HOLOCENE FAUNA OF BIG MANHOLE CAVE, EDDY COUNTY, NEW MEXICO

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ABSTRACT—Faunal remains of 40 vertebrate taxa were recovered from 15, 10-cm levels of Holocene deposits in Big Manhole Cave, New Mexico. Radiocarbon dates were determined for the 8 uppermost levels and ranged from 550 to 4,170 radiocarbon years before the present. Rapid deposition was indicated for levels 6, 7, and 8. Most identified taxa occurred in the immediate area at the time of our study, but the yellow-nosed cotton rat (*Sigmodon ochrognathus*), eastern cottontail (*Sylvilagus* cf., *S. floridanus*), and Mexican packrat (*Neotoma mexicana*) currently occur only at higher elevations in the region. The Mexican packrat was present in only the upper 4 levels, consistent with indications from other sites that it arrived east of the Rio Grande relatively recently. The extralimital taxa suggest greater effective precipitation, but the suggestion is confounded by our ignorance of pre-European ecological conditions in the area.

RESUMEN—Restos faunísticos de 40 diferentes taxa vertebrados fueron recobrados de 15 niveles de 10 cm en depósitos Holocenos en la Caverna Big Manhole, Nuevo México. Se determinaron fechas radiocarbónicas para los 8 niveles más altos y variaron entre 550 a 4170 años radiocarbono antes del presente. Deposito rápido se indicaba en los niveles 6, 7, y 8. La mayoría de los taxa identificados ocurrieron en el área inmediata al momento de nuestro estudio, pero la rata de nariz amarilla (*Sigmodon ochrognathus*), el conejo de monte (*Sylvilagus* cf., *S. floridanus*), y la rata montera (*Neotoma mexicana*), ahora ocurren solamente en elevaciones más altas de la región. Esta última especie aparece solamente en los 4 niveles más altos, consistente con indicios de otros sitios de que llegó al este del Río Bravo relativamente reciente. Los taxa localizados fuera del límite sugieren una precipitación más efectiva, pero la sugerencia se confunde por nuestra ignorancia de las condiciones ecológicas pre-europeas de la región.

Enormous climatic changes have occurred over the past 50,000 y in the Border Region of New Mexico and Trans-Pecos Texas (Wells, 1966; Harris, 1977; Van Devender et al., 1977, 1979, 1987; Van Devender and Spaulding, 1979; Harris, 1985, 1987, 1989, 1990, 1993; Van Devender, 1990). A series of Pleistocene-age cave faunas from the region have documented change through both time and space (Schultz and Howard, 1935; Slaughter, 1975; Harris, 1970; Logan and Black, 1979; Logan, 1983). Few faunas, however, were available for use in assessing faunal reactions to major climatic perturbations from the beginning of the Holocene (10,000 y BP) until the availability of archaeological faunas covering approximately the last millennium. Those Holocene faunas investigated (Gehlbach and Holman, 1974; Applegarth, 1979; Lundelius, 1979) primarily have involved sites with considerable disturbance of deposits. The purpose of this paper is to document and interpret the paleoenvironment of a late Holocene fauna undisturbed by humans, representing approximately the last 4,000 y of the Holocene.

Big Manhole Cave (Eddy County, New Mexico) is a pitfall trap located in Sec. 22, T24S, R24E, just north of Carlsbad Cavern National Park on land managed by the Bureau of Land Management (BLM). Elevation is about 1,280 m, similar to that of several nearby Pleistocene faunas (Harris, 1985). The area consists of rolling limestone hills about halfway between the Guadalupe Mountains front and the Pecos River.

Present vegetation is ecotonal between Upper and Lower Sonoran life zones. Common vegetation includes low-growing Pinchot's juniper (*Juniperus pinchotii*), sotol (*Dasylirion*), lechuguilla (*Agave lechuguilla*), allthorn (*Koeberlinea spinosa*), soaptree yucca (*Yucca elata*), beargrass (*Nolina*), and aromatic sumac (*Rhus trilobata*).

Occasional low-growing scrub oak (*Quercus turbinella*) and Texas madrone (*Arbutus xalapensis*) occur. Grasses are sparse.

