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ZAPUS HUDSONIUS IN SOUTHERN COLORADO

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Two species of jumping mouse (Zapodidae: *Zapus*) are known from Wyoming, Colorado, and New Mexico. The western jumping mouse (*Z. princeps princeps*) is the more common and widely distributed species in the region. It occurs throughout the western two-thirds of Colorado, mainly in riparian vegetation and mesic meadows from 1830 to 3500 m (Armstrong, 1972; Fitzgerald et al., 1994). Fitzgerald et al. (1994) suggested the possible occurrence of *Z. p. utahensis* in northwestern Colorado. The meadow jumping mouse (*Z. hudsonius*) is represented by three taxa, all with restricted distributions, in Wyoming, Colorado, New Mexico, and Arizona. The range of *Z. hudsonius campestris* includes the Black Hills of northeastern Wyoming (Clark and Stromberg, 1987). Preble's meadow jumping mouse, *Z. h. preblei*, is known only from Colorado's Front Range and from southeastern Wyoming (Clark and Stromberg, 1987; Fitzgerald et al., 1994). A third subspecies, *Z. h. luteus*, occupies isolated patches in New Mexico and in southeastern Arizona (Hafner et al., 1981). Local distributions of the taxa *luteus* and *preblei* are of special interest (e.g., Morrison, 1990, 1992; Meaney et al., 1996, 1997; Ryon, 1996; Hafner, 1997); New Mexico listed

luteus as endangered in 1983 and *preblei* was listed as federally threatened on 12 May 1998. The report by Clarion Associates (1998) includes a bibliography compiled by Chris Pague (cpague@tnc.org), which lists numerous surveys and status reports regarding *Z. h. preblei* in Colorado.

In 1996, I caught 14 jumping mice during a survey of mammals on the Lake Dorothea State Wildlife Area, southeast of Trinidad in Las Animas County, Colorado. The wildlife area is located in Sugarite Canyon, between Barela Mesa and Fishers Peak Mesa. Sugarite Canyon opens southwards, approximately 16 km NE of the city of Raton, New Mexico. Two creeks (Chicorica and Schwacheim) and two lakes (Dorothea and Maloya) occupy the canyon north of the Colorado border. Vegetation on the floor of the canyon includes meadows of grasses and forbs, in which meadow voles (*Microtus pennsylvanicus*) were the most frequently-captured rodent. Ruderal vegetation lines roads and parking areas; scrub oak (*Quercus gambelii*), ponderosa pines (*Pinus ponderosa*), and other conifers occupy the walls of the canyon. Jones (1996; in press) provided more detailed descriptions of the vicinity.

MATERIALS AND METHODS

In June and July 1996, I captured three jumping mice in Sherman live traps as part of a general survey of mammals (Jones, 1996). Consequently, in August 1996, C. Jones, D. Meshko, and I set snap traps to sample small mammals along Chicorica and Schwacheim creeks. I determined localities using the Global Positioning System and the U.S.G.S. Barela Quad topographic map. Skins and skulls were deposited in the Denver Museum of Natural History and frozen tissues were deposited at Texas Tech University. I also collected hair and ear-punch samples for use by the Colorado Division of Wildlife.

I recorded external measurements from skin tags and measured ten cranial characteristics, following Krutzsch (1954) and Hafner et al. (1981): greatest condylobasal length, greatest zygomatic breadth, least interorbital breadth, length of maxillary toothrow, palatal length, palatal breadth at P4, length of incisive foramina,

breadth of incisive foramina, interbullar width (at basioccipital-basisphenoid suture), and greatest mastoid breadth. Specimens were classified as adult or subadult based on presence or absence of wear on M3 (Krutzsch, 1954; Hafner et al., 1981). Sexes were combined, because neither Krutzsch (1954) nor Hafner et al. (1981) found evidence of sexual dimorphism. Measurements of the Lake Dorothee specimens were compared with those of samples of *Z. h. preblei* from Colorado, *Z. h. luteus* from New Mexico, and *Z. p. princeps* from both Colorado and New Mexico. Specific localities and catalogue numbers of material from the Denver Museum of Natural History (DMNH), the Museum of Southwestern Biology (MSB), the University of Colorado Museum (UCM), and of tissues from Lake Dorothee specimens deposited in the frozen tissue collection of Texas Tech University (TK), are listed under Specimens Examined. Nomenclature follows that of Saldaña-DeLeon and Jones (1998).

