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Taxonomic status and relationships of *Sorex obscurus parvidens* Jackson, 1921, from California

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The San Bernardino shrew, *Sorex obscurus parvidens* Jackson, 1921, is a population inhabiting the San Bernardino and San Gabriel mountains of southern California. For the past 9 decades, this population has been considered either a subspecies of *S. obscurus* Merriam, 1895, *S. vagrans* Baird, 1857, or *S. monticola* Merriam, 1890; or an undifferentiated population of *S. ornatus* Merriam, 1895. Aside from the changing taxonomic landscape that contextualizes the genus *Sorex*, previous study of *S. obscurus parvidens* has been retarded by the perception of limited available samples (typically, fewer than 8 specimens); misinterpretation of the provenance of specimens identified as *S. obscurus parvidens*; misunderstanding of the type locality; and inclusion of specimens of this taxon in the type series of another species with which *S. obscurus parvidens* has been both contrasted and allied at different times. My investigation of *S. obscurus parvidens* indicates that it is a distinctive population that is morphologically closest to *S. ornatus*, and it corresponds to the Southern Clade of that species. However, the appropriate names for deep clades within *S. ornatus* remain uncertain. Until this uncertainty is resolved, *S. obscurus parvidens* should be considered a distinctive population within *S. ornatus*; for conservation purposes, it should be recognized as *S. ornatus parvidens*.

Key words: Eulipotyphla, Insectivora, morphology, shrew, Soricidae, Soricomorpha

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Changes in recognized identity and diversity of target organisms are a direct and expected consequence of taxonomic revisionary studies. Such revisions, however, also may directly impact our understanding of related taxa, although they have not been specifically scrutinized. A case in point is that of the San Bernardino shrew, *Sorex obscurus parvidens* Jackson, 1921, a subspecies described from a small collection of long-tailed shrews from the San Bernardino Mountains, southern California. Although it has mostly been ignored in practice, the taxonomic history of this taxon (Table 1) reflects the effects of numerous revisionary studies of species to which it was perceived to belong, as well as the impact of subsequent authoritative compendia on mammals, ultimately leaving its identity, even its validity, in doubt.

The 1st evaluation of *S. obscurus parvidens* was Jackson's (1928) own revision of North American long-tailed shrews, in which he recognized the subspecies as a valid taxon. He also expanded its distribution to include the adjacent San Gabriel Mountains to the west of the San Bernardinos. Findley's (1955) later revision of the *Sorex vagrans–obscurus* species group relegated the subspecies of the dusky shrew, *S. obscurus* Merriam, 1895, including *S. obscurus parvidens*, to subspecies of a widespread vagrant shrew, *S. vagrans* Baird, 1857. This arrangement, described by Findley (1955) as representing a *rassenkreis*, or ring species, resulted in a number of subspecies with overlapping distributions. It was challenged as tenuous and unworkable by Johnson and Ostenson (1959), who recommended reversion to Jackson's (1928) taxonomic structure. Despite obvious problems, Findley's taxonomy was followed in the 1st edition of *The Mammals of North America* (Hall and Kelson 1959). The *Sorex vagrans* species complex was revisited by Hennings and Hoffmann (1977), who defined *S. vagrans* more concisely and treated the former subspecies of *S. obscurus* instead as subspecies of *Sorex monticola* Merriam, 1890. Nevertheless, the 2nd edition of *The Mammals of North America* (Hall 1981) continued to use Findley's (1955) taxonomy, as did the 2nd edition of *Mammal Species of the World* (Hutterer 1993). When Alexander (1996) reviewed *S. monticola*, she followed Hennings and Hoffmann (1977) in recognizing the former subspecies of *S. obscurus* as subspecies



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Table 1.—Historical summary of the taxonomic affiliations of *Sorex obscurus parvidens* from the San Bernardino Mountains, California.

Taxon	Source
S. ornatus	Merriam 1895; Grinnell 1908
S. obscurus parvidens	Jackson 1921, 1928
S. vagrans parvidens	Findley 1955; Hall and Kelson 1959
S. obscurus parvidens	Johnson and Ostenson 1959
S. monticola parvidens	Hennings and Hoffmann 1977
S. vagrans parvidens	Hall 1981; Hutterer 1993
S. monticola parvidens	Alexander 1996
S. ornatus ornatus (Southern Clade)	Maldonado et al. 2001, 2004
S. monticola parvidens	Hutterer 2005

of *S. monticola*. She also noted, however, a suggestion by D. F. Williams that *S. monticola parvidens* might pertain to yet another species, the ornate shrew, *Sorex ornatus* Merriam, 1895.

In a molecular study using mitochondrial DNA and allozymes, Maldonado et al. (2001) showed that *S. ornatus* comprises 3 distinctive clades that correspond to northern, central, and southern portions of its geographic distribution. Included in their study was a sample of shrews from the San Bernardino Mountains that nested genetically within their Southern Clade of *S. ornatus*. A subsequent morphological analysis by Maldonado et al. (2004) included the holotype and 2 paratypes of *S. obscurus parvidens* as *S. ornatus ornatus*. The focus of these 2 studies was phylogeny rather than taxonomy, however, and the inclusion of tissues from the type locality, and individuals from the type series, of *S. obscurus parvidens* was not specifically noted, so this usage has eluded many people. The 3rd edition of *Mammal Species of the World* (Hutterer 2005), for example, continued to recognize the San Bernardino shrew as *S. monticola parvidens*.

Since its description, *S. obscurus parvidens* has consistently been considered a valid subspecies of one species or another, but an apparent lack of specimens appears to have hindered direct study. Instead, the species affiliation of *S. obscurus parvidens* has closely tracked that of *S. obscurus*. As the taxonomy of *S. obscurus* has changed through the years, *S. obscurus parvidens* has basically gone along for the ride. Sample sizes for *S. obscurus parvidens* have never exceeded 7 individuals in studies in which its identity was specifically addressed (Alexander 1996; Findley 1955; Hennings and Hoffmann 1977; Jackson 1921, 1928), and 1 specimen of another species has been mistakenly included as *S. obscurus parvidens* in several revisionary studies (Alexander 1996; Hennings and Hoffmann 1977; Maldonado et al. 2004), presumably based on the misconception that it originated from the San Bernardino Mountains. Moreover, the type series of another species with which the San Bernardino shrew has been both contrasted and allied, *Sorex ornatus*, includes specimens from the type locality of *S. obscurus parvidens*. These facts speak to the difficulty of identifying species of California *Sorex* when the provenance is uncertain. In addition, there are inconsistencies regarding the correct provenance for some specimens in the type series of *S. obscurus parvidens*, making it appear that individuals originated from more than 1 locality.

The purpose of this paper is to clarify information regarding the type locality and type series of *S. obscurus parvidens* and to provide a comprehensive evaluation of this subspecies, in particular, to determine whether it is, in itself, a valid taxon and to define its relationships to *S. monticola* and *S. ornatus*.

Materials and Methods

I studied the history of the type series of *S. obscurus parvidens* and *S. ornatus* using information on the original skin labels; original Biological Survey Unit field catalogs and field notes maintained in the Division of Mammals, Department of Vertebrate Zoology, National Museum of Natural History (USNM), Washington; and additional relevant historical letters and documents preserved in the Smithsonian Institution Archives, Washington.

The taxa relevant to this study have undergone numerous taxonomic changes that can cause confusion. To facilitate subsequent discussion of taxa, populations, and individuals, I adopt the following ''shorthand'' for taxa by referring to the names *Sorex obscurus parvidens*, *Sorex monticola parvidens*, and *Sorex vagrans parvidens* simply as ''*parvidens*''; to *Sorex monticola monticola* as ''*monticola*''; to *S. monticola obscurus* and *Sorex obscurus obscurus* as ''*obscurus*''; and to *Sorex ornatus ornatus* as ''*ornatus*,'' unless further clarification is required. I also take this opportunity to clarify the spelling of the name *monticola*, which has been incorrectly spelled *monticolus* by a number of authors (Alexander 1996; Hennings and Hoffmann 1977; Hutterer 1993, 2005). Any species-group name ending in *-cola* (meaning dweller or inhabitant; *monticola* = mountain dweller) is an invariable noun in apposition rather than an adjective whose ending would change to match the genus-level name in gender and number (International Commission on Zoological Nomenclature 1999: Article 31.2.1; see also Gardner and Hayssen 2004). Other examples include *alticola* (highlander or high dweller), *arenicola* (sand dweller), *petricola* (rock dweller), and *paludicola* (marsh dweller). Merriam (1890:43) similarly made this error when he 1st named *Sorex monticola*, but he subsequently corrected the spelling (Merriam 1895:69).

The identity of *parvidens* was investigated using a combination of qualitative and quantitative characters. Qualitative characters included 5 noted by Jackson (1921, 1928) as useful for distinguishing *parvidens* from *obscurus* and 3 for separating members of his *S. vagrans–obscurus* group from members of the *S. ornatus* group (including 1 character common to both sets). I also investigated pigmentation of paracrista of P4 (4th upper premolar), a character noted by Carraway (1995).

