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DISTINGUISHING *ZAPUS HUDSONIUS PREBLEI* FROM *ZAPUS PRINCEPS PRINCEPS* BY USING REPEATED CRANIAL MEASUREMENTS

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Preble's meadow jumping mouse (*Zapus hudsonius preblei*), a federally listed threatened subspecies, and the western jumping mouse (*Zapus princeps princeps*) typically occur parapatrically but in some areas may be syntopic. Field differentiation between the taxa is difficult so we investigated the use of cranial characteristics as a basis for identification. We developed a discriminant function conducted on the means of repeated measurements to distinguish between the taxa from an initial sample of 105 specimens (n = 71 *Z. p. princeps* and n = 34 *Z. h. preblei*). We found that measurement error can contribute significantly to erroneous reclassification of specimens when only a single measurement set is used. Use of only presence or absence of the anterior median toothfold of M3 is not a reliable method for distinguishing between the subspecies. We used the discriminant function to identify 8 of 16 specimens collected in southeastern Wyoming as *Z. h. preblei*.

Key words: discriminant function analysis, meadow jumping mouse, measurement error, morphometrics, repeated measures, *Zapus hudsonius preblei*, *Zapus princeps princeps*

The recent listing of Preble's meadow jumping mouse (*Zapus hudsonius preblei*) as a threatened subspecies under the Endangered Species Act (United States Fish and Wildlife Service 1998) has prompted numerous surveys to improve knowledge of the current distribution of the subspecies. It is thought to be restricted to scattered locations along the western edge of the Colorado Piedmont and Front Range of Colorado and in southeastern Wyoming (Armstrong 1972; Clark and Stromberg 1987; Fitzgerald et al. 1994; Hall 1981; Krutzsch 1954; Long 1965). The range of the nearest subspecies of western jumping mouse (*Z. princeps princeps*) typically extends farther west and north than that of *Z. h. preblei* (Armstrong 1972; Clark and Stromberg 1987; Hall 1981; Krutzsch 1954; Long 1965). However, exact range demarcation between the taxa is not clear. Captures of *Z. h. preblei* and *Z. p. princeps* (as identified on museum specimens) have occurred as close as 5 km within the same drainage (Armstrong 1972), and the taxa may be syntopic in some areas (R. Schorr, pers. comm.; C. Jones, pers. comm.). Furthermore, the taxa are ecologically and physically similar and no reliable technique exists to distinguish live specimens in the field.

It is important to develop reliable methods of distinguishing the 2 taxa so distribution and habitat of *Z. h. preblei* can be documented and museum records validated and because taxonomic identifications have legal and economic implications. Inconclusive attempts have been made to distinguish the taxa genetically (L. A. Riggs, J. M.

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Dempey, and C. Orrego, in litt.). Presence or absence of the anterior median toothfold of M3 also has been considered a potential key for discriminating *Z. h. preblei* from *Z. p. princeps* (C. Jones, pers. comm.; Klingener 1963); however, this method has not been tested quantitatively.

Cranial measurements previously have been used to identify species and subspecies of *Zapus* within limited geographic areas. Krutzsch (1954) examined 11 specimens of *Z. h. preblei* and Hafner et al. (1981) examined specimens taken from 2 populations of *Z. p. princeps* and *Z. h. preblei* located near one another in Colorado. However, no study has evaluated the use of cranial measurements to distinguish the taxa on the broader spatial scale of their ranges in Colorado and southeastern Wyoming. In addition, most of the knowledge of the geographic distribution of *Z. h. preblei* and *Z. p. princeps* is based on museum specimens. Thus, the primary objective of our study was to determine the reliability of cranial features measured from prepared specimens, including the anterior median toothfold characteristic, to distinguish the 2 taxa throughout a broader geographic area where *Z. p. princeps* overlaps *Z. h. preblei* in distribution.

We used discriminant function analysis (DFA) in this study. Recommendations for reducing bias in DFA (Lance et al. 2000; Manly 1986) and quantifying measurement error in morphometric analysis (Arnqvist and Mårtensson 1998; Bailey and Byrnes 1990) have been published. Repeated measurements are the most general and effective way to reduce measurement error and ensure accurate identification. Thus, our 2nd objective was to evaluate measurement variation within and among observers and effects of this variation on DFA results.

