First Records of Two Species of Mammals in the Huachuca Mountains: Results of Ecological Stewardship at Fort Huachuca

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Abstract—*We report the first voucher of the cliff chipmunk (*Neotamias dorsalis*) and observations of Brazilian free-tailed bats (*Tadarida brasiliensis*) from the Huachuca Mountains, Arizona, where these species had not been documented. While presence of* T. brasiliensis *was expected on Fort Huachuca,* N. dorsalis *was a surprise after a century of unexpected absence. The chipmunk carcass from a cave on the Fort in 2003 suggests recent dispersal from other mountain islands.*

Introduction

The presence or absence of species in an area is inherently interesting, in part, because it is a first step in understanding nature. Such data from mountain islands, like the Madrean Archipelago, have numerous applications. For example, datasets of montane species diversity are used to test insular theory, to test models of competition, to model extinctions following environmental degradation by humans, and to set management priorities on public lands (Lomolino et al. 1989; McDonald and Brown 1992). Reasons why some species are present or absent, however, can be the subject of debate (Lomolino et al. 1989).

The Huachuca Mountains are a sky island in the Madrean Archipelago with high species richness. The range extends approximately 40 km across southwestern Cochise County, Arizona, and continues into north-central Sonora, Mexico (Brown and Lowe 1983; Hoffmeister and Goodpaster 1954). The Huachucas rise from Chihuahuan desertscrub on the east along the San Pedro River drainage at 1,525 m elevation, to Miller Peak at 2,889 m in mixed conifer forest (Hoffmeister and Goodpaster 1954). A large portion, 29,675 ha, of these mountains is the Fort Huachuca Military Reservation. During recent fieldwork on the Fort, we documented presence of two species not previously included in the faunal richness of the Huachucas.

To understand the significance of finding two additional species, it is necessary to know that the Huachuca Mountains have been well studied. Formal surveys for mammals were first conducted in the 1890s (Mearns 1907) as part of an inventory of the international border region. Later, Hoffmeister and Goodpaster (1954) surveyed the Huachucas specifically and thoroughly for mammals, obtaining and preparing 842 museum specimens. Later still, Howe and Lackey (1975) mist netted for bats on Fort Huachuca. More recently, within the past two decades, the Army has promoted responsible stewardship and provided for independent survey, monitoring, and research activities to protect the diversity of vegetation and wildlife on Department of Defense lands (e.g., Chace et al. 2000; Hass 2002; Morrison et al. 1995; Sidner 2000).

Methods

During survey efforts on Fort Huachuca, Sidner (with Russell Davis) netted bats in riparian areas in five canyons. We set multiple mist nets over small pools in forests and over large ponds in Woodcutter, Garden, and Tinker Canyons at elevations from 1,500-1,640 m on 11 nights during June-September 1993 and May-August 1994. Nets were tended from sundown until nearly sunup. Bats were removed from nets, identified to species, measured, photographed, and released. Sidner visited 6 caves and one mine during summers of 1989-2003 to locate roosting bats. In addition, Sidner identified bat carcasses at the Arizona State Health Lab in Tucson, including those from Fort Huachuca, sent in for routine rabies testing from 2000-2003.

On 04 November 2003, we descended 38 m into a vertical cave pit in a mixed conifer forest south of Scheelite Canyon, Fort Huachuca, at 2,562 m, to inventory vertebrates and invertebrates. This cave is part of a limestone outcrop where we observed the following species: mountain treefrogs (*Hyla eximia*), mountain patch-nosed snake (*Salvadora grahamiae*), mountain spiny lizard (*Sceloporus jarrovii*), a mountain snail (*Sonorella* spp.), cave little brown bat (*Myotis velifer*), rock squirrel (*Spermophilus variegatus*), and Mexican spotted owl (*Strix occidentalis lucida*). We recorded, sampled, and photographed species, including a decomposing chipmunk carcass at the bottom of this cave. Because cave air at the internal base is ≤8 ºC and >95% RH, conditions that slow decomposition, we could not determine how long the carcass had been there, but it had not been present during a previous visit in September 2002 (R. Toomey, personal communication). Pelage appeared fresh and was in good condition. On May 7, 2004, we returned to

retrieve the skeleton and remaining hairs after further decomposition. We measured the skull with a Fowler caliper (0.05 mm increments) and compared ours with measurements given by Hoffmeister (1986).