All measurements are in millimeters and all weights are in grams. External measurements were taken from specimen labels or field notes of the original collectors, except length of head and body, which was determined by subtracting tail length from total length. Seventeen skull variables, described and illustrated by Woodman and Timm (1993), were measured

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Table 2.—External and skull measurements (mm) of *Sorex*. Statistics are mean ± *SD* and range.

	S. monticola monticola ($n = 21$)	*S. monticola obscurus* ($n = 28$)	*S. obscurus parvidens* type series ($n = 6$)	*S. obscurus parvidens* ($n = 37$)	*S. ornatus ornatus* type series ($n = 7$)	*S. ornatus ornatus* ($n = 41$)
External measurements						
Head and body length (HB)	63 ± 4 54–70	64 ± 4 55–77	61 ± 3 57–65	62 ± 6 48–71	62 ± 2 60–65 ($n = 5$)	57 ± 5 45–67
Tail length (TL)	44 ± 3 37–51	46 ± 4 37–55	43 ± 3 40–48	42 ± 3 35–50	42 ± 2 38–44 ($n = 5$)	40 ± 3 34–45
Tail length as proportion of head and body length	70 ± 9 57–85	72 ± 7 59–87	71 ± 8 63–84	69 ± 8 53–90	68 ± 8 63–71 ($n = 5$)	71 ± 8 55–87
Length of hind foot (HF)	13 ± 1 12–14	13 ± 1 12–16	13 ± 1 12–14	13 ± 1 11–14	12 ± 1 12–13 ($n = 5$)	12 ± 1 11–13
Weight (WT)	—	—	—	5.4 ± 1.4 3.1–7.5 ($n = 15$)	—	4.0 ± 0.9 2.4–6.0 ($n = 34$)
Skull measurements						
Condylobasal length (CBL)	16.5 ± 0.3 16.0–17.0	16.7 ± 0.3 16.0–17.3	17.0 ± 0.4 16.4–17.5 ($n = 5$)	16.7 ± 0.5 15.8–17.5 ($n = 34$)	16.1 ± 0.3 15.8–16.5 ($n = 4$)	16.2 ± 0.4 15.1–16.9
Breadth of braincase (BB)	8.3 ± 0.2 8.0–8.7	8.3 ± 0.2 7.9–8.7	8.1 ± 0.05 8.0–8.1 ($n = 5$)	8.2 ± 0.3 7.7–8.7 ($n = 34$)	7.8 ± 0.1 7.7–7.9 ($n = 5$)	8.1 ± 0.2 7.6–8.5
Breadth of zygomatic plate (ZP)	1.3 ± 0.1 1.1–1.5	1.2 ± 0.1 1.0–1.5	1.1 ± 0.05 1.0–1.1	1.1 ± 0.1 0.9–1.4	1.1 ± 0.2 0.9–1.3	1.1 ± 0.1 0.8–1.3
Postorbital breadth (PO)	3.6 ± 0.1 3.5–3.7	3.6 ± 0.1 3.3–3.9	3.5 ± 0.2 3.3–3.7 ($n = 5$)	3.6 ± 0.1 3.3–3.8 ($n = 36$)	3.6 ± 0.1 3.4–3.7	3.5 ± 0.1 3.3–3.8
Breadth across 2nd molars (M2B)	4.6 ± 0.1 4.4–4.9	4.6 ± 0.1 4.4–4.9	4.8 ± 0.1 4.7–4.9	4.7 ± 0.1 4.5–4.9	4.7 ± 0.1 4.6–4.7 ($n = 6$)	4.6 ± 0.1 4.3–4.9
Length of palate (PL)	7.0 ± 0.2 6.7–7.3	7.2 ± 0.2 6.9–7.4	7.2 ± 0.2 7.0–7.4	7.1 ± 0.2 6.6–7.5	6.9 ± 0.3 6.6–7.5 ($n = 6$)	6.8 ± 0.2 6.4–7.4
Length of maxillary toothrow (TR)	6.3 ± 0.1 6.0–6.6	6.4 ± 0.1 6.3–6.7	6.4 ± 0.1 6.3–6.6 ($n = 5$)	6.3 ± 0.2 5.9–6.7	6.2 ± 0.2 6.0–6.6 ($n = 6$)	6.1 ± 0.2 5.4–6.4
Length of unicuspid toothrow (UTR)	2.3 ± 0.1 2.0–2.5	2.3 ± 0.1 2.2–2.5	2.3 ± 0.1 2.2–2.4	2.2 ± 0.1 2.0–2.4	2.2 ± 0.2 2.1–2.5 ($n = 6$)	2.2 ± 0.1 1.9–2.3
Length of molariform toothrow (MTR)	4.2 ± 0.1 4.1–4.4	4.3 ± 0.1 4.1–4.5	4.4 ± 0.1 4.2–4.4 ($n = 5$)	4.3 ± 0.1 4.0–4.5	4.2 ± 0.1 4.1–4.3	4.1 ± 0.1 3.9–4.4
Length of mandible (ML)	5.0 ± 0.1 4.7–5.3	5.1 ± 0.1 4.8–5.3	5.2 ± 0.2 5.0–5.4	5.2 ± 0.2 4.9–5.5	5.0 ± 0.1 4.9–5.2	5.0 ± 0.2 4.6–5.3
Height of coronoid process (HCP)	3.9 ± 0.2 3.7–4.2	4.0 ± 0.1 3.8–4.2	3.9 ± 0.1 3.7–4.0	3.9 ± 0.2 3.5–4.1	3.8 ± 0.05 3.8–3.9	3.8 ± 0.1 3.4–4.0
Height of coronoid valley (HCV)	2.0 ± 0.1 1.9–2.1	1.9 ± 0.1 1.8–2.1	1.9 ± 0.1 1.8–2.0	1.9 ± 0.1 1.8–2.1	1.9 ± 0.1 1.8–2.0	1.9 ± 0.1 1.8–2.1
Height of articular condyle (HAC)	2.7 ± 0.1 2.6–2.8	2.7 ± 0.1 2.5–2.9	2.8 ± 0.2 2.6–2.9	2.8 ± 0.1 2.5–3.0	2.7 ± 0.1 2.6–2.9	2.7 ± 0.1 2.5–3.0
Articular condyle to posterior margin of m3 (AC3)	3.5 ± 0.1 3.3–3.7	3.6 ± 0.1 3.3–3.9	3.6 ± 0.2 3.4–3.8	3.7 ± 0.1 3.4–4.0	3.5 ± 0.1 3.4–3.8	3.6 ± 0.2 3.2–3.9
Length of mandibular toothrow (TRM)	4.8 ± 0.1 4.7–5.0	5.0 ± 0.1 4.8–5.2	4.9 ± 0.2 4.6–5.1	4.9 ± 0.2 4.6–5.2	4.8 ± 0.1 4.6–4.9	4.7 ± 0.1 4.3–5.0
Length mandibular molar row (m13)	3.5 ± 0.1 3.3–3.7	3.6 ± 0.1 3.5–3.7	3.6 ± 0.1 3.3–3.7	3.5 ± 0.1 3.2–3.8	3.4 ± 0.1 3.3–3.6	3.4 ± 0.1 3.2–3.6
Breadth of articular condyle (BAC)	2.0 ± 0.1 1.8–2.1	2.0 ± 0.1 1.9–2.1	2.0 ± 0.1 1.9–2.1	2.0 ± 0.1 1.9–2.3	2.0 ± 0.1 1.9–2.1	2.0 ± 0.1 1.9–2.1 ($n = 39$)

to the nearest 0.1 mm using a digital caliper or an ocular micrometer in a dissection microscope. Abbreviations used for external and skull measurements are provided in Table 2. Univariate statistics calculated for each variable include mean, *SD*, and range. To counteract the problem of multiple comparisons when calculating Student's *t*-tests (Sokal and Rohlf 1981), I calculated a Bonferroni correction using the SISA (Simple Interactive Statistical Analysis) Bonferroni correction online (www.quantitativeskills.com; accessed 29 September 2011). Bivariate plots and regression lines were constructed in Microsoft Excel (Microsoft Corp., Redmond, Washington). I carried out principal component analyses and discriminant function analyses on correlation matrices of $\log_{10}$-transformed craniomandibular variables using Systat 11