RESULTS AND DISCUSSION

The first jumping mice caught near Lake Dorothee were two nonscrotal males captured 11 June 1996 in Sherman live traps along the south bank of Schwacheim Creek, one on either side of the footbridge between lakes Dorothee and Maloya. Both mice were captured in riparian vegetation consisting of grasses, forbs, and coyote willow (*Salix exigua*); one was prepared as a voucher (DMNH 8630). On 16 July a gravid female (DMNH 8631) carrying six embryos (measuring 6x4 mm) was captured in ruderal vegetation, including wild rose (*Rosa* sp.), legumes, and grasses, along the road through Sugarite Canyon. *Microtus pennsylvanicus*, *Reithrodontomys megalotis*, and *Thomomys talpoides* also were captured in this trapline. Eleven additional individuals (DMNH 8632-8642), including two lactating females, were caught in August 1996 in snap traps deployed at water's edge along Chicorica Creek and along the West Fork of Schwacheim Creek above Lake Dorothee. Vegetation at Chicorica Creek consisted primarily of willow; other species of mammals caught there were *Sorex palustris* and *M. pennsylvanicus*. Along the West Fork of Schwacheim Creek, willows were less abundant and the heavy groundcover consisted primarily of grasses and forbs; jumping mice were captured in the same

trapline as *S. monticolus*, *S. palustris*, *M. longicaudus*, and *Peromyscus maniculatus*. Thus, jumping mice were known from four different localities (all below an elevation of 7800') on the Lake Dorothee State Wildlife Area in 1996. An additional male (DMNH 9065) was captured near Chicorica Creek 24 August 1997 on the Lake Dorothee State Wildlife Area by staff of the Colorado Natural Heritage Program; this animal was collected 2-3 m from the water's edge underneath willow (M. B. Wunder, pers. comm., 1998). Except for this male and the female (DMNH 8631) collected on the roadside, all specimens from Lake Dorothee were captured no more than 1 m from the water, although others (Whitaker, 1972; Choate et al., 1991; Tester et al., 1993; Zwank et al. 1997; also see discussion by Morrison 1990:141) have reported captures of *Z. hudsonius* at more variable distances from water. Captures at greater distances from water might represent dispersal and/or movement to nests and hibernacula (e.g., Zwank et al., 1997).

Only measurements of adults were used in analyses. Average (and extreme) measurements of the nine adults from Lake Dorothee and of comparative material are shown on Tables 1 and 2. I did not in-

clude length of ear, which was not recorded by most early collectors of *Zapus*. Initial assignment of the Lake Dorothea material to the species *Z. hudsonius* was indicated by the presence of the anteromedian fold on the anterior edge of the m1 (Klingener, 1963; Hafner, 1993) and by characters in the key developed by Armstrong (1972:248) to separate Colorado *Zapus*; i.e., *Z. h. preblei* is distinguished from *Z. p. princeps* by a zygomatic breadth usually less than 11.5 mm and incisive foramina usually 4.5 or shorter. The Lake Dorothea specimens also lack the whitish ear fringe of the *Z. princeps* to which they were compared.

Hafner et al. (1981:509) described *Z. h. luteus* as "ochraceous-buff in color, with a but weakly defined middorsal band; ear either lacking pale fringe or possessing narrow ochraceous fringe; never with a white ear fringe." Only one specimen from Lake Dorothea (DMNH 8631) has a dark, well-defined dorsal stripe and all have an ochraceous-buff color similar to the New Mexican specimens examined. This ochre is brighter than the coloration of the 13 skins of *Z. h. preblei* to which they were compared, resembling the color of the few skins of *Z. h. americanus* and *Z. h. intermedius* housed in the DMNH collection. Generally, skulls of *Z. h. luteus* from New Mexico and from Lake Dorothea are broader and longer than those of *Z. h. preblei* (Table 2). Zygomatic breadth was greater in the specimens of *Z. h. luteus* from New Mexico than those from Colorado.

Ear and hair samples from 10 Lake Dorothea specimens (DMNH 8632-8637, 8639-8642) were included in mitochondrial-DNA analyses conducted by Biosphere Genetics Inc; non-coding region sequence data also suggested that jumping mice from Lake Dorothea belong to the subspecies *Z. h. luteus* (Riggs et al., 1997; pers. comm., 1998).

The population of *Zapus* on the Lake Dorothea State Wildlife Area represents the first reported in extreme southern Colorado. Neither species of *Zapus* was previously known near Sugarite Canyon (Armstrong, 1972). Six specimens collected by C. A. Meaney in San Isabel National Forest (in July 1991) extended the known range of *Z. princeps* into Las Animas County, approximately 64 km (40 air miles) northwest of Lake Dorothea. The southernmost record of *Z. h. preblei* is in El Paso County, approximately 224 km (140 miles) north of Las Animas County (C. A. Meaney and C. Pague, in litt, 1999). The closest historic record of *Z. h. luteus* in northern New Mexico is North Williams Lake in the Sangre de Cristo Mountains (Morrison, 1992), about 144 km (90 air miles) southwest of Lake Dorothea. The possible occurrence of isolated populations of *Zapus* along the Colorado-New Mexico border needs to be investigated further to elucidate the historical biogeography and present ecological requirements of members of this genus.