Subsequently, we used our findings to identify specimens of *Zapus* collected from sites in southeastern Wyoming. In Colorado, Fitzgerald et al. (1994) described *Z. p. princeps* as found typically at elevations >1,830 m, with *Z. h. preblei* at lower elevations. However, elevational demarcation may be less clear in southeastern Wyoming, and according to range maps (Clark and Stromburg 1987; Hall 1981; Krutzsch 1954; Long 1965), this area provides the greatest potential for range overlap of *Z. h. preblei* and *Z. p. princeps*. Thus, accurate identification of the taxa will help to clarify the range of *Z. h. preblei* in southeastern Wyoming.

Materials and Methods

Data collection.—A total of 121 skulls were measured to generate 2 data sets. We 1st measured 105 specimens from areas of allopatry to generate an initial data set used to develop the discriminant function (DF) to classify specimens to subspecies. The 2nd data set comprised measurements from 16 specimens collected in southeastern Wyoming, an area of potential sympatry. The DF developed from the initial data set was then used to classify the specimens in the 2nd data set. For both data sets we only measured adults; specimens were judged to be adults if the 3rd upper molar (M3) had some wear (Krutzsch 1954).

The initial data set of 105 museum specimens was collected in Colorado or southeastern Wyoming from 1901 to 1999 (Appendix I). To avoid use of specimens from areas of potential sympatry, we used specimens of *Z. p. princeps* collected at >2,400 m in elevation. All specimens from Colorado that were identified in museum collections as *Z. h. preblei* and that had intact skulls were measured. Of the 105 initial specimens, 71 were assumed to be *Z. p. princeps* because they were collected in Colorado (n = 53) and Wyoming (n = 18) at elevations >2,400 m and were identified by museums as *Z. p. princeps* (Fig. 1). The 34 specimens assumed to be *Z. h. preblei* were collected at elevations <2,200 m in Colorado and were identified by museums as *Z. h. preblei* (Fig. 1). Of the 16 skulls from potentially sympatric sites (<2,400 m) in southeastern Wyoming (Appendix I), 10 were from University of Kansas Museum of Natural History and were identified by museum tag as *Z. p. princeps*; the remaining 6 were voucher specimens collected in 1999 and 2000 that had not yet been identified (Fig. 1). Voucher specimens were deposited at Denver Museum of Nature and Science.

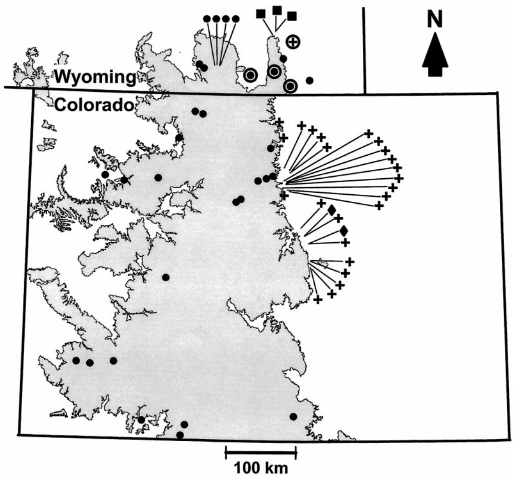

FIG. 1.—Locations of specimens of *Zapus hudsonius preblei* and *Z. princeps princeps* in Colorado and Wyoming; identification as determined by museum identification and by discriminant function analysis (DFA) on means of repeated measurements. Symbols indicate combinations of identifications: +, identified both by museum records and DFA as *Z. h. preblei*; ●, identified both by museum records and DFA as *Z. p. princeps*; ♦, identified by museum records as *Z. h. preblei* but by DFA as *Z. p. princeps*; ■, identified by museum records as *Z. p. princeps* but by DFA as *Z. h. preblei*; and circle around either + or ●, specimens identified only by DFA. Ten additional specimens are not indicated on map because they had inadequate collection coordinates or locality descriptions. One symbol may represent several specimens collected at the same location. Shaded area indicates elevations >2,400 m. See Appendix I for a detailed description of specimen locations.

We used 12 cranial variables and 1 dental variable. Following Hafner et al. (1981), we measured condylobasal length, zygomatic breadth, least interorbital breadth, length of upper molar toothrow, width of P4, length of incisive foramen, least interbullar width, and moment arm of masseter. Additionally, we measured palatal breadth at P4 (Whitaker 1972), palatal length, and length of lower molar toothrow, and we noted presence or absence of the anterior median toothfold on M3 (Klingener 1963). Descriptions of nontraditional characters measured include palatal breadth at P4 (between midpoints on lingual edges of alveoli), palatal length (from midpoint between lingual edges of incisor alveoli to midpoint on perpendicular across anteriormost point on posterior edge of palate), length of incisive foramen (anterior to posterior edge of incisive foramen; interior measurement) and width of incisive foramen (lateral edge to lateral edge).