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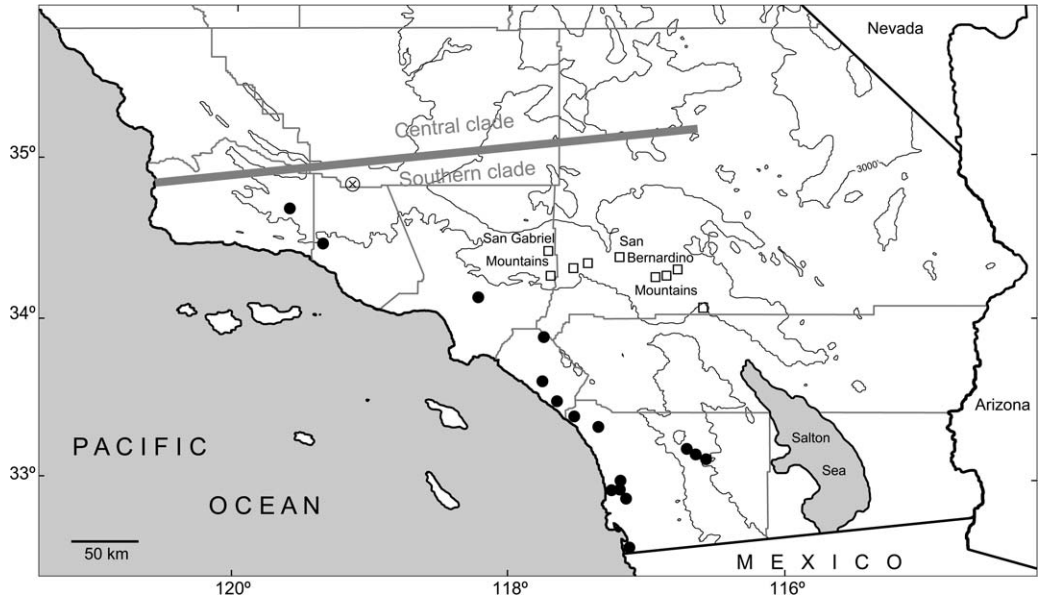


Fig. 1.—Map of southern California showing the locations of the San Bernardino and San Gabriel mountains and the hypothesized boundary (gray line) between the Central and Southern clades of *Sorex ornatus* (Maldonado et al. 2001). Distribution of specimens of *S. obscurus parvidens* used in this study is shown by the open squares; *S. ornatus ornatus*, by the filled circles. The type locality of *S. ornatus* is shown as an open circle containing an X. County boundaries are marked in gray. The black contour line marks an elevation of 3,000 feet.

(Cranes Software International, Bangalore, India). For multivariate comparisons investigating the relative similarities of skulls of *parvidens* with *monticola*, *obscurus*, and *ornatus*, my matrix included 13 variables (CBL, BB, PL, ZP, PO, TR, MTR, M2B, ML, UTR, HCP, TRM, and AC3) measured from 21 *monticola*, 28 *obscurus*, 41 *ornatus*, and 33 *parvidens*. Molecular analyses by Maldonado et al. (2004) indicated that *S. ornatus* comprises 3 distinctive clades in California that correspond to northern, central, and southern portions of its geographic distribution. The distributions of these clades do not, however, correspond to the boundaries of traditional morphological subspecies, and the subspecies *S. ornatus ornatus* is split between the deeply divided Central and Southern clades (Maldonado et al. 2001, 2004). In an attempt to avoid mixing members of different clades, I used only *ornatus* from within the geographical limits indicated by Maldonado et al. (2001, 2004) for their Southern Clade (Fig. 1). The exceptions to this rule in this analysis were individuals in the type series of *Sorex ornatus*, which originated from 4 distinct localities in California (see Appendix I). To examine the relationship between *parvidens* and *ornatus*, I 1st focused on the type series of *S. obscurus parvidens* and *S. ornatus*, both of which include specimens from Bluff Lake, the type locality of *parvidens*. In this analysis, I employed only those variables that were available for each specimen in both type series, a total of 9 variables, mostly from the mandible (ZP, ML, HCP, HCV, HAC, AC3, TRM, m13, and BAC).

Because of the resulting differences observed between geographic samples of long-tailed shrews within and without the San Bernardino Mountains, I subsequently analyzed groups based on geography, increasing the number of specimens and using a stricter definition for each group. All specimens from the San Bernardino and San Gabriel mountains were presumed to represent *parvidens*, and I restricted *ornatus* to include only individuals of the traditional subspecies from within the geographic range of the Southern Clade of Maldonado (2001, 2004). These steps required the partitioning of the type series of *S. ornatus*, with 2 specimens from the type locality (USNM 31333, 31334) excluded because of its location along the hypothesized border between the Central and Southern clades (Fig. 1); and 2 specimens from the San Bernardino Mountains (USNM 56560, 56682) reallocated to *parvidens*. I first examined these larger samples (Table 2) by comparing univariate statistics from each population and with bivariate plots to determine if any discernible relationships existed among variables within populations. I next examined the combined cohesiveness of the samples (40 *ornatus* and 33 *parvidens*) in multivariate space using principal component analysis on an expanded matrix of 17 variables (CBL, BB, PL, ZP, PO, TR, UTR, MTR, M2B, ML, HCP, HCV, HAC, AC3, TRM, m13, and BAC). In a 2nd test, I attempted to separate the 2 samples using discriminant function analysis on the same 17-variable matrix.

Specimens examined and measured for this study (see Appendix I) are deposited in the following collections (abbreviations in parentheses): California State University, Long Beach (CSULB); Dickey Collection, University of California, Los Angeles (UCLA); Los Angeles County Museum, Los Angeles (LACM); Museum of Comparative Zoology, Cambridge (MCZ); Museum of Vertebrate Zoology, Berkeley (MVZ); and National Museum of Natural History, Washington (USNM). No live animals were used in this study, so animal care guidelines approved by the American Society of Mammalogists (Sikes et al. 2011) were irrelevant.

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Type Series of Sorex Obscurus Parvidens and Sorex Ornatus

The type series of *S. obscurus parvidens* includes 4 specimens in the Biological Survey Collection (now USNM 56558, 56559, 56561, 56562) obtained by J. Ellis McClellan in September and October 1893 and 2 specimens in the Donald R. Dickey Collection (now UCLA 2590, 2602) collected by Laurence M. Huey in July 1920. Jackson (1921:161) based the type locality (''Spring known as Thurman's Camp, Bluff Lake, altitude 7,500 feet, western side of San Bernardino Peak, San Bernardino Mountains, California'') on McClellan's field catalog (Division of Mammals, USNM), which gives the locality for all 4 of his specimens as ''San Bernardino Peak, California … 9,000 feet,'' and on a letter from him dated November 6, 1893 (Smithsonian Institution Archives: RU 7176, Fish and Wildlife Service, USDI, Field Reports, Box 39, Folder 5), stating, ''the Arvicola, Sorex, and most of the Sitomys were taken at a Spring (called Thurman's camp) on the west side of San Bernardino Peak at an altitude of about 9,000 ft.'' The labels on Huey's 2 specimens give his collecting locality as ''Bluff Lake, San Bernardino Mts., Calif. … alt. 2,700 [m].'' Jackson (1928:124, footnote) subsequently corrected the type locality, noting, ''The writer is indebted to several of his California friends, namely Joseph Grinnell, Laurence M. Huey, Donald R. Dickey, and Edmund C. Jaeger, for calling attention to the fact that Bluff Lake is not on the western side of San Bernardino Peak, but is separated from the peak by Santa Ana Canyon. … The only camp in the San Bernardino mountains known as Thurmans Camp has long been abandoned and was located on what is now known as Bluff Lake, at an elevation of about 7,500 feet.'' Hence, all 6 specimens in the type series are from the same locality: Bluff Lake, San Bernardino County, California. In fact, Grinnell (1908:156–157) wrote, ''Shrews may occur along most of the permanent streams of the San Bernardino mountains, and I do not doubt that diligent and prolonged trapping would result in their discovery very generally in favorable places. But in all our trapping we succeeded in securing shrews only in the vicinity of Bluff lake, 7500 feet altitude.''

At the time Jackson described *parvidens* from the San Bernardinos, another species, *S. ornatus*, was already know from these same mountains. In fact, among the 7 specimens comprising the type series of *S. ornatus*, were 2 individuals (USNM 56560, 56682) obtained at Bluff Lake by McLellan at the same time (September and October 1893) that he collected the specimens that became the type series of *parvidens*. Jackson had access to these specimens, and we know from his 1928 revision that he examined them, as well as a specimen in the Dickey Collection (probably UCLA 2623) collected at Bluff Lake by L. M. Huey in 1920 and 2 specimens in the Museum of Vertebrate Zoology, Berkeley (a subset of MVZ 5284, 5285, 6919, 6920) collected at Bluff Lake by Joseph Grinnell and Joseph S. Dixon in 1905, all 3 of which Jackson (1928:167) referred to *ornatus*. It is clear that Jackson (1921, 1928) considered *parvidens* and *ornatus* syntopic in the San Bernardino Mountains, and he thought he could distinguish them (Jackson 1928:165): ''The [*ornatus*] group is superficially like the *vagrans-obscurus* group in general external appearance, but is usually more grayish in color and with relatively shorter tail; the two groups are distinctively separate in cranial characters.''