Table 1. Selected external measurements (means and extremes) of four samples of *Zapus*. Sample sizes were N=9 (*Z. h. luteus* from New Mexico), N=9 (*Zapus* from Lake Dorothea), N=12 (*Z. h. preblei*), and N=30 (*Z. p. princeps*).

	Total length	Length of Tail	Hindfoot
<i>Z. h. luteus</i>	213.4(205-221)	126.2(118-130)	29.6(28-31)
Lake Dorothea	211.8(204-216)	123.6(119-131)	29.4(29-31)
<i>Z. h. preblei</i>	208.5(195-231)	124.6(116-137)	29.7(27-32)
<i>Z. p. princeps</i>	231.0(200-247)	139.0(125-156)	31.6(29.5-34)

Table 2. Means and extremes for condylobasal length, zygomatic breadth, interorbital breadth, maxillary toothrow length, palatal length, palatal breadth, incisive foramina length, incisive foramina breadth, infraorbital width, and mastoid breadth of four samples of *Zapus*. Sample sizes were N=10 (*Z. h. luteus* from New Mexico), N=9 (*Zapus* from Lake Dorothea), N=13 (*Z. h. prebleii*), and N=30 (*Z. p. princeps*); smaller samples due to missing measurements are indicated.

	CB length	Zygomatic	Interorbital	Max tooth	Pal length	Pal breadth	IF length	IF width	IB width	Mastoid
<i>Z. h. luteus</i>	21.2 (20.7-21.6) N=9	11.7 (11.2-12.3) N=8	4.5 (4.2-4.6)	3.9 (3.7-4.0)	11.1 (10.7-11.5)	3.4 (3.0-3.6)	4.3 (4.1-4.5) N=9	2.4 (2.2-2.5)	1.9 (1.6-2.1) N=9	10.7 (10.0-11.0) N=9
Lake Dorothea	20.8 (20.2-22.0)	11.4 (11.3-12.0) N=8	4.5 (4.3-4.7)	3.8 (3.6-4.0)	11.0 (10.7-11.5)	3.5 (3.3-3.6) N=8	4.0 (3.8-4.4)	2.1 (2.1-2.3)	1.97 (1.8-2.2)	10.6 (10.3-11.0)
<i>Z. h. prebleii</i>	20.8 (19.9-21.8)	10.9 (10.7-11.8)	4.2 (4.0-4.5) N=12	3.8 (3.6-4.1)	10.5 (9.7-10.8)	3.3 (3.0-3.4)	4.3 (4.1-4.6)	2.1 (1.9-2.2)	1.9 (1.6-2.2)	10.6 (9.9-11.0)
<i>Z. p. princeps</i>	22.1 (19.5-23.5) N=26	12.5 (11.7-13.2) N=26	4.4 (4.1-4.7) N=28	4.2 (3.8-4.4)	11.5 (10.1-12.3) N=26	3.7 (3.3-4.0)	4.6 (4.0-5.2)	2.3 (2.0-2.5)	2.4 (2.1-2.9) N=23	11.1 (10.6-11.4) N=23

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SPECIMENS EXAMINED:

Zapus hudsonius americanus (1): New York: Otsego Co: Cherry Valley, 1 (DMNH 7476).

Zapus h. intermedius (4): North Dakota: Mercer Co: 3 km N Hazen, 3 (DMNH 7761, 7762, 7764); T145N, R87S, Sec 13, 1 (DMNH 7763).

Zapus h. luteus (31): Colorado: Las Animas Co: Lake Dorothea State Wildlife Area: Schwacheim Creek (36°59'48"N, 104°22'03"W; UTM 13 0556404E, 4094451N), 1 (DMNH 8630/TK 51253); 37°00'04"N, 104°21'30"W; UTM 13 0557093E, 4095188N, 1 (DMNH 8631/TK 51263); Chicorica Creek (37°00'02"N, 104°21'39"W; UTM 13 0556871E, 4095125N), 6 (DMNH 8632-8637/TK 51294, 51295, 51305-51308); NW of Lake Dorothea, West Fork Schwacheim Creek (37°00'25"N, 104°22'32"W; UTM 13 0555556E, 4095825N), 5 (DMNH 8638-8642/TK 51352-51356); Lake Dorothea State Wildlife Area, Chicorica Creek about 0.2 mi (0.3 km) upstream from confluence with Lake Maloya (UTM 13 0556480E, 4094600 N), 1 (DMNH 9065). New Mexico: Bernalillo Co: Isleta, T8N, R2E, Sec 12, 1 (MSB 58368); Otero Co: 8 mi E Cloudcroft, 1 (MSB 37155), 3.2 mi E (by road) Cloudcroft, 3 (MSB 41060, 41062, 41064), Silver Springs Canyon, T15S, R13E, Sec 29, 1 (MSB 61701); Sandoval Co: T19N, R2E, SW Sec 10, Fenton Lake, marsh E of lake, E of Rte 126, 1 (MSB 56982);

