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PALEOECOLOGICAL IMPLICATIONS of the MAMMALIAN FAUNA of LOWER SLOTH CAVE GUADALUPE MOUNTAINS, TEXAS

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SUMMARY

The vertebrate fauna of Lower Sloth Cave, Culberson County, Texas, spans the transition from late Wisconsinan to Recent time. Extinct species represent 4.8% of the mammalian fauna. Extant, but extralimital, mammalian species represent an additional 21.4% of the fauna; thus, 26.2% of the 37 taxa of mammals recorded from Lower Sloth Cave no longer occur in the Guadalupe Mountains. The majority of the extralimital mammals are found as near as the mountains of northern New Mexico, with only Cryptotis parva *suggesting an eastern influence on the fauna. Paleoclimatic reconstruction of the area indicates a slightly more mesic climate than at present. A late Pleistocene paleobotanical reconstruction of the area near Lower Sloth Cave suggests a spruce-fir forest interspersed with grassy glades or meadows. A single humerus of the Pleistocene Black Vulture (*Coragyps occidentalis*) was also recovered.*

FOR NEARLY HALF a century, the caves of the southern Guadalupe Mountains of New Mexico and Texas have provided a valuable source of information on vertebrate paleocommunities of the area. Rich bone deposits in Burnet Cave (Howard, 1932; Schultz and Howard, 1935), Dry Cave (Harris, 1970a), Pratt Cave (Gehlbach and Holman, 1974; Lundelius, 1979), Upper Sloth Cave (Logan, 1975; Logan and Black, 1979), and Williams Cave (Ayer, 1936) show dramatic changes in the vertebrate fauna of the southern Guadalupe Mountains over the past 15,000 years.

Remains of extinct vertebrates recovered from Lower Sloth Cave represent only three taxa: *Coragyps occidentalis* (Pleistocene Black Vulture), *Ovis canadensis catclawensis* (Pleistocene Bighorn Sheep), and *Nothrotherium shastense* (Shasta Ground Sloth). *Cryptotis parva* (Least Shrew), *Sorex cinereus* (Masked Shrew), *Sorex vagrans* (Wandering Shrew), *Marmota flaviventris* (Yellow-bellied Marmot), *Tamiasciurus hudsonicus* (Red Squirrel), *Sciurus* sp. (Tree Squirrel), *Cynomys gunnisoni* (Gunnison's Prairie Dog), *Neotoma cinerea* (Bushy-tailed Woodrat), and *Ovis canadensis* (Bighorn Sheep) are extant taxa represented in the vertebrate fauna of Lower Sloth Cave but have been extirpated from the area.

Excavations in Upper Sloth Cave, Lower Sloth Cave, Dust Cave, and Williams Cave, all within the boundaries of the Guadalupe Mountains National Park, have produced plant macrofossils and pollen profiles spanning the last 13,000 years (Van Devender, *et al.*, 1979a;b). These plant macrofossils and pollen, not commonly preserved in cave deposits, provide valuable information on paleohabitats and paleoclimates of the area.

Lower Sloth Cave (Fig. 1) is located in the extreme northwestern corner of Culberson County,

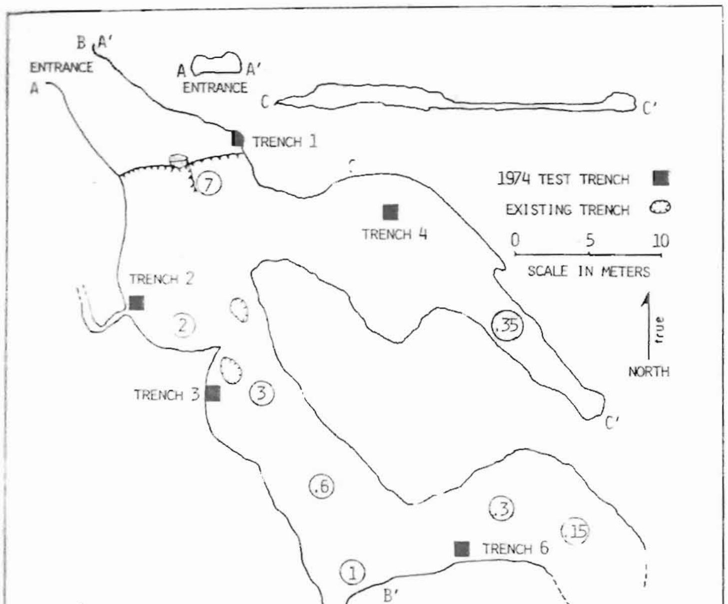

Figure 1. Lower Sloth Cave, Guadalupe Mountains National Park, Culberson County, Texas. CRG Grade 5 survey.

Figure 2. West face of the Guadalupe mountains, from Upper Sloth Cave. Arrow marks entrance of Lower Sloth Cave.