In addition to the type series, 1 other specimen (USNM 55550) has often been included in samples of *parvidens* (Alexander 1996; Hennings and Hoffmann 1977; Maldonado et al. 2004), presumably because, like the type series, it was collected in 1893 by J. E. McLellan and the locality on its tag, ''Summit, California,'' was interpreted as referring to the summit of San Bernardino Peak. This specimen was collected 19 August 1893, however, and McLellan's field catalog gives the locality as ''Donner, California.'' In his notes for this locality (Smithsonian Institution Archives: RU 7176, Fish and Wildlife Service, USDI, Field Reports, Box 39, Folder 6 Physiography), McLellan wrote, ''Donner, (or Summit as it is usually known) is situated in the Sierra Nevada, at an elevation of 7,015 ft. … The snow of the higher peaks drain into Lake Mary and Lake Evangeline, which form the sources of the Yuba River.'' The town of Donner is approximately 13 km west of Truckee along the border between Nevada and Placer counties, and Lake Evangeline is now given on some maps as Lake Angela. This locality is more than 630 km north-northwest of Bluff Lake. Morphologically, the skull of this specimen is distinct. Although it fits within the ranges for most measurements from the type series of *parvidens*, it combines a shorter than average condylobasal length with broader than average braincase. In this and other characteristics, this specimen matches 3 specimens of *S. vagrans* collected near Donner by Walter Kenrick Fisher in July 1900 (USNM 100380, 100499, 100500), and I identified this specimen as that species. The inclusion of the Summit specimen represents >14% of the small sample typically used to represent *parvidens*, thereby skewing the known proportions for the taxon.

Qualitative Characters

In his descriptions, Jackson (1921:161, 1928:124) differentiated *S. obscurus parvidens* from *S. monticola obscurus* (known at that time as *S. obscurus obscurus*) based primarily on 5 characteristics: ''… skull about the size of that of *S. o. obscurus*, narrower interorbitally, with distinctly flatter cranium, which is less expanded mastoidally (consequently the skull averages narrower in greatest lateral diameter); molariform teeth more deeply emarginate posteriorly than in *S. o. obscurus*, the unicuspids narrower, and the first incisors smaller.'' Jackson emphasized what he characterized as the taxon's ''weaker dentition'' in giving it the subspecific epithet *parvidens* (little-toothed).

My review of Jackson's 5 characters among my series of *monticola*, *obscurus*, *ornatus*, and *parvidens* yielded the following:

1. *Narrower interorbitally*.—I found that the interorbital breadths of *obscurus*, *monticola*, and *parvidens* average the same and are slightly greater than the mean value

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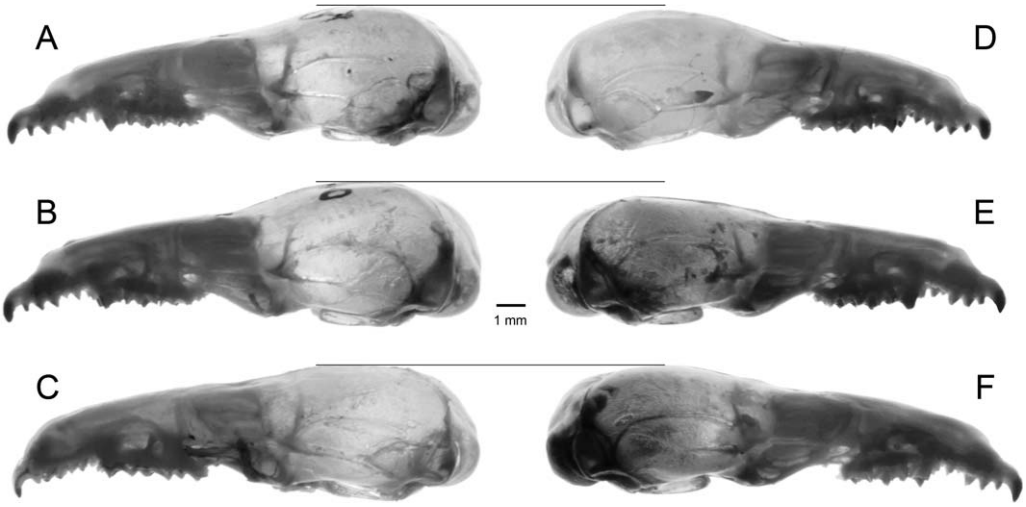


Fig. 2.—Right lateral views of crania of *Sorex monticola obscurus* (A, USNM 42411; B, USNM 42306), *S. ornatus ornatus* (C, USNM 569168; D, USNM 569215), and *S. obscurus parvidens* (E, USNM 56558; F, USNM 56559), illustrating the higher cranial vault of *obscurus*. Photos in the left column have been reversed for the purpose of comparison.

for *ornatus*, although there is broad overlap among the ranges of all 4 taxa (Table 2—measurement PO), rendering this character of little utility for distinguishing these taxa.

2. *Distinctly flatter, narrower braincase*.—*Sorex obscurus parvidens* has a lower, typically flatter skull than *obscurus* and *monticola* (Figs. 2 and 3). In addition, its braincase is narrower on average, although there is extensive overlap among samples (Table 2—measurement BB). A lower, flatter braincase also was used by Jackson (1928:101) as one of the primary characters for distinguishing his *Sorex ornatus* group from his *Sorex vagrans–obscurus* group (see below).
3. *More deeply emarginate upper molariform dentition*.—The emargination of the posterior border of the molariform teeth varies considerably within all 4 taxa, and I could discern no consistent patterns among the taxa that would assist in distinguishing any of them.
4. *Unicuspids narrower*.—The size, shape, and alignment of the unicuspids in all 4 taxa are variable, but in general, when viewed occlusally, unicuspids of *monticola* and *obscurus* are more robust than those of *parvidens* and *ornatus*. In addition, the unicuspid rows of *monticola* and *obscurus* have straighter, more regular medial and lateral margins; lingual ridges on the unicuspids are more robust and tend to be more darkly pigmented; and U3s are less anteroposteriorly compressed. Viewed laterally on unworn to slightly worn dentition, the U3s of *monticola* and *obscurus* generally have higher crowns that more closely resemble the shapes of U1, U2, and U4. The unicuspid

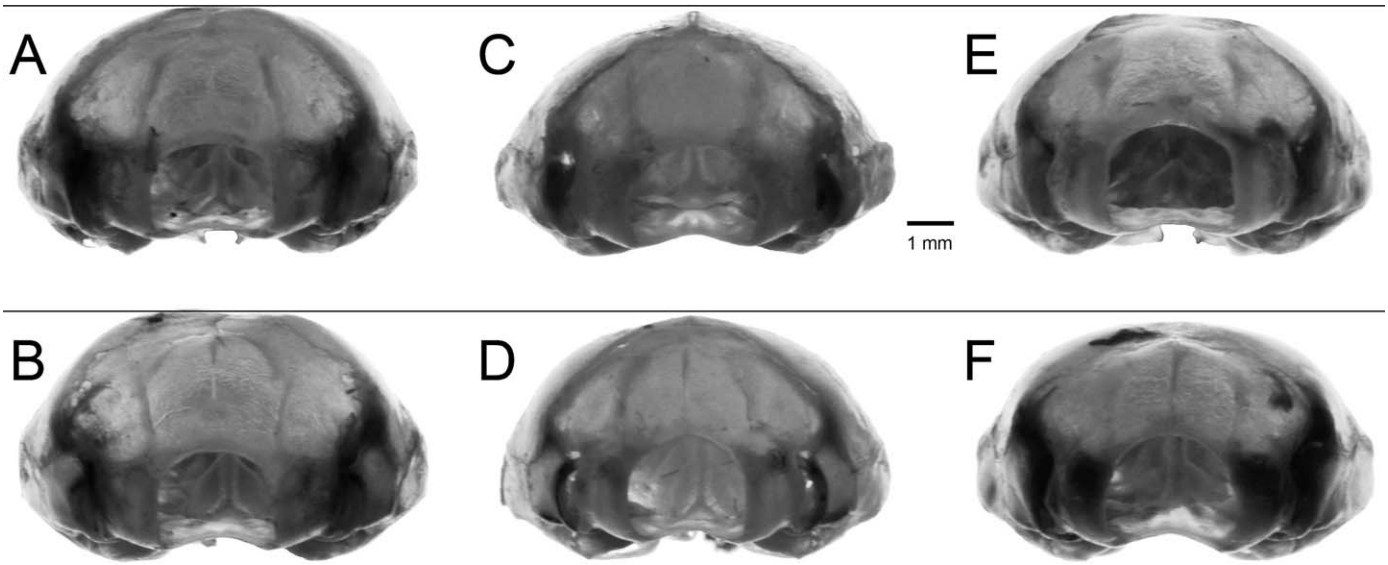


Fig. 3.—Posterior views of crania of *Sorex monticola obscurus* (A, USNM 42411; B, USNM 42306), *S. ornatus ornatus* (C, USNM 569168; D, USNM 569215), and *S. obscurus parvidens* (E, USNM 56558; F, USNM 56559), illustrating the higher cranial vault of *S. monticola obscurus*.

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toothrows of *monticola* and *obscurus* average longer than those of *parvidens* and *ornatus*, adding to the sense that the unicuspids of *monticola* and *obscurus* are more robust (Table 2—measurement UTR).

5. *Smaller 1st incisors*.—Like the unicuspids, the 1st incisors of *monticola* and *obscurus* are consistently broader and more robust than those of *parvidens* and *ornatus*.