The cave lies on the upper slopes of a hill with a moderate area of potential drainage above. Water usually is available at Turkey Spring, about 2 km to the northwest, and the Pecos River lies about 25 km to the east. The cave is accessible only through a small, nearly vertical opening near the top of the cave ceiling. Any non-volant animal entering necessarily freefalls about 15 m to the hard cave floor, a distance deemed sufficiently great to incapacitate animals larger than small rodents. Because of the placement of the entrance and the nature of the cave walls, vertebrates without the power of flight are trapped.

Unlike many sites that have been excavated in the Guadalupe Mountains region, human disturbance has been minimal. Remnants of a crude wire and wood ladder were on the cave floor, probably dating from about the 1920s, when several Carlsbad-area residents were exploring caves (J. Goodbar, pers. comm.). In recent years, spelunkers seeking open passageways below the cave fill have sunk several exploratory, shallow shafts and one deep shaft (the "clay shaft").

Seeking to bypass a dangerous, unstable area of open passageway encountered by the clay shaft, spelunkers requested BLM permission to sink another shaft. However, because fossil material had been encountered in the clay shaft, the BLM required responsible clearance of fossiliferous material before considering permits for further exploration. The Laboratory for Environmental Biology, University of Texas at El Paso, was contracted by the BLM to carry out clearance, and the authors were in the field from 18 to 24 March 1995.