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Texas, at an elevation of approximately 200 m. The entrance faces west-northwest and is located at the junction of a 35 m cliff of Permian limestone and a 60° talus slope (Fig. 2).

Lower Sloth Cave is a horizontal cave with a total vertical relief of less than 7 m. It is a very dry cave at present, with flour-like dust deposits up to 20 cm in depth. The cave is poorly ornamented and has only a few dead columns, stalactites, and minor draperies. There are a few solution pockets in the ceiling. These are utilized by bats of the genera *Plecotus, Myotis,* and *Eptesicus* as hibernation sites. Great Horned Owls occasionally utilize one ledge in the cave as a roost site.

METHODS

The locations for the six test trenches in Lower Sloth Cave (Fig. 1) were determined by surface prospecting for vertebrate remains throughout the cave, concentrating on areas of probable accumulation, *i.e.,* below owl roosts (presently utilized by Great Horned Owls) and at the bases of slopes. After an area was chosen, a one-meter square grid of nylon cord oriented north-south was placed above the surface of the deposit to define the limits of the excavation and to provide a reference point for determining the depth of the excavation.

Each trench was dug in 10 cm depth increments, taking care to keep separate the different stratigraphic units within each level. The matrix from each level was dry-screened through screens of 7 mm, 3 mm, and 0.75 mm mesh. Material that was too wet to dry screen immediately was sun-dried on vinyl sheeting and then screened. All levels deeper than 30 cm had to be dried prior to screening. Concentrate that was trapped by the 3 mm and 7 mm screens was examined in the field, and all organic material was saved. Concentrate trapped by the 0.75 mm screen was bagged and later examined under magnification in the laboratory. Vertebrate materials as small as isolated bat canines and incisors were recovered in this manner.

During the excavations, pollen samples were taken from each level and each stratigraphic unit. These samples were processed by Dr. Thomas Van Devender and Mr. Geof Spaulding of the University of Arizona. (Van Devender, *et al.,* 1979a;b). Some samples contained quantities of pollen; others had none.

After the excavation of each trench was completed, the trench was lined with polyvinyl sheeting and backfilled with the screened residue from the trench. This restored the cave to a more nearly normal condition as well as defined the limits of the excavation for future workers.

STRATIGRAPHY

The statigraphy of Lower Sloth Cave is so varied that correlations between trenches are extremely dubious in most cases. The only subsurface strata that can be correlated with any degree of certainty are the flowstone layer of trench one and the layer containing flowstone fragments in trench five. These strata certainly indicate a period of increased precipitation in the Guadalupe Mountains.

The depth within the deposit is obviously not useful in correlating sediments, considering the differences between trenches five and six. These trenches are within 12 m of each other, and, from surface indications, there should be little difference between them.

METHOD OF ACCUMULATION

The vertebrate material from Lower Sloth Cave apparently accumulated in the following manner:

1. **Natural deaths**—This mode of accumulation is apparently responsible for a very minor percentage of the total bone accumulation. Primarily, immature birds and bats seem to be involved. The bones of these animals, while relatively uncommon, have a tendency to show little breakage prior to deposition.
2. **Carnivore deposition**—The vast majority of vertebrate remains from Lower Sloth Cave are of vertebrates of jack rabbit (*Lepus* sp.) size or smaller. *Neotoma* sp. bones make up the bulk of the material. The breakage of these bones is nearly identical to the breakage of bone, described by Mellet (1974), observed in owl pellets and fecal

Figure 3. Simplified stratigraphy of trenches 1 to 6, Lower Sloth Cave, Culberson County, Texas. Excavations of July-August, 1974.