Jackson's (1928) concept of the *S. vagrans–obscurus* group comprised 5 species (*S. durangae* Jackson, 1925 [currently a synonym of *S. monticola*]; *S. obscurus* [a subspecies of *S. monticola*]; *S. pacificus* Coues, 1877; *S. yaquinae* Jackson, 1918 [a synonym of *S. pacificus*]; and *S. vagrans*); whereas his *S. ornatus* group contained 7 species (*S. juncensis* Nelson and Goldman, 1909 [a subspecies of *S. ornatus*]; *S. myops* Merriam, 1902 [a synonym of *S. tenellus*]; *S. nanus* Merriam, 1895; *S. ornatus*; *S. sinuosus* Grinnell, 1913 [a subspecies of *S. ornatus*]; *S. tenellus* Merriam, 1895; and *S. trigonirostris* Jackson, 1922 [a synonym of *S. vagrans*]). In his description of the *S. vagrans–obscurus* group, Jackson (1928:101) noted, ''Compared with any of the *ornatus* group, the skull is less flattened; the foramen magnum is placed relatively ventrad, encroaching less into supraoccipital and more into basioccipital; metacone of pm^3 comparatively low.''

My review of the Jackson's 3 characters and a 4th character noted by Carraway (1995) among my series of *monticola*, *obscurus*, *ornatus*, and *parvidens* revealed the following patterns:

1. *Skull less flattened*.—*Sorex m. monticola* and *obscurus* have higher, more rounded braincases than *ornatus* and *parvidens* (Figs. 2 and 3).
2. *Position of foramen magnum*.—Jackson (Jackson 1928:101, figure 20) illustrated the *S. vagrans–obscurus* group as having a foramen magnum that appears smaller than that of the *S. ornatus* group in posterior view of the cranium, but which extends farther anteriorly in ventral view of the skull. My review of this character in *monticola*, *obscurus*, *ornatus*, and *parvidens* indicates that the character is variable in each of these 4 taxa and there is no clear pattern that is useful in distinguishing any of them.
3. *Low metacone of ''pm^3''*.—Presumably, by ''pm^3'' (upper 3rd premolar), Jackson (1928) meant to refer to P4 rather than U5, the metacone of which is vestigial at best. The metacones of the P^4s of *monticola* and *obscurus* appear slightly lower in labial view with respect to the metacrista in contrast to those of *ornatus* and *parvidens*, but this is because of the higher metacristas of *monticola* and *obscurus*. In fact, the metacones on the P4s of *monticola* and *obscurus* are consistently broader along their entire heights, from base to tip. This is yet another character that confirms the subtly more robust dentitions of *monticola* and *obscurus* contrasted to those of *ornatus* and *parvidens*.
4. *Pigmentation of paracrista of P4*.—Carraway (1995:26, figure 25) noted that *S. monticola* has a partially to completely pigmented paracrista of P4, whereas *S. ornatus* lacks pigment on the paracrista. Among *monticola*, *obscurus*, *parvidens*, and *ornatus*, I found that this character varied within each taxon, the first 3 tending to have pigment more often than not, and *ornatus* tending to lack pigment more often.

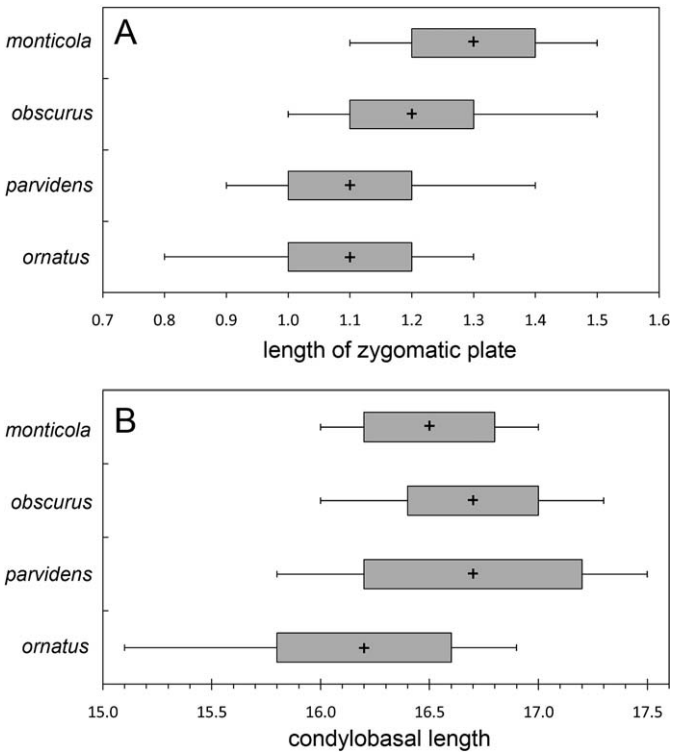


Fig. 4.—Box-and-whisker plots of A) length of zygomatic plate (ZP) and B) condylobasal length (CBL) for *Sorex monticola monticola*, *S. monticola obscurus*, *S. ornatus ornatus*, and *S. obscurus parvidens*. Means are represented by crosses, *SD*s by gray boxes, and ranges by the ends of the lines extending from the boxes (Table 2).

The characters that appear to be most useful in distinguishing *parvidens* from *monticola* and *obscurus* include the flatter cranium of *parvidens*; the size, shape, and alignment of the unicuspids; and the generally more robust dentition overall. These same characters also distinguish *ornatus* from *monticola* and *obscurus*. In addition, breadth of the zygomatic plate averages narrower in *parvidens* and *ornatus* than in *monticola* and *obscurus* (Fig. 4; Table 2). Together, these characters indicate that *parvidens* has a stronger relationship to *ornatus* than to *obscurus*.

Multivariate Morphometrical Analyses

Morphometrical analyses focused 1st on determining whether quantitative variation among *monticola*, *obscurus*, *ornatus*, and *parvidens* supported the qualitative characters. A plot of factor scores on the first 2 factor axes from the principal component analysis of 13 variables from the 4 taxa is shown in Fig. 5. In this analysis, all variables load on the 1st axis, indicating that it represents overall size, whereas the 2nd axis represents the variables AC3 and ML contrasted with ZP (Table 3). Individuals of all 4 taxa overlap extensively in the

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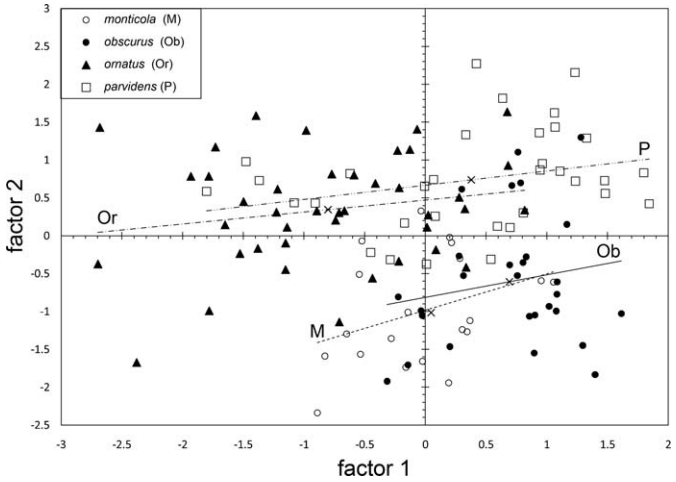


Fig. 5.—Plot of factor scores on the first 2 factor axes from principal component analysis of 13 craniomandibular variables from *Sorex monticola monticola*, *S. monticola obscurus*, *S. ornatus ornatus*, and *S. obscurus parvidens*. Regression lines plotted for each taxon show similar weak, but offset, trends of increasing AC3 and ML and decreasing ZP (factor 2; Table 3) with increasing size (factor 1). The centroid for each taxon is indicated by the X along its respective regression: *monticola* (M; $y = 0.4802x - 0.9838$; $R^2 = 0.1233$); *obscurus* (Ob; $y = 0.2978x - 0.8151$; $R^2 = 0.0319$); *ornatus* (Or; $y = 0.1584x + 0.4703$; $R^2 = 0.036$); and *parvidens* (P; $y = 0.1873x + 0.6664$; $R^2 = 0.0735$).

plot, reflecting the general similarity in size and cranial shape among these shrews and emphasizing the difficulty in distinguishing them. To assist with interpreting trends among taxa, I plotted the centroid for each taxon and calculated a regression for their respective scores. Along the 1st factor axis, the centroid of *ornatus* is negative, whereas those of the other 3 taxa are positive, reflecting the smaller overall size of *ornatus*. The centroids of both *ornatus* and *parvidens* are positive along the 2nd factor axis, whereas those of the 2 subspecies of *S. monticola* are negative. This plot shows the similarity of *parvidens* to *monticola* and *obscurus* in average size (factor 1 axis), and its similarity to *ornatus* in shape (factor 2 axis). Both quantitatively and qualitatively, *parvidens* appears more closely related to *S. ornatus* than to either population of *S. monticola*.

Table 3.—Component loadings from first 3 axes of a principal component analysis of 13 craniomandibular variables from *Sorex monticola monticola*, *S. monticola obscurus*, *S. ornatus ornatus*, and *S. obscurus parvidens*. See Fig. 5.