Measurement protocols were exactly the same for the initial and southeastern Wyoming data sets. Observers were blind to museum identification and collection locality. Measurements were taken with digital calipers and recorded to the nearest hundredth of a millimeter. A dissection microscope was used to assess tooth wear for aging and to look for the anterior median toothfold. Measurements were taken on either the right or left side. To evaluate between-observer and within-observer measurement error, experienced observers took 4 sets of measurements (2 sets during each of 2 trials). During each trial, the observer took a measurement then moved the calipers away from the skull, reset them, then repeated the measurement. The 2 trials were separated by ≥1 day.

Presence or absence of the anterior median toothfold was evaluated twice by each observer, resulting in 4 toothfold scorings per skull. The toothfold was considered present when scored as present in at least 3 of 4 observations; otherwise it was identified as absent.

Data analysis.—We used least-squares means with the variance corrected for repeated measures in the PROC MIXED procedure in Statistical Analysis System (SAS) software (Littell et al. 1996; SAS Institute Inc. 1990) to estimate mean cranial measurements and their standard errors. Subspecies, state, sex, observer, and sex × subspecies were included in the mixed model as fixed effects; specimen, nested within subspecies, was modeled as a random effect. By using the same model as for mean estimates, we conducted an analysis of variance to test for differences in mean cranial measurements by subspecies, state, sex, and observer. To control overall type I error in the multiple nonindependent comparisons, we applied a sequential Bonferroni test to the set of comparisons before ascribing statistical significance (Manly 2001; Rice 1989). To test for a difference in the mean measurement vector between subspecies and observers, we conducted a multivariate analysis of variance and used Hotelling's T^2 as the test statistic (Johnson and Wichern 1992; Manly 1986) with the denominator degrees of freedom adjusted for heteroscedastic covariance (Seber 1984).

We used DFA to calculate the posterior probability that a specimen was *Z. p. princeps* or *Z. h. preblei*. We used the proportion of each taxon in the sample for prior probability of group membership. To avoid overestimating intertaxon differences, we used a jackknifing cross-validation procedure (CROSSVALIDATE option in PROC DESCRIM software—SAS Institute Inc. 1990) that classified each initial sample based on a DF derived from all other initial specimens (Lance et al. 2000; Manly 1986).

We used model selection procedures to choose an appropriate DF. We included all 12 cranial measurements, plus presence or absence of the anterior median toothfold, and used forward, backward, and stepwise selection to choose the best distinguishing measurements for the DF (Manly 1986; SAS Institute Inc. 1990). After the DF was developed, we conducted the DFA by using 2 approaches. First, we performed a separate DFA for each set of cranial measurements; thus potentially 8 DFAs were performed for each specimen (fewer than 8 DFAs were performed on a specimen if a measurement was missing because of skull damage). We then examined each DFA run separately to evaluate the effect of measurement error on DFA reclassification rates within and between observers. For the 2nd approach, we conducted a DFA on the mean of the 8 measurements taken for each specimen. For both methods, if the DFA posterior probability was >0.5, the specimen was identified as *Z. p. princeps*, otherwise it was identified as *Z. h. preblei*.

To further evaluate the effect of measurement error on DFA classification error, we performed a bootstrap procedure. For each specimen, we randomly selected 1 of the 8 repeated measurements for the cranial characteristics used in DFA. We then performed a jackknifed DFA on randomly selected measurements 1,000 times to generate the distribution of possible DFA classification error.

We used the DF developed from the initial data set to classify the 16 specimens from southeastern Wyoming ($<$2,400 m). We ran these 16 specimens as a test data set (TESTDATA and TESTLISTERR options for PROC DISCRIM software—SAS Institute Inc. 1990) and based classification on the mean measurements for each variable (2nd approach, as described above).

Results

Initial data set.—For the initial sample, univariate analyses revealed no statistical differences in cranial measurements or toothfold characteristic by sex for either subspecies ($P > 0.370$ for sex and $P > 0.163$ for sex $\times$ subspecies). However, significant differences were found between subspecies ($P < 0.0001$) and observers ($P < 0.0001$) for *Z. p. princeps* and *Z. h. preblei* by Hotelling's T^2 test. Cranial measurements were significantly greater for *Z. p. princeps* than for *Z. h. preblei* (Table 1). Some statistical differences were found in cranial measurements by observer ($P < 0.001$), but differences were random and small (range 0.00–0.18 mm) relative to differences between taxa.