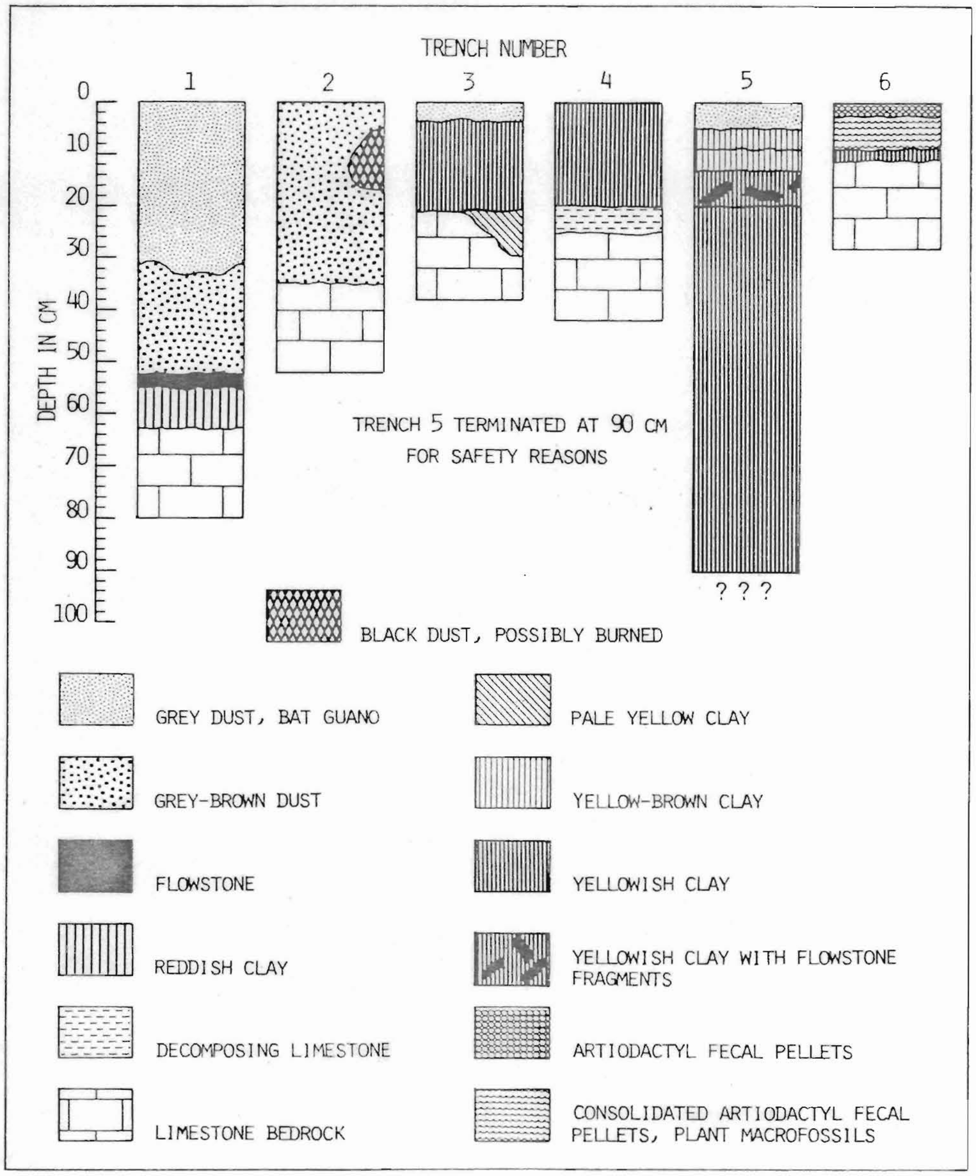


Table 1. Distribution of mammalian species of Lower Sloth Cave by collecting locality. Taxa marked with the symbol '*' are extinct; taxa marked with the symbol '†' are extant, but have been extirpated from the area.

Taxa	Trench 1	Trench 2	Trench 3	Trench 4	Trench 5	Trench 6	Surface or Existing Trench
Order Insectivora							
Family Soricidae							
†**Sorex cinereus*					X		
† *S. vagrans*					X	X	
† *Cryptotis parva*			X		X	X	
Notiosorex crawfordi	X	X			X	X	
Order Chiroptera							
Family Vespertilionidae							
Myotis sp.	X	X	X		X	X	
M. velifer	X	X			X	X	
M. thysanodes	X						
M. leibii	X						
Eptesicus fuscus	X				X	X	
Plecotus townsendii	X	X			X		
Antrozous pallidus	X				X		
Family Molossidae							
Tadarida sp.	X						
T. brasiliensis		X				X	
Order Edentata							
Family Megatheriidae							
**Nothrotherium shastense*							X
Order Lagomorpha							
Family Leporidae							
Sylvilagus sp.	X	X				X	
Order Rodentia							
Family Sciuridae							
† *Sciurus* sp.					X		
† *Tamiasciurus hudsonicus*	X					X	
† *Marmota flaviventris*	X				X		
† *Cynomys gunnisoni*	X						
Spermophilus spilosoma					X		
S. variegatus	X					X	
Eutamias sp.	X						
Family Geomyidae							
Thomomys umbrinus						X	
Family Muridae							
Peromyscus sp.					X	X	
Onychomys leucogastor						X	
O. torridus						X	
Neotoma sp.	X	X	X	X	X	X	X
N. micropus						X	
N. albigula					X	X	
N. mexicana					X	X	
† *N. cinerea*	X				X		
Microtus sp.	X	X	X		X		
M. mexicanus	X	X				X	
Family Erethizontidae							
Erethizon dorsatum					X	X	
Order Carnivora							
Family Canidae							
Canis sp.	X						
Family Procyonidae							
Bassariscus astutus	X					X	
Family Mustelidae							
Mustela frenata						X	
Spilogale gracilis						X	
Order Artiodactyla							
Family Cervidae							
Odocoileus sp.	X						
Family Bovidae							
† *Ovis canadensis*	X						X
**O. canadensis catclawensis*		X					

pellets of small carnivores. The only direct evidence of carnivores, other than bone breakage, is the presence of remains of *Bassariscus astutus, Spilogale gracilis,* and *Canis* sp. in the deposits. The two smaller species are carnivores that could be directly responsible for the scat accumulation in the cave. During the excavations, small pieces of very friable carnivore scat were observed in the upper levels of trenches five and six.