Variable	Component loadings		
	1	2	3
PL	0.899	0.132	0.100
CBL	0.897	0.182	0.044
TR	0.845	−0.262	0.379
TRM	0.838	−0.167	0.284
MTR	0.824	0.064	0.331
HCP	0.780	0.063	−0.333
BB	0.696	−0.105	−0.493
M2B	0.645	0.168	−0.295
ML	0.638	0.569	0.107
UTR	0.610	−0.453	0.453
PO	0.562	−0.337	−0.508
AC3	0.523	0.631	−0.135
ZP	0.494	−0.574	−0.317
Eigenvalues	6.833	1.565	1.381
Percent of total variance explained	52.564	12.036	10.621

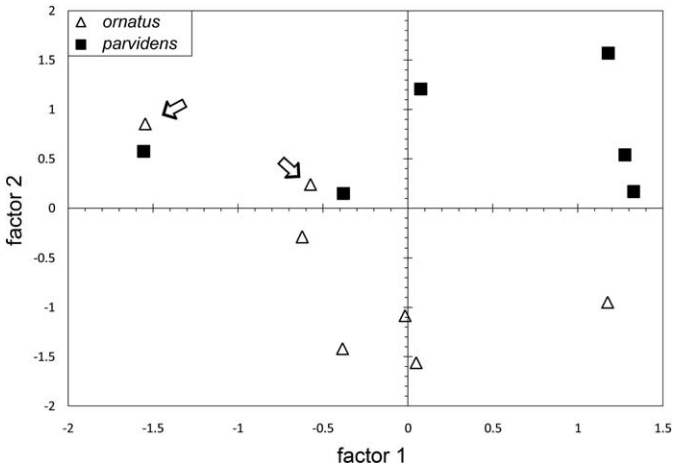


Fig. 6.—Plot of factor scores on the first 2 factor axes from principal component analysis of 9 craniomandibular variables (Table 4) from the type series of *Sorex obscurus parvidens* and *S. ornatus*. The 2 specimens of *S. ornatus* that plot positively on the 2nd factor axis (indicated by arrows) are from Bluff Lake, the type locality of *S. obscurus parvidens*.

The 1st step in examining the morphometrical relationships between *ornatus* and *parvidens* involved comparison of their respective type series. A plot of factor scores on the first 2 factor axes from the principal component analysis of 9 variables from the type series of these 2 taxa is shown in Fig. 6. Specimens from the 2 series overlap entirely along the 1st factor axis, interpreted as size (Table 4), but there is some separation along the 2nd axis, which primarily represents ZP, with some contribution from BAC, and a contrast with ML. All *parvidens* plot positively on the 2nd axis, whereas 5 of the 7 *ornatus* plot negatively. The remaining 2 *ornatus* plot positively on this axis, overlapping with *parvidens*. These 2

Table 4.—Component loadings from first 3 axes of a principal component analysis of 9 $\log_{10}$-transformed variables from the type series of *Sorex obscurus parvidens* and *S. ornatus* (Fig. 6).

Variable	Component loadings		
	1	2	3
HAC	0.913	0.059	0.137
HCP	0.870	0.198	0.027
TRM	0.813	0.136	−0.510
HCV	0.789	−0.375	0.091
AC3	0.775	0.134	0.453
BAC	0.659	−0.588	−0.044
m13	0.649	0.339	−0.639
ML	0.615	0.475	0.464
ZP	0.353	−0.762	0.001
Eigenvalues	4.833	1.486	1.118
Percent of total variance explained	53.696	16.512	12.427

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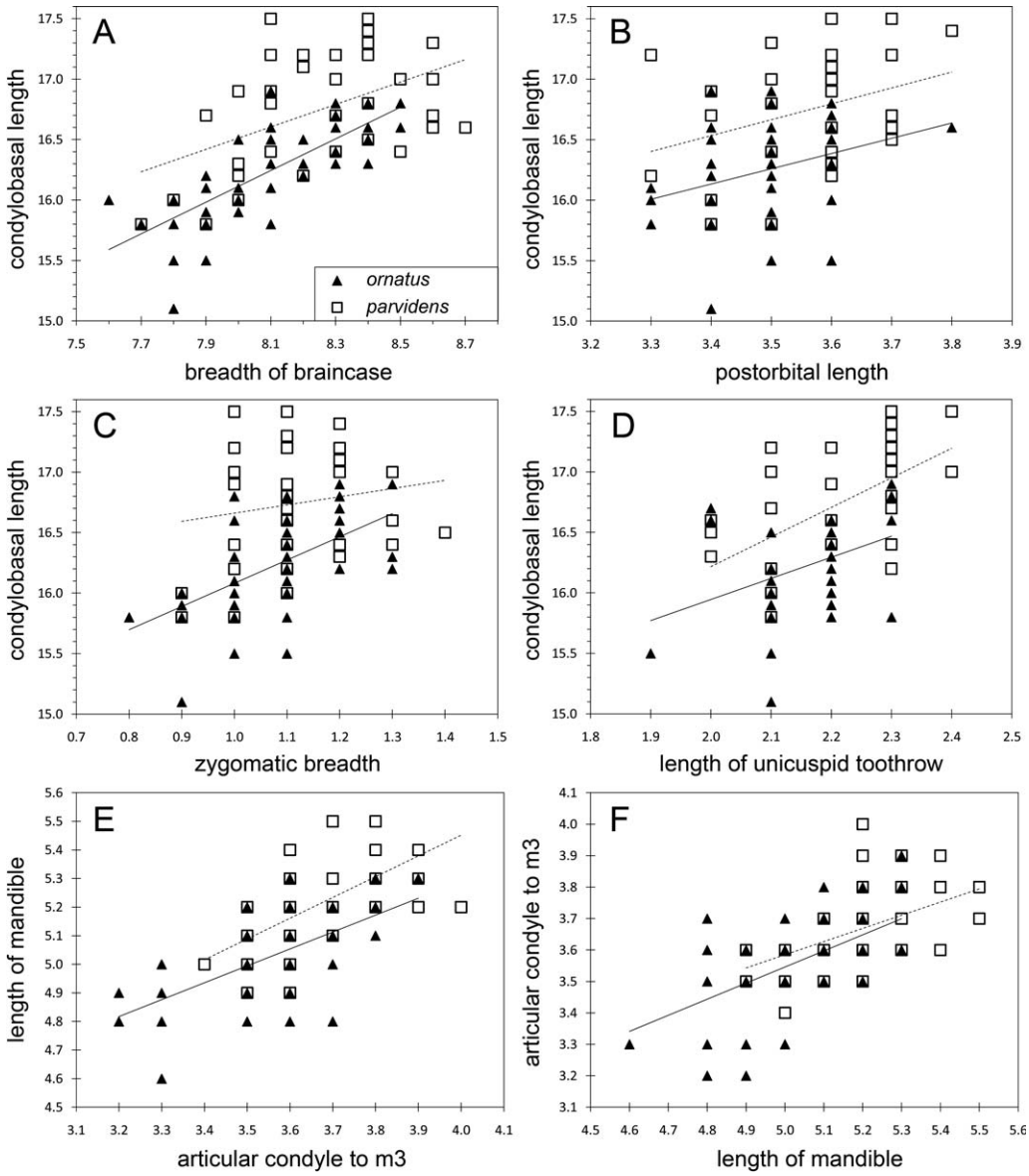


Fig. 7.—Bivariate plots with regressions showing variation in proportions of craniomandibular variables between *Sorex obscurus parvidens* (dashed lines) and *S. ornatus* (solid lines): A) CBL regressed on BB (*parvidens*: y = 0.9278x + 9.089; R^2 = 0.2363; *ornatus*: y = 1.3097x + 5.636; R^2 = 0.523); B) CBL regressed on PO (*parvidens*: y = 1.3131x + 12.07; R^2 = 0.1091; *ornatus*: y = 1.2604x + 11.847; R^2 = 0.1188); C) CBL regressed on ZP (*parvidens*: y = 0.6772x + 15.984; R^2 = 0.0256; *ornatus*: y = 1.9193x + 14.162; R^2 = 0.3168); D) CBL regressed on UTR (*parvidens*: y = 2.4462x + 11.325; R^2 = 0.3245; *ornatus*: y = 1.7449x + 12.455; R^2 = 0.1622); E) ML regressed on AC3 (*parvidens*: y = 0.7267x + 2.545; R^2 = 0.304; *ornatus*: y = 0.591x + 2.9259; R^2 = 0.3023); and F) AC3 regressed on ML (*parvidens*: y = 0.4183x + 1.4938; R^2 = 0.304; *ornatus*: y = 0.5115x + 0.9884; R^2 = 0.3023).

specimens are, in fact, the only 2 members of the type series of *ornatus* from the San Bernardino Mountains, the type locality of *parvidens*. Rather than there being 2 species in the San Bernardinos, this result suggests that there may instead be a distinction between long-tailed shrews in the San Bernardinos (*parvidens*) and those from without the mountains (*ornatus*).