Determining presence or absence of the anterior median toothfold of M3 was not consistent within or between observers. Twenty-four percent of the specimens were recorded as having the toothfold both present and absent, which represents approximately equal inconsistency within and between observers. However, when multiple observations of presence or absence were considered, presence worked reasonably well for identifying *Z. h. preblei*: every specimen where at least 3 of 4 observations recorded the toothfold as present ($n = 20$) were identified as *Z. h. preblei* by the DFA. However, the toothfold was absent (i.e., recorded in fewer than 3 of 4 observations) in 41% ($n = 14$) of specimens classified by DFA as *Z. h. preblei*.

The DF chosen by forward, backward, and stepwise regression included the same 6 variables: least interbullar width, palatal breadth at P4, palatal length, length of lower molar toothrow, moment arm of masseter, and anterior median toothfold. We tested for equivalence of covariance matrices between subspecies by using Bartlett's test in PROC DISCRIM (SAS Institute Inc. 1990). The null hypothesis of equal covari-

TABLE 1.—Descriptive statistics for cranial measurements of specimens of *Zapus hudsonius preblei* and *Z. princeps princeps* from Colorado and southeastern Wyoming (initial set).[a]

Variable	*Z. h. preblei* (n = 71)			*Z. p. princeps* (n = 34)		
	Mean	*SE*	Range	Mean	*SE*	Range
Zygomatic breadth	11.3	0.09	9.8–12.0	12.2	0.07	10.0–13.5
Condylobasal length	20.6	0.14	18.2–22.7	21.9	0.10	19.2–23.7
Least interorbital breadth	4.26	0.03	3.4–4.9	4.48	0.02	3.9–5.1
Least interbullar width	1.79	0.02	1.3–2.9	2.15	0.02	1.5–2.9
Moment arm of masseter	8.81	0.06	7.2–10.1	9.23	0.04	7.6–10.3
Palatal breadth at P4	3.36	0.03	2.7–3.7	3.79	0.02	3.1–4.7
Palatal length	8.38	0.06	7.5–9.3	9.14	0.04	8.2–10.2
Length of upper molar toothrow	3.90	0.03	3.4–4.8	4.13	0.02	3.5–5.0
Length of lower molar toothrow	3.77	0.03	3.2–4.3	4.10	0.02	3.4–5.5
Length of incisive foramen	4.22	0.04	3.6–4.8	4.63	0.03	3.5–5.5
Width of incisive foramen	2.02	0.02	1.2–2.6	2.21	0.02	1.8–2.6
Width of P4	0.52	0.01	0.4–0.9	0.55	0.01	0.3–0.9

[a] Mean estimated by least square means; *SE* based on variance estimate from type III sum-of-squares with degrees of freedom adjusted for repeated measurements. All differences are statistically significant after sequential Bonferroni adjustment (P = 0.002 for width of P4 and $<$0.001 for other comparisons).

ance was rejected ($P < 0.0001$) so we used a quadratic identification rule for the DF (Johnson and Wichern 1992; SAS Institute Inc. 1990).

The estimated error rate is the proportion of specimens not reclassified to their subspecific identification given on the museum tag (Johnson and Wichern 1992). For the 1st approach, when each DFA was considered separately, up to 8 DFAs were performed for each specimen, 1 for each set of measurements (Table 2). No statistical difference was found in mean estimated error rate between observers for overall error rate (P = 0.124) or for *Z. p. princeps* (P = 0.763), but a difference was found for *Z. h. preblei* (P = 0.026). Estimated error rate for the observers was 0–20.6% with no definite pattern (Table 2). Twenty-one of the 105 initial specimens were erroneously reclassified by DFA at least once. The bootstrap revealed that the estimated error rate observed in this study was less than the expected mean for both taxa (Table 2).

In contrast, when a single DFA was performed on mean measurements for each skull, the estimated error rate was 0.0% for *Z. p. princeps* and 5.9% for *Z. h. preblei*. The overall estimated error rate for both taxa was 1.9%; 2 of the 105 initial specimens were erroneously reclassified by DFA.

