	5.89 ± 0.06 5.1–6.3 0.06	5.08 ± 0.06 4.4–5.7 0.07	6.27 ± 0.04 5.8–6.7 0.04	1.39 ± 0.04 1.0–1.7 0.15	0.84 ± 0.02 0.7–1.0 0.11	1.64 ± 0.03 1.3–2.0 0.11
S. sonomae tenelliodus	30	8.70 ± 0.07 8.2–9.7 0.04	5.10 ± 0.05 4.8–5.8 0.05	4.34 ± 0.05 4.1–5.0 0.06	5.66 ± 0.04 5.3–6.1 0.04	1.14 ± 0.03 0.8–1.5 0.15	0.73 ± 0.01 0.6–0.8 0.09	1.44 ± 0.03 0.9–1.8 0.12

Table 2. Continued.

Taxon	*n*	Length of dentary	Height of coronoid process	Length of coronoid-condyloid processes	Length of *c1-m3*	Height of *m1*	Height of unpigmented portion of *m1*	Depth of mandible below *m1*
S. tenellus	11	6.57 ± 0.08 6.2–7.2 0.04	3.17 ± 0.08 2.9–3.7 0.08	2.78 ± 0.06 2.5–3.2 0.07	4.30 ± 0.05 4.2–4.7 0.04	0.92 ± 0.05 0.7–1.1 0.17	0.48 ± 0.01 0.4–0.5 0.08	0.80 ± 0.04 0.7–1.1 0.18
S. trowbridgii montereyensis	12	7.87 ± 0.12 7.3–8.8 0.05	3.97 ± 0.05 3.6–4.2 0.05	3.48 ± 0.05 3.1–3.6 0.05	5.38 ± 0.06[b] 5.0–5.6 0.04	1.09 ± 0.04 0.8–1.3 0.12	0.56 ± 0.01 0.5–0.6 0.09	1.16 ± 0.03 1.0–1.3 0.08
S. trowbridgii other subspecies	30	7.62 ± 0.07 6.6–8.2 0.05	3.84 ± 0.02 3.7–4.2 0.03	3.37 ± 0.03 3.2–3.7 0.04	5.14 ± 0.03 4.8–5.5 0.04	0.95 ± 0.03 0.5–1.3 0.20	0.49 ± 0.02 0.3–0.7 0.18	1.09 ± 0.02 0.9–1.3 0.09
S. tundrensis	30	7.47 ± 0.04 6.8–7.9 0.03	3.96 ± 0.02 3.7–4.2 0.03	3.46 ± 0.03 2.9–3.6 0.04	4.70 ± 0.02 4.5–5.0 0.02	1.05 ± 0.03 0.7–1.2 0.14	0.51 ± 0.01 0.5–0.6 0.06	1.08 ± 0.01 1.0–1.2 0.06
S. ugyunak	30	6.69 ± 0.04[c] 6.3–7.1 0.03	3.12 ± 0.02[b] 3.0–3.3 0.03	2.79 ± 0.02[b] 2.3–3.0 0.05	4.29 ± 0.79[b] 4.1–4.5 0.02	0.89 ± 0.16 0.6–1.0 0.11	0.54 ± 0.01 0.5–0.6 0.08	0.86 ± 0.01 0.8–1.0 0.07
S. vagrans	30	6.99 ± 0.05 6.5–7.7 0.04	3.59 ± 0.03 3.2–4.0 0.05	3.19 ± 0.03 2.9–3.5 0.05	4.61 ± 0.03 4.3–5.0 0.03	0.99 ± 0.02 0.7–1.2 0.10	0.51 ± 0.01 0.4–0.6 0.09	1.01 ± 0.02 0.9–1.3 0.10

Table 2. Continued.