Results and Discussion

Brazilian Free-Tailed Bats

We netted 146 bats on Fort Huachuca during 1993-1994, including 12 female and 13 male Brazilian free-tailed bats (*T. brasiliensis*). Captured free-tailed bats were identified by forearm measurements between 41.2-44.5 mm and by complete basal separation of ears at the forehead. Even though not previously documented in the Huachuca Mountains, the species was the second most common bat we caught after *Eptesicus fuscus*. Other species captured in the same nets as *T. brasiliensis* included *E. fuscus*, *Lasiurus blossevillii*, *L. cinereus*, *Lasionycteris noctivagans*, *Leptonycteris curasoae*, *Myotis auriculus*, *M. thysanodes*, *M. velifer*, *M. volans*, and *Pipistrellus hesperus*. We saw no *T. brasiliensis* in any of the caves and mine on Fort Huachuca that were monitored for 14 y. However, *T. brasiliensis* was the most common species of bat from Fort Huachuca sent to the Arizona State Health Lab in Tucson for routine rabies testing during 2000-2003 (41 of 72 bats; Sidner, lab notes). This pattern indicates that the species now roosts in buildings on post as was predicted by Hoffmeister and Goodpaster (1954).

Absence of *T. brasiliensis* in previous surveys was of interest, in part, because it is one of the most common and abundant bat species in Arizona. Other attempts to document the species in the Huachucas have been inconclusive or incorrect. Duncan and Sidner (1990) reported two *T. brasiliensis* in regurgitation pellets of Mexican spotted owls (*Strix occidentalis lucida*) from a canyon on Fort Huachuca, but these prey may have been obtained outside the Huachucas and carried in. A specimen misidentified as *T. mexicana* (= *T. brasiliensis*) from the Huachucas in the Chicago Natural History Museum is a *M. velifer* (Hoffmeister and Goodpaster 1954). The other literature reference to Brazilian free-tailed bats in the Huachucas refers to a locality, now called Pyeatt Ranch, and associated cave (Hoffmeister and Goodpaster 1954), probably Pyeatt Cave or Manila Mine/Cave, which is now on Fort Huachuca property. This reference is from Vernon Bailey's 1924 field notes that "*Nyctinomys mexicanus* [= *T. brasiliensis*] …occupy one cave at [Pyeatt Ranch]…Much guano has been taken out of these caves and they are very smelly and full of bats" (Hoffmeister 1986). Because there is no specimen to verify Bailey's observation, and because there are no *T. brasiliensis* in those sites today, but rather, one is occupied by a large aggregation of *M. velifer*, Bailey's notation must be questioned.

It is likely that *T. brasiliensis* was not collected before simply because it was missed. Biologists often net bats over small water pools for convenience (Howe and Lackey 1975). Freetails, however, prefer to fly over relatively large bodies of water, and we purposely selected large bodies for our netting surveys. Hoffmeister and Goodpaster (1954) collected bats by shooting over ponds at dusk or by "searching several thousands of feet" of tunnels. Thus, its prior absence in field surveys suggests the possibilities that *T. brasiliensis* arrived only recently, or was present before in lower numbers than now. Brazilian free-tailed bats are a crevice-dwelling species (Hoffmeister 1986). Current human land use in the Huachucas would encourage and sustain new arrivals. Humans have increased artificial habitat for bats by building structures with small crevices and by creating new water sources that provide moist foraging areas in an arid environment.

Cliff Chipmunk

The chipmunk carcass found in the pit cave in November 2003 was identifiable by its facial stripes. We identified the species *N. dorsalis* (Baker et al. 2003) by body size, by color pattern showing a distinct mid-dorsal dark line with relatively indistinct other body lines, and because only the cliff chipmunk is known from southern Arizona (Hoffmeister 1986). Cranial measurements of our specimen (with average measurements of *N. d. dorsalis* from the Pinaleno and Chiricahua Mountains by Hoffmeister, 1986:149) were: condylobasal length, 32.6 (32.2); palatilar length, 15.0 (14.8); postpalatal length, 13.0 (13.2); least interorbital breadth, 9.1 (8.1); postorbital breadth, 12.0 (11.4); zygomatic breadth, 19.6 (19.8); cranial breadth, 17.3 (16.5); bullae length, 8.7 (8.4); maxillary toothrow, 5.7 (5.7); and cranial depth, 14.5 (14.5). Because there can be overlap in cranial and external measurements between *N. dorsalis* and three other species of chipmunks in northern Arizona, we used Hoffmeister's (1986:159) scattergram that graphically separates the species using 3 cranial characters: cranial breadth, palatilar length, and postpalatal length. A point on that scattergram that represents our measurements of the skull from Fort Huachuca falls entirely within the range of *N. dorsalis* and out of the range of skull dimensions of the other species.