Specimens from southeastern Wyoming.—We analyzed the 16 southeastern Wyoming specimens as a test data set, identifying them by the DFA generated from the initial data set. When using mean measurements per skull, the DFA-estimated error rate for southeastern Wyoming specimens was 70%, which was much higher than for the initial specimens. All reclassifications were from museum-tag identifications of *Z. p. princeps* to DFA identifications of *Z. h. preblei*. For these individuals, we checked the data set for each reclassified specimen and found no gross measurement or recording errors. Data for the 8 specimens identified by DFA as *Z. h. preblei* revealed that all specimens had a toothfold recorded as present at least once, 5 specimens had toothfold recorded as present on all 4 examinations, and means for most cranial measurements were close to those for *Z. h. preblei* (Table 1).

DISCUSSION

We undertook this study to determine whether *Z. h. preblei*, a threatened subspe-

TABLE 2.—Observed and expected estimated error rates (EERs) from discriminant function analysis for the initial data set of 105 specimens of *Zapus princeps princeps* and *Z. hudsonius preblei* from Colorado and southeastern Wyoming. Values in parentheses are *SE* of means.

Data set	Estimated error rate (*SE*)		
	Z. h. preblei	*Z. p. princeps*	Overall
Observer 1			
Measurement set 1	0.094	0.055	0.069
Measurement set 2	0.094	0.055	0.069
Measurement set 3	0.069	0.000	0.024
Measurement set 4	0.000	0.000	0.000
Mean	0.064	0.028	0.041
	(0.022)	(0.016)	(0.017)
Observer 2			
Measurement set 1	0.182	0.044	0.089
Measurement set 2	0.182	0.029	0.078
Measurement set 3	0.206	0.029	0.087
Measurement set 4	0.088	0.029	0.048
Mean	0.165	0.033	0.076
	(0.026)	(0.004)	(0.009)
Mean observed EER[a]	0.114	0.030	0.058
	(0.025)	(0.008)	(0.011)
Mean expected EER[b]	0.121	0.046	0.072
	(0.008)	(0.005)	(0.005)
P (expected EER > observed EER)	0.516	0.847	0.682

[a] Observed EER is proportion of specimens not reassigned by discriminant function analysis to subspecies identified on museum tag.

[b] Expected EER is mean proportion of specimens not reassigned by bootstrap procedure to subspecies identified on museum tag.

cies, could be reliably distinguished from *Z. p. princeps* throughout Colorado and southeastern Wyoming by using cranial measurements. Based on larger and more geographically comprehensive samples than those used by Hafner et al. (1981) and Krutzsch (1954), we confirmed that skulls of *Z. h. preblei* are smaller than those of *Z. p. princeps*.

We found little variation within or between observers for cranial measurements compared to variation between the taxa. However, 1 extreme cranial measurement may result in an erroneous reclassification of the specimen by DFA, even though it may not dramatically change a mean or 95% confidence interval. That is, reclassification occurred more frequently when single measurements were used in the DFA compared to when means of repeated measurements were used in the DFA. In this study, use of the mean of repeated measurements decreased the probability that a specimen was erroneously reclassified (from 21% to 6%). Moreover, the bootstrap procedure shows that potentially 52% of the specimens of *Z. h. preblei* could be reclassified because of measurement error if the DFA is based on a single set of measurements. Thus, we conclude that cranial features are reliable for distinguishing between *Z. p. princeps* and *Z. h. preblei* when used with DFA. However, cranial measurements need to be repeated because measurement error can contribute significantly to DFA misclassification of *Z. p. princeps* and *Z. h. preblei*.

We used initial specimens from presumed areas of allopatry, as determined by elevation, and not from midelevational areas of potential overlap, so we consider that reclassification from 1 set of measurements resulted from observer error, not from misidentification by museums. Furthermore, only 2 specimens were reclassified when the means of repeated measurements were used in a single DFA.

Sampling variation occurred within and between observers in the recording of presence or absence of the anterior medial toothfold of M3. Its presence provided good evidence that a specimen was *Z. h. preblei* but its absence was uninformative. Consideration of tooth wear when scoring the character and examination of both right and left sides could decrease measurement variation and increase this character's usefulness.

The range of *Z. h. preblei* in southeastern Wyoming was based previously on 7 specimens (C. S. Garber, in litt.; Hafner et al. 1981; Krutzsch 1954). Our DFA classified 7 of 10 museum-labeled specimens of *Z. p. princeps* from southeastern Wyoming plus 1 of 6 recently collected specimens as *Z. h. preblei*. Additional voucher specimens from the area should be obtained to improve knowledge of the current distribution *of Z. h. preblei* there.

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APPENDIX I

Specimens examined

All specimens were borrowed from Denver Museum of Nature and Science, University of Colorado Museum, and University of Kansas Museum of Natural History. Numbers in parentheses refer to museum catalog numbers; Co. = County.