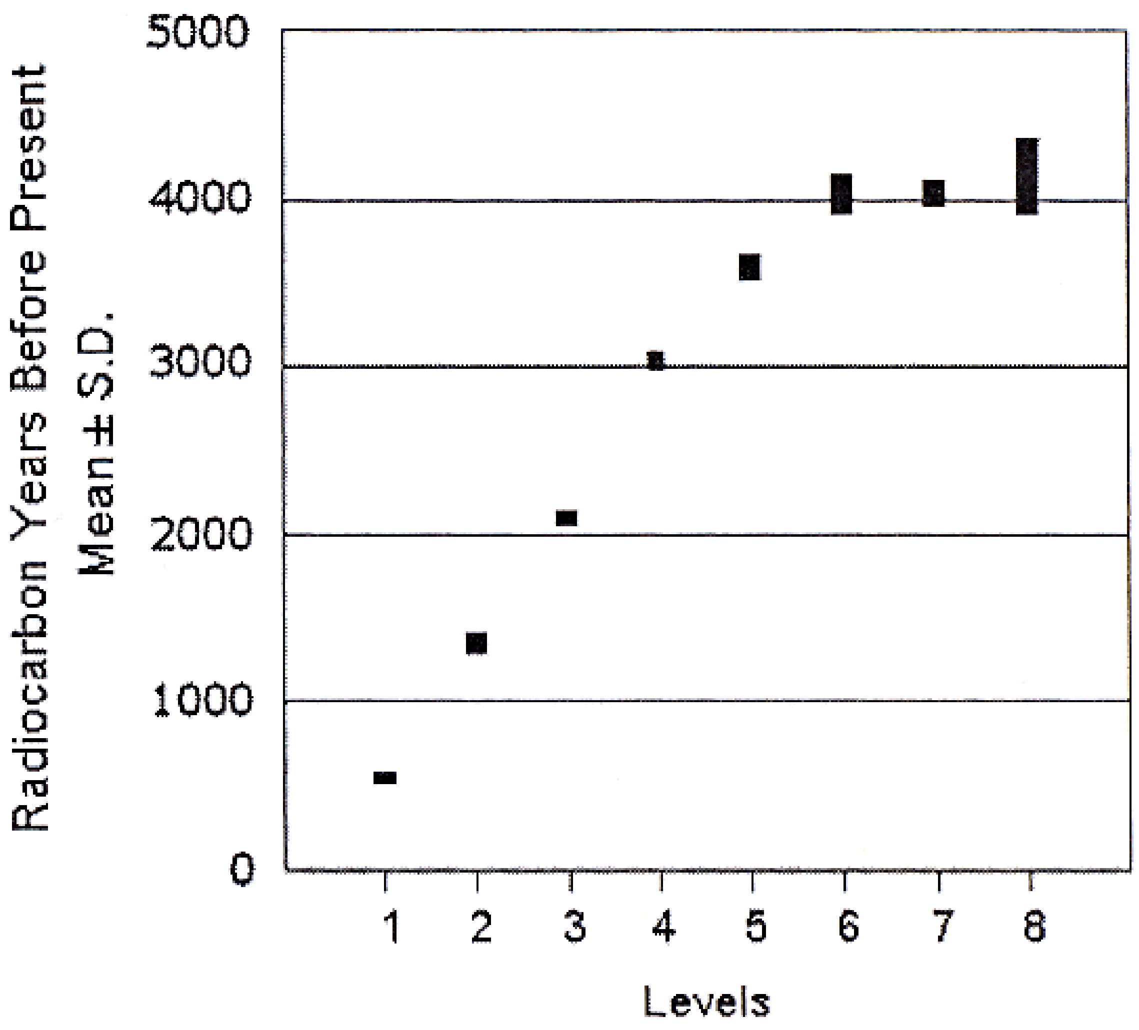

FIG. 1—Uncorrected radiocarbon dates (years before 1950 ± 1 *SD*) for the upper 8 levels at Big Manhole Cave, Eddy County, New Mexico.

METHODS—Excavations were aided by both BLM personnel and spelunker volunteers. Surface spoil from the earlier excavations was removed, and a backfilled test trench beside the selected site was cleared to enable examination of its face for possible stratigraphy. Dimensions of the excavation were dictated by the BLM-selected site, with surface dimensions consisting of a polygon with sides of 1.0 × 1.0 × 0.8 × 1.36 m.

In the absence of discernable stratigraphy, excavation was carried out in 10-cm levels as measured from a ceiling datum point approximately 2 cm above the surface of the unit, causing the uppermost level, level 1, to be approximately 2 cm thinner than subsequent levels, with a possibility of contamination by spoil from earlier excavations. Excavation was carried down to a flowstone layer appearing at about a depth of 1 m on the side of the excavation toward the cave center and at about 1.5 m on the far side. As a result, in levels past 1 m, fill volumes decreased with depth.

Excavation was by trowel, with bone material noted during excavation bagged and labeled. We removed large rocks and bagged the remaining matrix in heavy-duty plastic bags to be hauled to the surface. Pollen samples were taken from the excavation walls on the last day. Some matrix was dry-sifted through window-screen in the field; the remainder returned to the laboratory for processing, where, after preliminary screening, matrix was allowed to dry and then wet-screened (30-mesh, openings 0.59 mm). Screened matrix was hand picked and also floated to recover gastropods. Vertebrate identification efforts concentrated on elements most likely to be identifiable to species level.

Small specks of charcoal, presumably from surface fires and carried by run-off into the cave, were dispersed throughout the fill. Charcoal from each of levels 1 through 8 was submitted to the Laboratory of Isotope Geochemistry at the University of Arizona for radiocarbon dating. There was insufficient carbon for dating from levels 9 through 15.

RESULTS—Radiocarbon dates ranged in chronological order from about 550 to 4170 radiocarbon years before present (Fig. 1, Table 1). However, standard deviations of dates for levels 6 through 8 overlap broadly and might represent shorter spans of time. Lack of visible stratigraphy and vertically oriented long bones of larger mammals (e.g., porcupine) suggest rapid deposition during major storms, with flooding waters swirling about matrix and biological materials. Probable injury during entry to animals large enough to seriously disrupt sediments

TABLE 1—Sample numbers (Laboratory of Isotope Geochemistry, University of Arizona) for levels 1 through 8, Big Manhole Cave, Eddy County, New Mexico; radiocarbon dates and *SD*. All dates are on charcoal.

Level	Laboratory number	Conventional date
1	A-8838	545 ± 50
2	A-8839	1,360 ± 65
3	A-8840	2,085 ± 45
4	A-8841	3,035 ± 60
5	A-8842	3,580 ± 75
6	A-8843	4,020 ± 120/−115
7	A-8844	4,025 ± 75
8	A-8845	4,170 + 195/−190

by digging renders disturbance from such sources unlikely.

Pollen analysis was carried out on the uppermost 13 levels (Cornell, 2001). Few palynomorphs were present and dominated by spores, mostly fungal in origin. In the uppermost level, about 10% of the palynomorphs were a *Poa*-type (grass) pollen, absent elsewhere. *Pinus*-type pollen ranged from an average of 5% in levels 2 to 7 to about 18% in levels 12 and 13. Probable fern spores were common. Due to poor preservation and consequent lack of diversity, the palynomorphic record is not informative. The abundant, but low-diversity, gastropod record remains to be analyzed in detail.