BOTANY OF THE AREA

Van Devender, *et al.*, (1979a;b) characterize the present vegetation as complex, high elevation Chihuahuan desert scrub mixed with chaparral and grassland species, including *Agave* spp. (Century Plant), *Cerococarpus montanus* (Mountain Mahagony), *Dasylirion leiophyllum* (Sotol), *Echinocerus* sp. (Hedgehog Cactus), *Ephedra* sp. (Mormon Tea), *Fallugia paradoxa* (Apache Plume), *Lesquerella* sp. (Bladder Pod), *Nolina* sp. (Bear Grass), *Oenothera* sp. (Evening Primrose), *Opuntia imbricata* (Cane Cholla), and *Opuntia* sp. (Prickly Pear). The only trees presently near Lower Sloth Cave are two relict *Pinus edulis* (Colorado Pinyon) in protected mesic microhabitats.

Plant macrofossils from Upper Sloth Cave and Dust Cave (Van Devender, *et al.*, 1979a;b), both within 400 m horizontally and 50 m vertically of Lower Sloth Cave, and from Lower Sloth Cave indicate a subalpine forest with *Picea* sp. (Spruce), *Juniperus* sp. (Juniper), *J. communis* (Dwarf Juniper), *Pseudostuga menziesii* (Douglas Fir), *Pinus strombiformis* (Southwestern White Pine), *P. edulis* (Colorado Pinyon), *Ostrya knowltonii* (Hop Hornbeam), *Quercus gambelii* (Gambel Oak), *Arctostaphylos* sp. (Manzanita), *Robinia neomexicana* (New Mexico Locust), and *Rubus strigosus* (Raspberry). Radiocarbon dates obtained from *Picea* sp. needles from Dust Cave and from Upper Sloth Cave were 13,000 ± 730 YBP (A-1539)* and 13,060 ± 280 YBP (A-1549) respectively.

* University of Arizona Laboratory.

Picea sp., *Juniperus communis* and *Rubus strigosus* are no longer components of the flora of Trans-Pecos Texas, but all three presently occur in New Mexico within 450 km of Lower Sloth Cave. The nearest population of *Juniperus communis* is in the southern end of the Rocky Mountains, in north-central New Mexico (Van Devender, *et al.*, 1979b).

During the late Pleistocene, the area around Lower Sloth Cave was probably a subalpine forest interspersed with grassy meadows (Van Devender, *et al.*, 1979a;b). The transition to the present high-elevation desert shrub community, which currently occurs near Lower Sloth Cave, was probably the result of the more arid conditions which prevail in the Guadalupe Mountains today.

MAMMALIAN FAUNA

The mammalian fauna of Lower Sloth Cave consists of at least 37 discernible taxa—(Table 1). The following list summarizes where specimens of these taxa were recovered during the excavations.

CLASS MAMMALIA

ORDER INSECTIVORA

Family Soricidae

Sorex cinereus (Kerr)—Masked Shrew

Material: Left mandible with I_1-M_2 (TTU-P-8485); left mandible with M_1(TTU-P-8486).

Discussion: The closest modern occurrence of *S. cinereus* is in the mountains of northern New Mexico, a distance of approximately 480 km (Hall and Kelson, 1959). Specimens from Lower Sloth Cave agree closely with a modern specimen (MALB-2684) from San Miguel County, New Mexico that is deposited in the collections of the Museum of Arid Lands Biology, the University of Texas at El Paso.

Sorex cinereus has previously been reported from late Wisconsinan sediments in Upper Sloth Cave, in the southern Guadalupe Mountains of Culberson County, Texas by Logan (1975) and by Logan and Black (1979), where it was the most abundant shrew in the deposits.

In New Mexico, masked shrews seem to be restricted to hydrosere communities, usually above 3,465 m (Findley; *et al.,* 1975). The elevation of Lower Sloth Cave is approximately 2000 m. This indicated former depression of life zones agrees with the interpretation by Van Devender, *et al.,* (1979a;b) based on plant macrofossils and pollen profiles taken from Upper Sloth Cave, Lower Sloth Cave, Dust Cave, and Williams Cave, all from the southern tip of the Guadalupe Mountains.

The presence of this species in the deposit is an indicator of more mesic conditions than presently occur in the southern Guadalupe Mountains.

Sorex vagrans (Baird)—Vagrant Shrew

Material: Left mandible with M_1 (TTU-P-8487); left mandible with M_{1-2} (TTU-P-8488); right mandible with U_2-M_1 (TTU-P-8489); right mandible with M_{1-2} (TTU-P-8490); left mandible with M_2 (TTU-P-8491).