While *N. dorsalis* occurs in nearby Santa Catalina, Rincon, Pinaleno, and Chiricahua Mountains, it had not been documented in the Huachucas. Mearns' (1907) borderlands survey in the 1890s did not find cliff chipmunks in the Huachucas despite many weeks of survey and trapping in appropriate habitat. Mearns observed and trapped the species to the north and east, and his descriptions show that he knew the species well. Mearns (1907) commented, "The absence of any species of chipmunk from the Huachuca Mountains is remarkable." This absence was later supported by Cockrum (1960), Hall (1981), Hoffmeister (1986), and Hoffmeister and Goodpaster (1954).

The absence of *N. dorsalis* in earlier surveys in the Huachucas was of interest because the species, like *T. brasiliensis*, is otherwise common in Arizona in appropriate habitats and is common in nearby mountains (Hoffmeister 1986). Cliff chipmunks are most often found in canyons in the vicinity of large rocks, rocky outcrops, and cliffs in woodlands and forest habitats, but range lower into scrub in the presence of permanent water (Hart 1992; Hoffmeister 1986). The species occurs from southern Idaho and Wyoming, south to Durango, with isolated subspecies in western coastal Sonora and Coahuila (Hall 1981). The subspecies, *N. d. dorsalis*, is widely distributed in mountains of central and southeastern Arizona, east to western New Mexico, and south through Chihuahua to northern

Durango (Findley et al. 1975; Hall 1981; Hoffmeister 1986). In proximity to the Huachucas, *N. d. dorsalis* is also known from the Peloncillo and Animas Mountains in southwestern New Mexico (Findley et al. 1975), and the Sierra San Luis and Sierra Madre Occidental in Chihuahua (Hall 1981). A specimen from Sonora, in the vicinity of the Sierra del Tigre, and sight records from the west slope of the Sierra Huachinera are known (Caire 1978).

When a species is discovered initially in a montane area of the Southwest, one assumes either that it was present but missed previously, or that the species only recently moved into the area. The former explanation suggests relictual presence, that is, the species has been present and remained undetected since the Pleistocene (Davis et al. 1988). If this were the case for *N. dorsalis*, then the implication is that chipmunks in the Huachucas have been missed by biologists for 100 years. We think it unlikely that these chipmunks have been missed by the cadre of many biologists visiting the Huachucas, reviewing the work of others, and making judgments about where to draw distribution lines on range maps (Hall 1981; Hoffmeister 1986) because this is a visible and vocal species (Dunford 1974). An alternative possibility we do not accept is that this specimen was dropped by a raptor after being carried 78 km from the nearest source, the Rincon Mountains. Neither do we think chipmunks were released into the area by humans. Ground squirrels are difficult to capture, maintain, and transport. It is not clear what purpose would be served by transporting and releasing chipmunks. A fourth possibility is that the species may have arrived recently as a result of natural dispersal. However, the Huachucas are separated from other sky islands where cliff chipmunks do occur, to the north by semidesert grasslands, to the east by desertscrub and a small grassland bridge via the Mule Mountains. Differences in quality and quantity of separation between mountain ranges undoubtedly affect dispersal capabilities of a small, relatively non-vagile species. Yet there must be much plasticity in environmental tolerance in this species. The subpopulation of cliff chipmunks living along the coast of Mexico at Guaymas in Sonoran desertscrub are found to nest in woodpecker holes in cardon cactus (Callahan and Davis 1977).

There is no way to know for certain when these squirrels first arrived, but at the present time, while not common, there is evidence that chipmunks are successfully established. Besides our specimen, Mark Pretti (naturalist with The Nature Conservancy and frequent hiker in Ramsey Canyon) has observed chipmunks on four occasions in the summers of 1997-2002 at elevations of 2,440 to 2,530 m in the upper Ramsey Canyon drainage and the south face of Carr Peak. However, as new colonizers, cliff chipmunks may be present in low numbers in the Huachucas. We have no other reports of observations, although we have asked other biologists who have conducted intensive animal surveys in the vicinity (e.g., mammalogist C. Hass and ornithologist J. Martin, personal communication).

The "discovery" of *T. brasiliensis* in the Huachucas is not surprising given the vagility of bats. For a small, nonvolant mammal, however, new presence of a species on a montane island is more exciting. Most ecologists accept the possibility of range expansion within suitable habitat, but dispersal by a species across seemingly unsuitable habitat to colonize new territory is a troubling alternative to some (Davis et al. 1988). However, dispersal through such habitats does occur. Colonization by Abert's squirrels from pine forest of one mountain to another across gaps consisting of lower elevation woodlands and grasslands (Davis and Brown 1989), and range expansions northward by yellow-nosed cotton rats in the Madrean Archipelago (Davis and Dunford 1987) are recent examples. It appears that cliff chipmunks have provided another example of recent dispersal from one mountain to another in sky islands of the region.

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