A total of 6,300 vertebrate specimens catalogued under 2,874 numbers has been processed, with 40 vertebrate taxa identified (Table 2). Specimens are deposited in the paleobiology collections of the Laboratory for Environmental Biology, University of Texas at El Paso.

DISCUSSION—The long drop between the only Holocene opening into the cave and the cave floor strongly suggests survivors were unlikely to have been fit to significantly disturb cave sediments. Radiocarbon dates suggest even rates of accumulation between the present and level 6, at which time the dates suggest a serious disruption mingled at least 30 cm of sediments. We consider it likely that one or more severe storms sent powerful surges of water into the cave.

The source of vertebrate remains likely was a combination of animals seeking shelter in the near-vertical crevice forming the opening and animals dying on the up-slope surface and eventually washed into the cave. The large number of surface-dwelling gastropods (estimated roughly at more than 14,000 individuals) indicates such slope wash was important for deposition of at least the smaller creatures. Flying vertebrates were rare (2 specimens of bats and 109 of birds), and the majority were quail and towhees, both terrestrial taxa. Owls were thought to be an unlikely source of faunal remains, both because of the lack of owl remains and because of the constricted nature of the near-vertical, short passageway piecing the dome. The possibility of some faunal remains entering as stomach contents of predators cannot be ruled out.

Most vertebrates identified were those to be expected under historical conditions, but several were extralimital forms, all from the upper 4 levels that seemed to be undisturbed. The yellow-nosed cotton rat (*Sigmodon ochrognathus*) was represented by a maxillary fragment with first and second molars in place, recovered from the 40–50 cm level (3580 ± 75 radiocarbon years before present) and identified by using Stangl and Dalquest (1991). This rodent was recorded recently for the first time in the Guadalupe Mountains, about 3 mi northeast of the Guadalupe Mountains National Park Headquarters (Hollander et al., 1990). The species generally is considered a montane animal in the Southwest, associated with grasses in woodland or higher-elevation habitats.

A cottontail now unknown regionally at the elevation of Big Manhole Cave was identified from a single edentulous dentary from level 3. Size separates this specimen from any of the jackrabbits (*Lepus*), except the snowshoe hare (*L. americanus*), which occurs no closer than northern New Mexico today. The mandible clearly is not that of the desert cottontail (*Sylvilagus audubonii*) currently present, but could represent either Nuttall's cottontail (*S. nuttallii*) or the eastern cottontail (sensu lato, including *S. floridanus* and *S. cognatus*). Identification was on the basis of dentary height, relatively shorter compared to toothrow length in the eastern cottontail complex than in *S. audubonii* (Findley et al., 1975). Because members of the *S. floridanus* complex occur regionally at higher elevations in the Guadalupe Mountains and in the grasslands of the Great Plains to the northeast, the specimen most likely represents that complex. Its presence suggests either heavy

TABLE 2—Levels of occurrence of taxa at or below the generic level identified from Big Manhole Cave, Eddy County, New Mexico. Radiocarbon dates for levels in Table 1.