Discussion: *S. vagrans* presently occurs within 160 km of Upper Sloth Cave, in the Sacramento Mountains of Lincoln and Otero counties, New Mexico (Findley; *et al.,* 1975).

The vagrant shrew is more common in hydrosere communities and less common within montane forests, with hydrosere communities of grasses and sedges seeming to be an important feature to this species (Findley, 1955).

The presence of *Sorex vagrans* in the fauna is an indicator of more mesic conditions than presently occur in the southern Guadalupe Mountains.

Cryptotis parva (Say)—Least Shrew

Material: Right mandible with U_1-M_1 (TTU-P-8492); right mandible with I_1-M_3 (TTU-P-8494).

Discussion: *Cryptotis parva* has previously been reported from Upper Sloth Cave, Culberson County, Texas, with an associated radiocarbon date of 11,760 ± 610 YBP (Logan, 1975; Logan and Black, 1979) and Dry Cave, Eddy County, New Mexico by Harris, *et al.,* (1973) and Harris (1970a; 1979), associated with a radiocarbon date of 10,730 ± 150 YBP.

The specimens of *C. parva* from Lower Sloth Cave are the second reported occurrence of this species from the Trans-Pecos of Texas. These records indicate a former range extension of over 320 km to the southwest of its present known range.

Graham (1976) characterizes *C. parva* as a 'deciduous' species to show its eastern affinities. However, it occurs primarily in grasslands, with occasional individuals being found beneath logs and in leaf litter in forested areas (Davis, 1974).

The presence of this species is an indicator of a more mesic climate than occurs in the area today.

Notiosorex crawfordi (Coues)—Desert Shrew

Material: Four left mandibles with I_1-M_3 (TTU-P-846-8464); two right mandibles with I_1-M_3 (TTU-P-8465, 8470); two right mandibles with I_1-M_1 (TTU-P-8473-8474); two right mandibles with M^{1-2} (TTU-P-8475-8476); left mandible with U_2-M_3 (TTU-P-8466); right mandible with U_2-M_3 (TTU-P-8467); left mandible with U_2-M_2 (TTU-P-8472); right maxilla with I-U^3 (TTU-P-8477); right maxilla with I^1-M^1 (TTU-P-8478); left maxilla with I^1-U^3 (TTU-P-8479); left maxilla with U^2-M^3 (TTU-P-8480); right maxilla with U^2-M^3 (TTU-P-848); right maxilla with U^2-M^3 (TTU-P-848); left maxilla with M^{2-3} (TTU-P-8483); right maxilla with M^2 (TTU-P-8484).

Discussion: The desert shrew is known from widely scattered localities in southwestern United States and western Mexico (Hall and Kelson, 1959). This strew does not seem to be restricted to any particular habitat (Davis, 1974). Although no desert shrews have been reported taken from Culberson County, Texas, specimens have been taken from Jeff Davis County, which adjoins it on the south (Davis, 1974) and from Eddy County, New Mexico, which adjoins it on the north (Findley, *et al.,* 1975).

Fossil specimens of *N. crawfordi* have previously been reported from the following localities in the southern Guadalupe Mountains: Dry Cave, Eddy County, New Mexico (Harris, 1970b); Pratt Cave, Culberson County, Texas (Lundelius, 1979); Upper Sloth Cave, Culberson County, Texas (Logan and Black, 1979); and Muskox Cave, Eddy County, New Mexico (Logan, 1981).

ORDER CHIROPTERA

Family Vespertilionidae

Myotis sp.—Mouse-eared Bat

Material: Numerous fragmentary and/or edentulous mandibles from throughout the cave.

Discussion: Several species of small *Myotis* are found in the immediate vicinity of Lower Sloth Cave today. These small, western *Myotis* are extremely difficult, if not impossible, to identify on the basis of fragmentary material. The worldwide distribution of the genus makes it useless as a paleoclimatic indicator.

Myotis velifer (J. A. Allen)—Cave Myotis

Material: Skull with right P^3-M^1 and left P^4-M^2 (TTU-P-8413); fragmentary skull with right P^2-M^3 and left P^{3-4} (TTU-P-8414); rostrum with right and left P^4M^2 (TTU-P-8415); left mandible with P_4-M_3 (TTU-P-8416); right mandible with C, P_4-M_2 (TTU-P-8417); right mandible with M_{2-3} (TTU-P-8418); left mandible with M_{2-3} (TTU-P-8419); left mandible with M_3 (TTU-P-8420); right mandible with M_{1-2} (TTU-P-8421); left mandible with M_2 (TTU-P-8422); right mandible with M_{2-3} (TTU-P-8423); right mandible with M_{2-3} (TTU-P-8424).

Discussion: *M. velifer,* the Cave Myotis, is a common inhabitant of caves throughout southwestern United States and has been collected from McKittrick Canyon in Guadalupe Mountains National Park (Davis, 1974). These specimens do not differ significantly from a series of *M. velifer* from west Texas and New Mexico. *Myotis velifer* occurs in a wide variety of habitats.