Initial specimens—Denver Museum of Nature and Science

Zapus hudsonius preblei.—Colorado: Boulder Co., Niwot (2394); 3 mi NW Niwot (2971); S Boulder Creek (9314); S. Boulder Creek, 400 m S Baseline Rd. (9564, 9578); 0.25 mi. S Saint Vrain Rd. on U.S. 36 (9204, 9205); UTM coordinates 480280E, 4423640N Zone 13 (9843); Douglas Co., Colorado Division of Wildlife property, Woodhouse Ranch (9570, 9573, 9875, 9876, 9878); Maytag Property (9576, 9577); Pine Cliff (9853, 9857); El Paso Co., Beaver Creek, 2 mi. SW Monument (9579); Air Force Academy (9315); Dirty Woman Creek (9313, 9562, 9565); Gilpin Co., Ralston Creek (9312); Jefferson Co., 1.25 mi W Semper (6634); Rocky Flats (9203); Larimer Co., Young's Gulch (9561); Little Bear Gulch (9568).

Zapus princeps princeps.—Colorado: Archuleta Co., Navaho River (1229, 1484, 1486, 1488, 1489); Devils Creek (5575, 5576); Boulder Co., no location (3354); Larimer Co., Big Thompson River in Estes Park (9560); no location (1053); Las Animas Co., Purgatory Campground, San Isabel National Forest (7914, 7915, 7917–7919); Routt Co., Stillwater Reservoir (4970, 4971). Wyoming: Laramie Co., Warren Air Force Base (9316).

Initial specimens—University of Colorado at Boulder

Zapus hudsonius preblei.—Colorado: Boulder Co., 5 mi E Boulder (503); south of Boulder at intersection of Baseline Rd and Turnpike (1225); 8.5 mi N, 3.25 mi E Boulder (5210); 0.5 mi ESE of Eldorado Springs (17001); Van Vleet Open Space, Cherryvale at S. Boulder Rd, Boulder (17733); El Paso Co., U.S. Air Force Academy, Monument Creek, 0.25 mi S sewage treatment plant (17002); Jefferson Co., Rocky Flats, Woman Creek, 0.5 mi W Indiana Rd (17196).

Zapus princeps princeps.—Colorado: Boulder Co., Science Lodge, 3 mi SSW Ward (5270, 5273, 14226, 14227); 1 mi E Lakewood (5271, 5272); Pennsylvania Gulch, 0.25 mi SW Sunset (5105); Fourth-of-July Campground, 10 mi NW Nederland (5968–5970); Dolores Co., 12 mi N Rico (5397); Grand Co., Lone Cone Peak (13741), Steelman Creek (14365–14368); McQueary Creek (14370, 14372–14375); Grand Co., Ptarmigan Camp (14913, 14915); Gunnison Co., Crested Butte, Deckers' Ranch (10920), Jackson Co., Lake John, Brand's Ranch (10916); Mt Zirkel, Ute Pass Trail (10917, 10918); Ouray Co., Red Mountain Pass (13737, 13739, 13740, 13742, 13744); Routt Co., Steamboat Springs (10912); Rio Blanco Co., Meeker (10913), Big Beaver Creek (10914, 10915).

Initial specimens—University of Kansas

Zapus princeps princeps.—Wyoming: Albany Co., 3 mi ESE Brown's Peak (17575–17582); Albany Co., 2 mi S Brown's Peak (17573); Nash's Fork (91354); Carbon Co., 14 mi E, 6 mi S Saratoga (26500); 18 mi E, 8 mi N Encampment (26566); Lake Marie, Medicine Bow National Forest (27666–27670).

Southeastern Wyoming specimens—Denver Museum of Nature and Science

Zapus sp.—Wyoming: Albany Co., between Snowy Range and Laramie (1822–1824); Laramie Co., South Lodgepole Creek, Medicine Bow National Forest (1825); I80, Harriman Road exit, Lone Tree Creek (1826); Chugwater Creek (1827).

Southeastern Wyoming specimens—University of Kansas

Zapus princeps princeps.—Wyoming: Albany Co., 30 mi N, 10 mi E Laramie (27671); 29 mi N, 8.75 mi E Laramie (27938–27943); 26.75 mi N, 6.5 mi E Laramie (27944); Carbon Co., 10 mi N, 12 mi E Encampment (26505, 26506), Laramie Co., 1 mi N, 5 mi W Horse Creek Post Office (15856–15858).