Among the 20 external and craniomandibular variables measured from *parvidens* and *ornatus*, all overlap in range, and most have means that fall within the *SD* of the other population (Table 1). Exceptions are the craniomandibular variables CBL, PL, MTR, and TRM, for which the means of the populations are significantly different statistically using a Bonferroni correction for multiple comparisons (CBL, t_{73} = 4.851, $P < 0.001$; PL, t_{77} = 3.766, $P < 0.01$; MTR, t_{77} = 6.345, $P < 0.001$; TRM, t_{77} = 5.993, $P < 0.001$). These variables are all measurements parallel to the longitudinal axis of the cranium, and all are correlated with each other at >0.72, suggesting an inherent difference in the length of the skull between the 2 populations.

A series of bivariate plots indicates that a number of cranial variables exhibit distinctive nearly parallel, but offset, patterns with relation to the length of the skull. A plot of CBL plotted against BB (Fig. 7A), for example, shows that, although ranges of values overlap broadly between taxa, at any given

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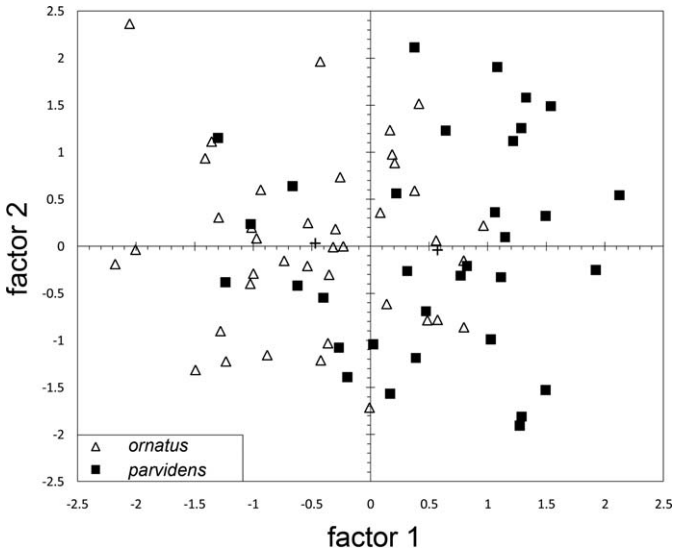


Fig. 8.—Plot of factor scores on the first 2 factor axes from principal component analysis of 17 craniomandibular variables (Table 5) from 33 *Sorex obscurus parvidens* and 40 *S. ornatus ornatus*. Centroids of the 2 taxa are shown as crosses; that of *parvidens* (right) is positive on both axes and that of *ornatus* (left) is negative. The mean values of the 2 populations along the 1st factor axis are significantly different ($t_{76} = 4.7099$, $P < 0.001$).

value of BB, *parvidens* averages a longer CBL than does *ornatus*. The offsets between the 2 regression lines vary from about 0.9 to 0.2 mm, with differences decreasing at wider BB. Similar offset regressions occur in the relationships of CBL with PO (Fig. 7B), ZP (Fig. 7C), M2B (not shown), and UTR (Fig. 7D). In the mandible, HCV, HAC, AC3, and TRM exhibit a similar relationship with ML, such that, for example, at any given value of AC3, *parvidens* averages a longer ML than does *ornatus* (Fig. 7E). In this case, the offset between regressions varies from about 0.1 to 0.2 mm, with differences increasing at longer AC3. These relationships typically do not, however, function in the opposite direction, so there is no tendency, for example, for either species to have a wider BB at a given CBL, or a longer AC3 at a longer ML (Fig. 7F). So, in addition to *parvidens* averaging a longer skull than *ornatus*, the proportional relationships of some other craniomandibular variables to skull length (CBL) and mandibular length (ML) differ between the 2 taxa.

Multivariate analysis of 17 craniomandibular variables from larger, geographically redefined samples of *ornatus* and *parvidens* primarily emphasized a mean size difference between the 2 populations. In a plot of factor scores on the first 2 factor axes from principal component analysis (Fig. 8), the centroids of the 2 taxa are separated along the 1st axis, which represents overall size (Table 5), although individuals of the 2 populations overlap extensively. The 2nd factor represents 4 mandibular variables (HCV, HAC, AC3, and BAC) contrasted with 2 measures of toothrow length (UTR and TR). Here, the 2 samples overlap nearly completely, and the difference in the centroids is negligible. The 3rd factor axis from this analysis represents PO and ZP contrasted with HAC and UTR (Table 5). A plot of factor scores on the 1st and 3rd factor axes from this analysis (not shown) similarly shows little difference between centroids along the 3rd axis, and extensive overlap between the 2 samples, but with overall greater dispersion. The separation between specimens from within and without the San Bernardino Mountains, seen in the principal component analysis of the type series of *ornatus* and *parvidens* (Fig. 6), is not emphasized in this analysis, the greater difference instead being in average craniomandibular size of the respective populations.

Table 5.—Component loadings from first 3 axes of a principal component analysis of 17 $\log_{10}$-transformed variables from *Sorex obscurus parvidens* and *S. ornatus* (Fig. 8).

Variable	Component loadings		
	1	2	3
CBL	0.923	−0.055	0.027
PL	0.895	−0.143	0.064
HCP	0.860	0.243	0.071
ML	0.839	0.098	−0.070
MTR	0.835	−0.262	−0.203
TR	0.829	−0.401	−0.199
m13	0.829	−0.317	0.019
TRM	0.826	−0.332	−0.075
BB	0.726	0.144	0.429
M2B	0.687	−0.189	0.304
BAC	0.657	0.491	0.014
AC3	0.634	0.469	−0.217
HAC	0.580	0.499	−0.437
UTR	0.568	−0.483	−0.428
PO	0.555	0.086	0.530
HCV	0.537	0.532	−0.241
ZP	0.467	0.067	0.503
Eigenvalues	9.154	1.827	1.392
Percent of total variance explained	53.846	10.744	8.187

The most discriminatory model resulting from discriminant function analysis of 17 variables from *ornatus* and *parvidens* included 9 variables (m13, HCV, UTR, and ZP contrasted with TRM, PL, MTR, HCP, and M2B; Table 6). The discriminant function correctly classified 85% of specimens overall, with 5 *ornatus* and 6 *parvidens* incorrectly classified as the other taxon. Jackknifed classification for the model correctly identified 81% of specimens, with 7 of each taxon incorrectly classified. A plot of canonical scores from this analysis describes what can be interpreted as a unimodal curve (Fig. 9). In general, the discriminant function analysis fails to separate the 2 taxa, but again emphasizes the difference in average sizes of the 2 taxa.

Morphometrically and morphologically, *parvidens* is closer to *ornatus* than it is to *monticola* or *obscurus*. In direct comparisons with Southern Clade *ornatus* (sensu Maldonado et al. 2001), *parvidens* is difficult to distinguish, although its skull averages somewhat larger, and it averages narrower in certain skull variables at any specified length of skull or length of mandible.

Identification, Taxonomy, and Synonomy

The population of long-tailed shrews inhabiting the San Bernardino and San Gabriel mountains that was described as

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Table 6.—Canonical discriminant functions and classification matrices from backward stepwise discriminant function analysis of 17 variables from *Sorex obscurus parvidens* and *S. ornatus ornatus* (Fig. 9).

Canonical discriminant functions			
Constant	93.418		
ZP	5.911		
M2B	−36.103		
PL	−41.201		
UTR	23.569		
MTR	−40.486		
HCP	−37.417		
HCV	26.522		
TRM	−75.857		
m13	89.743		
Eigenvalue	0.787		
Canonical correlations	0.664		
Cumulative proportion of total dispersion	1.000		
	ornatus	*parvidens*	% correct
Classification matrix			
ornatus	35	5	88
parvidens	6	27	82
Total	41	32	85
Jackknifed classification matrix			
ornatus	33	7	83
parvidens	7	26	79
Total	40	33	81

S. obscurus parvidens is closer morphologically to *S. ornatus* than to either *S. monticola obscurus* or *S. monticola monticola*. Compared directly to either classical *S. ornatus ornatus* or Southern Clade *S. ornatus* (sensu Maldonado et al. 2001) from southern California, *parvidens* proves to be distinctive as a population, although it remains difficult to identify any given individual without knowledge of its provenance. Phylogenetically and taxonomically, it seems best to recognize *parvidens* as a distinctive population of what is currently recognized as *S. ornatus* (but see caveats in the following paragraphs). For the purposes of conservation and risk assessment, it is appropriate to recognize this population as *S. ornatus parvidens*.

The appropriate names for the 3 clades of *S. ornatus* delimited by Maldonado et al. (2001, 2004) are somewhat difficult to determine. They do not correspond directly to classical subspecies of *S. ornatus*, and no clear morphological characters are currently known that distinguish the clades. The type localities for 2 of the older names, *S. ornatus* Merriam, 1895, and *S. californicus* Merriam, 1895, fall near the hypothesized geographic boundaries of the clades, and the genotypes of the type specimens or of any topotypes currently are unknown.