Taxon	*n*	Angle e	Distance of *i1* to *p4*	Width of *c1*	Width of *p4*	Width of *m1*	Width of *m2*	Length of *m1*	Length of *m2*
S. alaskanus	2	5	1.0[b]	0.7[b]	0.7[b]	1.0[b]	1.0[b]	1.55[b]	1.4[b]
S. arcticus	30	7.9 ± 2.8 5–15	0.39 ± 0.01 0.3–0.5 0.13	0.71 ± 0.01 0.6–0.8 0.07	0.77 ± 0.01 0.7–0.8 0.06	0.87 ± 0.01 0.7–1.0 0.08	0.84 ± 0.01 0.7–1.0 0.08	1.47 ± 0.01 1.3–1.6 0.04	1.25 ± 0.01 1.1–1.4 0.05
S. arizonae	6	14.2 ± 0.8[b] 13–15	0.33 ± 0.02 0.3–0.4 0.13	0.55 ± 0.02 0.5–0.6 0.09	0.72 ± 0.02 0.7–0.8 0.06	0.87 ± 0.02 0.8–0.9 0.06	0.87 ± 0.03 0.7–0.9 0.09	1.37 ± 0.02 1.3–1.4 0.04	1.22 ± 0.02 1.2–1.3 0.03
S. bairdii	30	11.0 ± 2.4 5–15	0.36 ± 0.01 0.2–0.5 0.21	0.71 ± 0.01 0.6–0.9 0.09	0.80 ± 0.01 0.7–1.0 0.09	0.95 ± 0.02 0.8–1.2 0.10	0.93 ± 0.02 0.8–1.1 0.09	1.58 ± 0.02 1.4–1.8 0.06	1.32 ± 0.01 1.2–1.5 0.05
S. bendirii palmeri	29	10.7 ± 2.5 8–15	0.66 ± 0.02 0.4–0.8 0.03	0.98 ± 0.02 0.8–1.1 0.09	1.02 ± 0.02 0.9–1.1 0.08	1.15 ± 0.02 1.0–1.3 0.07	1.13 ± 0.01 1.0–1.3 0.06	1.72 ± 0.03 1.3–2.0 0.09	1.51 ± 0.02 1.1–1.7 0.07
S. bendirii other subspecies	51	11.3 ± 2.3 8–17	0.62 ± 0.01 0.5–0.8 0.13	0.84 ± 0.01 0.7–1.0 0.07	0.89 ± 0.01 0.8–1.0 0.07	1.06 ± 0.01 1.0–1.2 0.06	1.04 ± 0.01 0.9–1.1 0.06	1.67 ± 0.01 1.5–1.9 0.05	1.45 ± 0.01 1.3–1.6 0.04

Table 2. Continued.

Taxon	*n*	Angle e	Distance of *i1* to *p4*	Width of *c1*	Width of *p4*	Width of *m1*	Width of *m2*	Length of *m1*	Length of *m2*
S. cinereus	33	4.3 ± 2.2[b] 1–10	0.25 ± 0.01[b] 0.2–0.4 0.24	0.49 ± 0.01[b] 0.4–0.5 0.06	0.54 ± 0.01[b] 0.4–0.7 0.11	0.69 ± 0.01 0.6–1.0 0.11	0.69 ± 0.01 0.6–1.0 0.11	1.24 ± 0.02 0.7–1.4 0.10	1.08 ± 0.01 1.0–1.2 0.05
S. haydeni	30	7.5 ± 1.6 5–10	0.21 ± < 0.00 0.2–0.3 0.11	0.49 ± 0.01 0.4–0.6 0.08	0.54 ± 0.01 0.5–0.8 0.12	0.68 ± 0.01 0.6–0.9 0.11	0.69 ± 0.01 0.6–0.8 0.10	1.22 ± 0.02 0.7–1.3 0.09	1.02 ± 0.01 0.7–1.1 0.08
S. hoyi	30	11.6 ± 1.9 8–15	0.09 ± 0.01 0.07–0.17 0.34	0.51 ± 0.01 0.4–0.6 0.09	0.56 ± 0.01 0.5–0.6 0.09	0.70 ± 0.01 0.6–0.8 0.07	0.69 ± 0.01 0.6–0.8 0.07	1.26 ± 0.01 1.2–1.3 0.04	1.06 ± 0.01 1.0–1.2 0.05
S. hydrodromus	30	10.4 ± 1.6 8–14	0.41 ± 0.01 0.3–0.5 0.08	0.53 ± 0.01 0.4–0.6 0.10	0.52 ± 0.01 0.5–0.6 0.08	0.66 ± 0.01 0.6–0.8 0.08	0.66 ± 0.01 0.6–0.8 0.09	1.24 ± 0.01 1.2–1.3 0.04	1.05 ± 0.01 1.0–1.1 0.05
S. jacksoni	20	4.9 ± 1.9 1–8	0.39 ± 0.11 0.2–0.4 1.28	0.52 ± 0.01 0.5–0.6 0.07	0.50 ± 0.00 0.5–0.5 0.00	0.61 ± 0.01 0.6–0.7 0.05	0.59 ± 0.01 0.5–0.6 0.04	1.25 ± 0.01 1.2–1.3 0.04	1.06 ± 0.01 1.0–1.1 0.05
S. longirostris	34	10.0 ± 1.6 7–14	0.21 ± 0.01 0.1–0.3 0.19	0.48 ± 0.01 0.4–0.5 0.08	0.52 ± 0.01 0.5–0.6 0.08	1.19 ± 0.01 1.1–1.3 0.03	1.02 ± 0.01 0.9–1.1 0.04	1.19 ± 0.01 1.1–1.3 0.03	1.02 ± 0.01 0.9–1.1 0.04

Table 2. Continued.