Scientific name	Common name	Levels
Scaphiopus/Spea	Spadefoot toads	3, 5, 10
Bufo	Bufonid toads	1–3, 5, 10
B. cognatus	Great Plains toad	5
B. punctatus	Red-spotted toad	1–12, 14
Phrynosoma cornutum	Texas horned lizard	2, 5
P. modestum	Round-tailed horned lizard	8
cf., *Cnemidophorus*	Whip-tailed lizards	5
Bogertophis/Elaphe	Rat snakes	1
B. subocularis	Trans-Pecos rat snake	1, 3, 5, 11
Elaphe guttata	Corn snake	1
Coluber/Masticophis	Racers/Coachwhips	1, 3–15
Lampropeltis getula	Common kingsnake	1
Pituophis melanoleucus	Pinesnake	1, 3
Salvadora	Patch-nosed snakes	3–5, 7, 12
Thamnophis	Garter snakes	3, 12
Crotalus	Rattlesnakes	1–15
Callipepla/Cyrtonyx/Colinus	Quail/Bobwhite	3–11, 14, 15
Mimus polyglottus	Northern mockingbird	2
Pipilo fuscus	Canyon towhee	3–6, 10
Notiosorex crawfordi	Desert shrew	1–15
Myotis	Myotis bats	6, 11
Canis latrans	Coyote	4
Urocyon/Vulpes	Gray foxes/Red foxes	3, 4, 7, 11
Urocyon cinereoargenteus	Gray fox	5, 6
Bassariscus astutus	Ringtail	1–5, 9–10, 12–13
Mustela frenata	Long-tailed weasel	2–5
Mephitis	Striped skunks	3
Spilogale	Spotted skunks	2–7, 14–15
Spermophilus (small)	Ground squirrels	3–4, 7, 11
S. variegatus	Rock squirrel	1–7, 9–11
Thomomys bottae	Botta's pocket gopher	1, 5
Dipodomys spectabilis	Banner-tailed kangaroo rat	2
Chaetodipus/Perognathus	Spiny/Silky pocket mice	1–13
Perognathus flavus/flavescens	Silky/Plains pocket mice	7
Neotoma	Packrats	1–15
N. leucodon	Eastern white-throated packrat	1–13
N. mexicana	Mexican packrat	1–4
Onychomys arenicola	Mearn's grasshopper mouse	2, 4–5, 7–8, 12–13
O. leucogaster	Northern grasshopper mouse	2, 4–5
Peromyscus	Deer mice	1–15
Reithrodontomys	Harvest mice	1–13
Sigmodon ochrognathus	Yellow-nosed cotton rat	5
Erethizon dorsatum	Porcupine	1–15
Lepus	Jackrabbits	3–4, 6, 10
Sylvilagus	Cottontail rabbits	1–10, 12–13, 15
Sylvilagus cf., *S. floridanus*	Eastern cottontail	3

brushy growth (its habitat at higher elevations in the Guadalupe Mountains) or relatively lush grasslands, as in the Great Plains.

Eleven specimens of the Mexican packrat (*Neotoma mexicana*) were recovered from the upper 4 levels. This species is the only current member of the genus in the region with a well-developed lateral dentine tract on the lower first molar and a deep antero-medial reentrant on the first upper molar (Harris, 1984). It occurs today at higher elevations in the Guadalupe Mountains, and its presence suggests greater precipitation than occurs currently at the cave site.

We suggest that *N. mexicana* reached southern New Mexico and Trans-Pecos Texas late in the Holocene, presumably by invasion from the north rather than from the west. Occurrence in these relatively recent levels and absence in earlier levels fits with data from other sites east of the Rio Grande Valley (Harris, 1984, 2003), where the taxon is noted only in Holocene deposits. The exception is a report of Mexican packrats in Upper Sloth Cave Pleistocene deposits (Logan and Black, 1979). Until both modern and fossil packrats of the Southwest were studied in detail (Harris, 1984), there was potential confusion between identifications of the Mexican packrat and the now extirpated bushy-tailed packrat (*N. cinerea*), which is common in local Pleistocene deposits. Logan and Black (1979:154) stated that "*N. cinerea* is differentiated from *N. mexicana* on the basis of accessory cusps developed in the re-entrant angles of some of the teeth ..., a condition found in 50% of the Recent specimens of *N. cinerea* examined and lacking in all Recent specimens of *N. mexicana* examined." Apparently, specimens without accessory cusps were identified as *N. mexicana*, despite the common occurrence of teeth from *N. cinerea* lacking such accessory cusps.

Because of the distance of the cave from appreciably higher elevations, a distance of many kilometers would be necessary for any of these 3 taxa to be brought to the cave by predators under current conditions, insofar as present distributions are known. Thus, it seems most likely that the taxa occurred in the immediate vicinity of the site.

Although the extralimital taxa indicate denser vegetation more typical of higher elevations or more abundantly watered areas of the region, the effect of historical human occupancy is little known. The general area has been subjected to grazing and browsing by domestic stock. Bedrock commonly is exposed, and soils, when present, usually are thin. Deposits of dark silt in local caves suggest erosion resulting in the loss of soil that might have historically supported more verdant vegetation than possible in the present landscape.

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