Maldonado et al. (2001) indicated that their Northern Clade *ornatus* are genetically comparable to *S. vagrans* Baird, 1857; therefore, this name should apply to that clade. The appropriate name for the Central Clade is complicated by relatively uncertain boundaries between this clade and the neighboring Northern and Southern clades and the fact that the type localities for *S. californicus* and *S. ornatus* are close to where those uncertain boundaries are mapped. If future genotyping of *S. ornatus* indicates that it is affiliated with the Central Clade, then *S. ornatus* is the appropriate name. If *S. ornatus* is genetically a member of the Southern Clade, however, and the holotype of *S. californicus* belongs to the Central Clade, then *S. californicus* would apply. If both *S. ornatus* and *S. californicus* prove to belong to other clades, then the name that applies to the Central Clade is *S. relictus* Grinnell, 1932. The correct name for the Southern Clade depends upon the genetic affiliation of *S. ornatus*. If *S. ornatus* is a member of the Southern Clade, that name applies to it. If *S. ornatus* proves to be a member of the Central Clade,

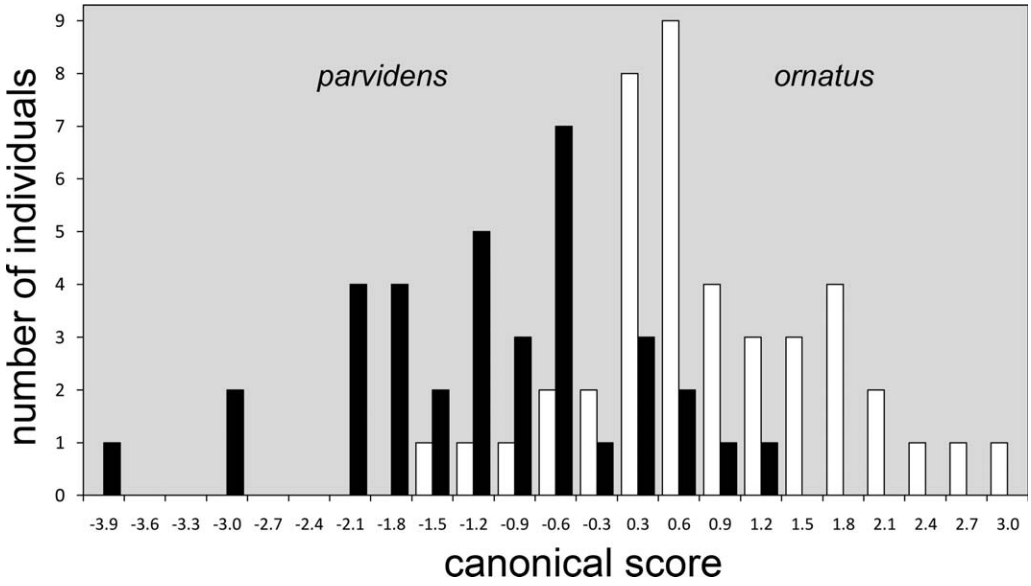


Fig. 9.—Plot of canonical scores from discriminant function analysis of craniomandibular variables (Table 6) from 33 *Sorex obscurus parvidens* (black) and 40 *S. ornatus ornatus* (white). Mean canonical scores: *parvidens* = −0.97963; *ornatus* = 0.737774.

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however, then the Southern Clade would be known as *S. orinus* Elliott, 1903a (name corrected 1903b), and *parvidens* would be known as *S. orinus parvidens*.

Presuming that *S. ornatus* pertains genetically to the Southern Clade, the following synonymy would be appropriate for *parvidens*.

Sorex ornatus parvidens Jackson, 1921

Sorex obscurus parvidens Jackson, 1921:161. Type locality: ''Spring known as Thurman's Camp, Bluff Lake, altitude 7,500 feet, [San Bernardino Co.] … San Bernardino Mountains, California.''

Sorex ornatus Merriam, 1895:79. Type locality: ''head of San Emigdio Canyon, Mount Piños, [Kern Co.] California''; [in part: 2 specimens in type series from type locality of *S. obscurus parvidens*].

Sorex vagrans parvidens: Findley 1955:58.

S.[*orex*] *monticolus* [sic] *parvidens*: Hennings and Hoffmann 1977:30.

Sorex monticolus [sic] *parvidens*: Alexander 1996:32.

S.[*orex*] *o.*[*rnatus*] *ornatus* (Southern Clade): Maldonado et al. 2001:129.

Sorex ornatus ornatus (Southern Clade): Maldonado et al. 2004:895.

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APPENDIX I

Specimens examined.—The catalog numbers of the type series of *Sorex obscurus parvidens* are in boldface type; those of the type series of *S. ornatus* are in boldface italic type.

Sorex monticola monticola (21).—ARIZONA: APACHE CO.: Springerville (USNM 24829); White Mountains, Little Colorado River, 2,530 m (USNM 158587, 158589, 158590); White Mountains, Mt. Thomas, E slope, 2,896 m (USNM 208664, 209333, 209334, 209336, 209337); White Mountains, White River, Horseshoe Cienega, 2,530 m (USNM 209326, 209330); Tunitcha Mountains, Spruce Creek, 2,377 m (USNM 227460–227463, 227465, 227466). COCHISE CO.: Chiricahua Mountains, Flys Park, N side Flys Peak (USNM 66090, 66091). COCONINO CO.: San Francisco Mt. (USNM 17599—holotype). GRAHAM CO.: Graham Mountains, N side Mt. Graham near head of Ash Creek, 2,804 m (USNM 204189).

Sorex monticola obscurus (29).—CALIFORNIA: FRESNO CO.: Sierra Nevadas, San Joaquin River (USNM 30065, 30068); Horse Corral Meadow (USNM 30180–30182). INYO/FRESNO CO.: Sierra Nevadas, Bishop Creek (USNM 30060, 30061, 30063). INYO CO.: Round Valley (USNM 30428). INYO/TULARE CO.: Mt. Whitney (USNM A42369, 29156, 30564, 30839). KERN CO.: Onyx (USNM 108815). KERN/TULARE CO.: S fork Kern River (USNM 29556, 29557); Kern Lakes (USNM 30427). MADERA/TUOLUMNE CO.: Mt. Lyell (USNM 110287, 110290, 116022). TULARE CO.: Sequoia National Park (USNM 30187, 30190, 274874); E Fork Kaweah River (USNM 30321, 30323–30325, 30327). IDAHO: LEMHI CO.: Salmon River (= Lemhi) Mountains, 10 miles W Junction, near Timber Creek, 2,499 m (USNM 23525—holotype).

Sorex obscurus parvidens (39).—CALIFORNIA: SAN BERNARDINO CO.: San Bernardino Mountains, Covington Ranch (MVZ 65713, 65714); Bluff Lake (LACM 10313, 19556; MVZ 5284, 5285, 6919, 6920; UCLA **2590**, **2602**; USNM **56558**, **56559**, ***56560***, **56561—**holotype, **56562**, ***56682***); Big Bear Lake P.O. (LACM 87439, 87440, 91039–91046, 91082); Metcalf Meadows (MVZ 198735, 198737); Fawnskin (MVZ 198733, 198734); Deep Creek near Lake Arrowhead (CSULB 4766); Silverwood [Lake] (USNM 569315). SAN BERNARDINO CO.: San Gabriel Mountains, Lytle Creek (USNM 127976, 127977); Camp Baldy, San Antonio Cañon, 4,250 feet (UCLA 1753, 1754, 7731). LOS ANGELES CO.: San Gabriel Mountains, 0.4 miles W Wrightwood, 6,000 feet (CSULB 6423).

Sorex ornatus ornatus [Southern Clade] (44).—CALIFORNIA: ORANGE CO.: Aliso and Woods canyons (USNM 569168, 569170, 569171); Chino Hills (USNM 569179); Puente Hills (USNM 569182); San Joaquin Hills West (USNM 569185). SAN DIEGO CO.: Camp Pendleton (LACM 49581, 49582; USNM 569215, 569219); Carmel Mountain (USNM 569223, 569225, 569227, 569229, 569320); Del Mar Mesa (USNM 569235, 569237, 569238, 569319); Elliott Reserve (USNM 569243); Rancho Santa Fe (LACM 43755); San Ysabel (USNM ***73771***, ***73772***); San Ysabel Ecological Reserve (USNM 569272, 569273, 569284); Tijuana Estuary (USNM 569296, 569300); Torrey Pines State Natural Reserve (LACM 49564–49573, 49575–49578). SANTA BARBARA CO.: Big Pine Mountain (USNM 129693). VENTURA CO.: Ventura River (USNM ***32017***).

Sorex ornatus ornatus [specimens from the type series not, or potentially not, in the Southern Clade] (2).—CALIFORNIA: KERN CO.: Mt. Pinos, Head of San Emigdio Canyon (USNM ***31333—***holotype, ***31334***).

Sorex vagrans vagrans (4).—CALIFORNIA: PLACER CO.: Donner, 7,500 feet (USNM 100380); Donner Peak, 7,900 feet (USNM 100499, 100500). NEVADA/PLACER CO.: Summit [Donner], 7,015 feet (USNM 55550).

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