Myotis thysanodes (Miller)—Fringed Myotis

Material: Skull with right and left P^4 and M^1 (TTU-P-8411), skull with right P^2, P^4M^3 and left P^4M^3 (TTU-P-8412).

Discussion: *M. thysanodes* is a western bat that enters Texas in the Trans-Pecos and has been collected in McKittrick Canyon in the Guadalupe Mountains, Culberson County (Davis, 1974). This species is commonly recorded from caves (Findley, *et al.,* 1975).

Myotis leibii (Audubon and Bachman)—Small-footed Myotis

Material: Partial skull with right P^4-M^2 and left P^4-M^3 (TTU-P-8425).

Discussion: *M. leibii* is a small *Myotis* with a relatively flattened skull and is most easily confused with *M. californicus;* which has a more globuse skull (Bogan, 1974). Bogan states that 'Rostral breadth as measured at the junction of M^1-M^2; 96% of *californicus* not exceeding 5.0 mm, and 92% of *leibii* equalling or exceeding 5.2 mm.' Bogan (1975) lists a maximum rostral breadth of 5.2 mm for *M. californicus*. Specimen TTU-P-8425 has a rostral breadth of 5.65 mm and is referred to *M. leibii* on this basis.

Findley, *et al.,* (1975) suggests that *M. leibii* is primarily a rock crevice of cave inhabiting bat in western United States. Davis (1974) states that *M. leibii* is 'restricted in Texas to the Trans-Pecos region. Recorded from Brewster, Culberson, and Jeff Davis counties.' *M. leibii* is found throughout much of the United States (Hall and Kelson, 1959) and is therefore not useful as a climatic indicator.

Eptesicus fuscus (Beauvois)—Big Brown Bat
Material: Right mandible with M_1 (TTU-P-8433), left mandible with P_4-M_2 (TTU-P-8434), right mandible with M_{2-3}(TTU-P-8435), edentulous left mandible (TTU-P-8436), left maxilla M^{1-3} (TTU-P-8437), left maxilla P^4 (TTU-P-8438).

Discussion: Some of the specimens of *E. fuscus* from Lower Sloth Cave are eight to ten percent larger than modern specimens from Texas and New Mexico, while others are very close in size to these modern specimens. The larger specimens are the size of *E.f. grandis,* described by Brown (1908). Guilday (1967) and Engels (1936) both documented substantial sexual dimorphism and clinal variation with regard to size within this species. Guilday (1967) has shown that *E.f. grandis* (Brown, 1908) cannot be adequately separated from the modern subspecies *E.f. fuscus.*

Plecotus townsendii (Cooper)—Townsend's Big-eared Bat
Material: Left mandible with M_{2-3} (TTU-P-8444); edentulous left mandible (TTU-P-8445); edentulous right mandible (TTU-P-8446).
Discussion: The above mentioned specimens do not differ significantly from recent specimens from Culberson County, Texas. Upper Sloth Cave, located approximately 250 m from Lower Sloth Cave, was the site of a nursery colony of approximately 50 *P. townsendii* from 20 July 1974 to 17 August 1974. *P. townsendii* was observed hibernating in both Upper and Lower Sloth Caves in 1974 and 1975.

Family Molossidae
Tadarida brasiliensis (Saussure)—Brazilian Freetail Bat
Material: Right P^4-M^2 (TTU-P-8441); right P^4-M^2 (TTU-P-8442); edentulous right mandible (TTU-P-8443).
Discussion: *Tadarida brasiliensis* is a relatively common bat in the southern Guadalupe Mountains. The largest colony is at Carlsbad Caverns, approximately 40 km north of Lower Sloth Cave. The specimens from Lower Sloth Cave closely agree in both size and morphology with a series from Eddy County, New Mexico and Culberson County, Texas.

ORDER EDENTATA

Family Megatheriidae
Nothrotherium shastense Sinclair—Shasta Ground Sloth
Material: Fragments of dung balls (TTU-P-8428).
Discussion: No ground sloth dung was obtained from the 1974 excavations, although it was obtained from the working face of a previous excavation. This trench possibly was excavated by H. P. Mera in 1931; when he used Lower Sloth Cave for a campsite while excavating High Cave, now called Upper Sloth Cave (Mera, 1938). Samples of *N. shastense* dung from Lower Sloth Cave have been radiocarbon dated at 11,590 + 230 YBP (A-1519). This date agrees closely with radiocarbon dates from other North American sloth dung sites (Van Devender, *et al.,* 1979a;b). No bones of *N. shastense* have been found in Lower Sloth Cave, but the dung balls agree closely with specimens from Gypsum Cave, Nevada (Stock, 1931; Eames, 1930) and from Rampart Cave, Arizona (Wilson, 1942). *N. shastense* is one of two extinct mammals known from Lower Sloth Cave.