S. lyelli	6	4.2 ± 1.2 3–6	0.31 ± 0.03 0.2–0.4 0.22	0.48 ± 0.02 0.4–0.5 0.08	0.55 ± 0.03 0.5–0.7 0.15	0.70 ± 0.03 0.6–0.8 0.09	0.72 ± 0.02 0.7–0.8 0.06	1.33 ± 0.02 1.3–1.4 0.04	1.08 ± 0.03 1.0–1.2 0.07
S. merriami	30	15.9 ± 1.8 12–20	0.20 ± 0.01 0.1–0.3 0.22	0.53 ± 0.01 0.4–0.6 0.09	0.66 ± 0.01 0.5–0.8 0.11	0.86 ± 0.01 0.7–1.0 0.09	0.84 ± 0.01 0.7–1.0 0.09	1.48 ± 0.01 1.3–1.6 0.05	1.23 ± 0.01 1.0–1.3 0.06
S. minutissimus	2	4.5 ± 0.5 4–5	0.20 ± 0.00 0.2–0.2 0.00	0.33 ± 0.03 0.3–0.35 0.11	0.60 ± 0.00 0.6–0.6 0.00	0.50 ± 0.00 0.5–0.5 0.00	0.43 ± 0.03 0.4–0.45 0.08	1.05 ± 0.05 1.0–1.1 0.07	0.88 ± 0.03 0.85–0.90 0.04
S. monticolus neomexicanus	20	5.2 ± 2.6[c] 1–8	0.37 ± 0.01 0.3–0.5 0.16	0.69 ± 0.01 0.63–0.83 0.04	0.77 ± 0.01 0.72–0.80 0.04	1.03 ± 0.03 0.9–1.5 0.13	0.93 ± 0.03 0.8–1.3 0.12	1.59 ± 0.03 1.05–1.7 0.09	1.31 ± 0.02 1.0–1.4 0.06
S. monticolus other subspecies	30	8.3 ± 2.6 5–15	0.29 ± 0.01 0.2–0.3 0.14	0.58 ± 0.01 0.5–0.7 0.08	0.67 ± 0.01 0.6–0.9 0.10	0.84 ± 0.01 0.7–1.0 0.09	0.80 ± 0.01 0.7–1.0 0.08	1.46 ± 0.01 1.4–1.6 0.05	1.24 ± 0.01 1.1–1.3 0.05
S. nanus	30	10.1 ± 2.9 5–14	0.21 ± 0.01 0.15–0.3 0.18	0.43 ± 0.01 0.3–0.5 0.14	0.50 ± 0.01 0.4–0.6 0.09	0.67 ± 0.01 0.6–0.8 0.08	0.67 ± 0.01 0.6–0.8 0.09	1.16 ± 0.01 1.1–1.3 0.05	1.02 ± 0.01 1.0–1.1 0.04
S. ornatus	30	10.8 ± 1.8 8–14	0.26 ± 0.01 0.2–0.3 0.20	0.54 ± 0.01 0.5–0.7 0.10	0.61 ± 0.01 0.5–0.7 0.09	0.77 ± 0.01 0.7–0.9 0.08	0.76 ± 0.01 0.7–0.9 0.07	1.34 ± 0.02 0.9–1.5 0.08	1.18 ± 0.01 1.0–1.3 0.06

Table 2. Continued.