Rio Cebolla, T19N, R1E, no section, 1 mi upstream from intersection with Rio Las Vacas, 1 (MSB 62097); T19N, R2E, NE Sec 30, Rio Cebolla at intersect. of Rte 376 & Lake Fork Creek, 1 (MSB 56985); Socorro Co: 8 mi S San Antonio, Bosque del Apache National Wildlife Refuge, 6 (MSB 41223, 41225, 41226, 41228, 41229, 41234), 11 mi S San Antonio, Bosque del Apache Game Refuge, 2 (MSB 36119, 36143).

Zapus h. preblei (21): Colorado: Adams Co: Croak's Lake, 1 (DMNH 2822); Boulder Co: South Boulder Creek, irrigation ditch, 1 (DMNH 9314), ¼ mi S St. Vrain Road on U.S. hwy 36 on unnamed drainage, UTM 13 0477420E, 4446330N, elevation 1689 m, 2 (DMNH 9204, 9205), south of Boulder, 1 (UCM 1225), 3 mi E Boulder, 1 (UCM 551), 5 mi E Boulder, 1 (UCM 503), 8.5 mi N, ¾ mi E Boulder, 1 (UCM 5210), 0.5 mi SSE Eldorado Springs, T1S R70W NE ¼ NW ¼ Sec 31, 6000', 1 (UCM 17001), Niwot, 1 (DMNH 2394); 3 mi NW Niwot, 1 (DMNH 2971); Douglas Co: West Plum Creek, 8 mi N county line, T9S R68W, SW ¼ SW ¼ Sec 24, 2 (UCM 17003, 17004); El Paso Co: U.S. Air Force Academy, 1 (DMNH 9315), U.S. Air Force Academy, Monument Creek, 0.25 mi S Sewage Treatment Plant, T12S R67W SW ¼ NW ¼ NW ¼ Sec 30, 6440', 1 (UCM 17002),

Monument, Dirty Woman Creek, T11S R67W NE ¼ SW ¼ Sec 14, UTM 13 0512100E, 4326700N, 1 (DMNH 9206), near Monument on Dirty Woman Creek, T11S R67W, NE ¼ SW ¼ Sec 14, UTM 13 0512100E, 4326700N, 1 (DMNH 9313); Gilpin Co: along Ralston Creek, T2S R70W NE ¼ SW ¼ Sec 31, 6400', 1 (DMNH 9312); Jefferson Co: ¼ mi W Semper, 2 (DMNH 6633, 6634), Rocky Flats, Walnut Creek Drainage, 5809', 1 (DMNH 9203).

Zapus princeps princeps (38): Colorado: Archuleta Co: Devil's Creek, near Dyke, 2 (DMNH 5575, 5576); Upper Navajo River, 5 (DMNH 1227, 1229-1231, 1233); headwaters of Navajo River, 9 (DMNH 1483-1489, 1498, 1499); Boulder Co: 7,000 ft, 2 (DMNH 3258, 3354); 3 mi E Pine Cliff, 3 (DMNH 3378-3380); Clear Creek Co: Camp Lemon, 2 (DMNH 4395, 4396); Gunnison Co: Taylor Park, 1 (DMNH 3903); Jackson Co: 4 mi NW Northgate, 2 (DMNH 1052, 1053); Las Animas Co: San Isabel National Forest, Purgatoire Campground, 2625 m, 6 (DMNH 7914-7919); Routt Co: Dome Peak, Middle Stillwater Creek, 1 (DMNH 4938); Stillwater Reservoir, 10,300 ft, 3 (DMNH 4970-4972). New Mexico: Taos Co: 4 mi N, 11 mi E Arroyo Hondo, 2 (MSB 41346, 41347).

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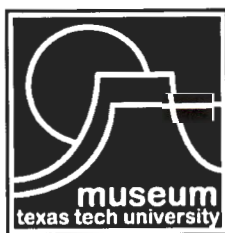
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