ORDER LAGOMORPHA

Family Leporidae
Sylvilagus sp.—Cottontail Rabbit
Material: Left mandible with P^3 (TTU-P-8439).
Discussion: *Sylvilagus auduboni* and *S. floridanus* both presently occur in the southern Guadalupe Mountains. In addition to these two species, *S. nuttallii* has been reported from Dry Cave, Eddy County, New Mexico (Harris, 1970b). No further identification of this specimen is possible on the basis of material present.

ORDER RODENTIA

Family Sciuridae
Sciurus sp.—Tree Squirrel
Material: Isolated left M^1 or M^2 (TTU-P-8512).
Discussion: Tree squirrels, which are commonly represented in many modern faunas, are relatively uncommon in the fossil record of the southwestern U.S. This is the first record of the genus *Sciurus* from the Guadalupe Mountains and the first fossil record of the genus from Trans-Pecos Texas. In neighboring New Mexico, tree squirrels have been reported from only three fossil localities: *Sciurus arizonensis* (cf) was reported from the Brown Sand Wedge Local Fauna, Roosevelt County, by Slaughter (1964); a squirrel 'the size of *Tamiasciurus hudsonicus*' from La Bajada Hill, Santa Fe County, was reported by Stearns (1942); and *Tamiasciurus hudsonicus* was reported from Muskox Cave, Eddy County by Logan (1981).

Modern populations of *S. niger* and *S. carolinensis* presently occur in eastern Texas (Davis, 1974); populations of *S. niger, S. arizonensis,* and *S. aberti* occur in New Mexico (Findley, *et al.,* 1975). This specimen most likely represents *S. aberti;* if we accept the paleobotanical reconstruction of the area proposed by Van Devender, *et al.,* (1977a;b). *Sciurus aberti* is an animal of coniferous or at least mixed coniferous forests; whereas the other species of *Sciurus* mentioned occur primarily in deciduous forests (Findley, *et al.,* 1975; Davis, 1974).

The presence of *Sciurus* sp. in the fauna is an indicator of more forested and more mesic conditions than occur in the Guadalupe Mountains today.

Tamiasciurus hudsonicus (Erxleben)—Red Squirrel
Material: Isolated left M^2 (TTU-P-8456); isolated left M^3 (TTU-P-8457); fragmentary left mandible with P_4-M_1 (TTU-P-8498).
Discussion: These specimens closely resemble a series of *Tamiasciurus hudsonicus* from northern New Mexico that are deposited in collections of the Division of Mammals, U.S. National Museum of Natural History.

T. hudsonicus presently occurs as near as the Sacramento Mountains of northern Otero County, New Mexico, but does not occur in the southern Guadalupe Mountains of Eddy County, New Mexico and Culberson County, Texas (Hall and Kelson, 1959). Findley, *et al.,* (1975) state that red squirrels are limited to mixed coniferous and spruce-fir forests. The presence of this species in the fauna gives considerable support to the proposed paleobotanical reconstruction of spruce-fir forest previously existing in the area (Van Devender, *et al.,* 1979a;b).

The presence of *T. hudsonicus* and spruce-fir forests in the area are both indicators of a more mesic and possibly cooler environment than occurs in the area today.

Marmota flaviventris (Audubon and Bachman)—Yellow-bellied Marmot
Material: Isolated right M^3 (TTU-P-8458); isolated left M_3 (TTU-P-8459); isolated left P^3 (TTU-P-8460).
Discussion: *Marmota flaviventris* is easily distinguished from *M. caligata* and *M. monax* by its smaller and less massive dentition (Howell, 1915). *M. monax,* which may have existed south and west of its present range during the late Pleistocene, is easily distinguished from *M. flaviventris* on gross dental morphology. The M_3 of *M. flaviventris* has a triangular outline when viewed from the occulusal surface; while the corresponding tooth in *M. monax* is much more quadranglar in outline. The M^3 of *M. monax* is nearly equal in length and width, while the M^3 of *M. flaviventris* is longer than wide (over 20% longer than wide in the Lower Sloth Cave specimen.)

The specimens from Lower Sloth Cave, referred to *M. flaviventris,* are indistinguishable from a series of late Pleistocene *M. flaviventris* from Rampart Cave, Arizona, housed in the collections of the Department of Paleobiology, National Museum of Natural History, Washington, D.C. A similar series of specimens, also from Rampart Cave, are referred to *M. flaviventris* cf. *engelhardti* by Wilson (1942).

M. flaviventris has previously been reported from the following localities in the southern Guadalupe Mountains: Upper Sloth Cave (Logan, 1975; and Logan and Black, 1979), Burnet Cave (Murray, 1957), Dry Cave (Harris, 1970a) and Muskox Cave (Logan, 1981). The present closest occurrence of *M. flaviventris* is in the mountains of northern New Mexico (Findley, *et al.,* 1975). Murray (1957) attributes the presence of *M. flaviventris* to the extension of the forests southward and to a lower elevation.