Taxon	*n*	Angle e	Distance of *i1* to *p4*	Width of *c1*	Width of *p4*	Width of *m1*	Width of *m2*	Length of *m1*	Length of *m2*
S. pacificus	30	11.6 ± 2.8 5–17	0.36 ± 0.01 0.25–0.4 0.16	0.78 ± 0.01 0.7–0.9 0.10	0.88 ± 0.01 0.8–1.0 0.08	1.00 ± 0.01 0.9–1.1 0.07	0.97 ± 0.02 0.8–1.2 0.09	1.68 ± 0.02 1.5–1.9 0.06	1.38 ± 0.01 1.2–1.5 0.05
S. palustris	31	9.6 ± 2.9 3–14	0.43 ± 0.01 0.35–0.6 0.13	0.60 ± 0.11[b] 0.5–0.7 1.01	0.67 ± 0.01 0.5–0.8 0.09	0.93 ± 0.01 0.8–1.0 0.08	0.92 ± 0.02 0.8–1.1 0.09	1.51 ± 0.01 1.4–1.7 0.05	1.35 ± 0.02 1.2–1.8 0.08
S. preblei	33	6.8 ± 1.7 5–14	0.21 ± 0.01 0.15–0.3 0.18	0.46 ± 0.01 0.4–0.5 0.11	0.51 ± 0.01 0.5–0.6 0.06	0.67 ± 0.01 0.6–0.8 0.09	0.67 ± 0.01 0.5–0.8 0.11	1.17 ± 0.01 1.0–1.3 0.06	1.02 ± 0.01 0.8–1.2 0.07
S. sonomae sonomae	30	14.0 ± 1.9 8–17	0.44 ± 0.01 0.3–0.6 0.18	0.98 ± 0.02 0.7–1.1 0.09	1.09 ± 0.02 0.8–1.5 0.12	1.14 ± 0.01 1.0–1.3 0.07	1.06 ± 0.01 0.9–1.1 0.05	1.83 ± 0.01 1.7–1.9 0.04	1.47 ± 0.01 1.3–1.6 0.05
S. sonomae tenelliodus	30	12.3 ± 2.0 8–15	0.39 ± 0.02 0.2–0.6 0.21	0.79 ± 0.01 0.7–1.0 0.10	0.88 ± 0.01 0.8–1.0 0.08	1.01 ± 0.01 0.9–1.1 0.06	0.97 ± 0.01 0.9–1.1 0.07	1.68 ± 0.01 1.6–1.8 0.04	1.38 ± 0.01 1.2–1.5 0.05
S. tenelllus	11	10.5 ± 2.5 8–15	0.24 ± 0.01 0.2–0.3 0.21	0.48 ± 0.01 0.4–0.5 0.08	0.52 ± 0.01 0.5–0.6 0.08	0.68 ± 0.01 0.6–0.7 0.06	0.68 ± 0.01 0.6–0.7 0.06	1.30 ± 0.02 1.2–1.4 0.05	1.11 ± 0.01 1.1–1.2 0.03

Table 2. Continued.

S. trowbridgii montereyensis	12	8.7 ± 3.8 5–14	0.34 ± 0.02 0.2–0.4 0.19	0.60 ± 0.02[b] 0.5–0.7 0.12	0.72 ± 0.02 0.6–0.8 0.10	0.95 ± 0.02 0.8–1.05 0.08	0.91 ± 0.02[b] 0.8–1.0 0.08	1.48 ± 0.03 1.3–1.6 0.06	1.32 ± 0.02[b] 1.2–1.4 0.06
S. trowbridgii other subspecies	30	8.6 ± 1.7 5–13	0.40 ± 0.01 0.3–0.5 0.10	0.56 ± 0.01 0.4–0.6 0.10	0.65 ± 0.01 0.6–0.7 0.08	0.83 ± 0.01 0.7–0.9 0.09	0.80 ± 0.01 0.7–0.9 0.09	1.48 ± 0.01 1.3–1.7 0.04	1.28 ± 0.01 1.2–1.4 0.05
S. tundrensis	30	6.6 ± 2.3 1–10	0.28 ± 0.01 0.2–0.4 0.16	0.59 ± 0.01 0.5–0.7 0.07	0.61 ± 0.01 0.5–0.7 .07	0.74 ± 0.01 0.7–0.8 0.07	0.73 ± 0.01 0.6–0.8 0.08	1.39 ± 0.01 1.3–1.5 0.04	1.18 ± 0.01 1.1–1.3 0.05
S. ugyunak	30	2.1 ± 1.3[d] 1–5	0.22 ± 0.05[e] 0.15–0.30 0.15	0.50 ± 0.01 0.4–0.6 0.06	0.50 ± 0.01 0.4–0.6 0.06	0.63 ± 0.01 0.5–0.7 0.08	0.61 ± 0.01 0.5–0.7 0.06	1.23 ± 0.01 1.1–1.3 0.05	1.05 ± 0.01 0.9–1.1 0.05
S. vagrans	30	8.5 ± 2.0 4–12	0.31 ± 0.01 0.2–0.4 0.19	0.51 ± 0.01 0.5–0.6 0.06	0.58 ± 0.01 0.5–0.7 0.12	0.77 ± 0.02 0.6–1.0 0.12	0.76 ± 0.01 0.6–1.0 0.11	1.36 ± 0.01 1.3–1.5 0.05	1.14 ± 0.02 1.0–1.6 0.09

[a]Summary statistics based on a circular distribution (Zar, 1984:428–432).
[b]Sample size one less than *n*.
[c]Sample size two less than *n*.
[d]$n = 19$.
[e]$n = 20$.

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