Harris and Findley (1964) point out that *M. flaviventris* occurs in other habitats, and its presence in conjunction with non-forest forms, as in Dry Cave (Harris, 1970a), may indicate an open habitat that now exists even farther to the north.

M. flaviventris is an indicator of more mesic conditions than presently occur in the southern Guadalupe Mountains. Harris (1970b) suggests that a minimum increase of two inches of winter precipitation would be necessary to provide enough green forage to carry this species through the spring dry season.

Cynomys cf. *gunnisoni* (Baird)—Gunnison's Prairie Dog
Material: Isolated right M^3 (TTU-P-8501).
Discussion: *Cynomys gunnisoni* may be differentiated from *C. ludovicianus* by its smaller and less specialized dentition (Pizzimenti, 1975). The specimen from Lower Sloth Cave agrees closely with a series of *C. gunnisoni* from New Mexico that are housed in the Recent mammal collections of the National Museum of Natural History.

Cynomys gunnisoni occurs in a variety of grassland situations in western and northern New Mexico, from low valleys to parks and meadows in montane forests up to at least 3050 m (Findley, *et al.*, 1975).

The presence of Gunnison's prairie dog, a primarily montane species, is an indicator of slightly more mesic conditions than presently occur in the southern Guadalupe Mountains.

Spermophilus spilosoma Bennet—Spotted Ground Squirrel
Material: Left maxilla with M^{1-2} (TTU-P-8440).
Discussion: This specimen is very close in size and morphology to recent material from Culberson and Jeff Davis counties. *S. spilosoma* was observed on the sandy flats west of Lower Sloth Cave during the period of excavation.

Spermophilus variegatus (Erxleben)—Rock Squirrel
Material: Isolated right P_4 (TTU-P-8430); isolated right M_3 (TTU-P-8431); left maxilla with P^4-M^3 (TTU-P-8432).
Discussion: The material referred to as this species does not differ significantly in size or morphology from modern specimens from Culberson County. *S. variegatus* has previously been reported from Williams Cave (Ayer, 1936), Pratt Cave (Lundelius, 1979), and Upper Sloth Cave (Logan and Black, 1979), all of which are located in Culberson County, Texas. Rock squirrels presently occur throughout Trans-Pecos Texas (Hall and Kelson, 1959; Davis, 1974).

Eutamias sp.—Chipmunk
Material: Right maxilla with P^4-M^1 (TTU-P-8426); isolated left P^4 (TTU-P-8429).
Discussion: Five species of *Eutamias* presently occur in New Mexico (Findley; *et al.*, 1975) but only *E. canipes* occurs in the Guadalupe Mountains of Texas (Davis, 1974: Genoways; *et al.*, 1979). On the basis of material preserved, these specimens cannot be referred to any specific species of *Eutamias* with certainty. *E. canipes* has been observed within 300 m of Lower Sloth Cave.

Family Geomyidae
cf. *Thomomys umbrinus* (Richardson)—Southern Pocket Gopher
Material: Maxilla with right M^1 (TTU-P-8508).
Discussion: *T. umbrinus* is the most abundant pocket gopher in the higher elevations of the Guadalupe Mountains (Davis, 1974). *Thomomys umbrinus* occupies valleys and mountain meadows of the southwestern United States, where it prefers a loamy soil, but it also occurs in sandy or rocky soil (Burt and Grossenheider, 1964). *T. umbrinus* is probably the pocket gopher that inhabits the small, grassy meadow directly above Lower Sloth Cave.

Family Muridae
Onychomys leucogastor (Wied)—Northern Grasshopper Mouse
Material: Right maxilla with M^2 (TTU-P-8450); right maxilla with M^{1-3} (TTU-P-8451).
Discussion: *O. leucogastor* is known from throughout Trans-Pecos Texas (Davis, 1974), where it is found primarily in areas of powdery or sandy soils. *O. leucogastor* also occurs in the sand and gravel flats southwest of Lower Sloth Cave.

Onychomys torridus (Coues)—Southern Grasshopper Mouse
Material: Right maxilla with M_{1-2} (TTU-P-8847); right maxilla with M_{2-3} (TTU-P-8448).
Discussion: *O. torridus* presently occurs in the sand and gravel flats southwest of Lower Sloth Cave. The distance to these flats, approximately 8 km, may explain the scarcity of this species in the fauna.

Neotoma sp.—Woodrat
Material: Numerous isolated teeth and fragmentary maxillae and mandibles from deposits throughout the cave.
Discussion: There is much variation in *Neotoma*, both at the individual and at the specific levels (Hall and Kelson, 1959), and certain individual specimens may be correctly placed systematically only with difficulty, even as to subgenus. This particular problem is substantially amplified when working with fragmentary dentitions, often making specific identifications sheer guesswork.

The vast majority of the fragmentary material is identified only to genus.

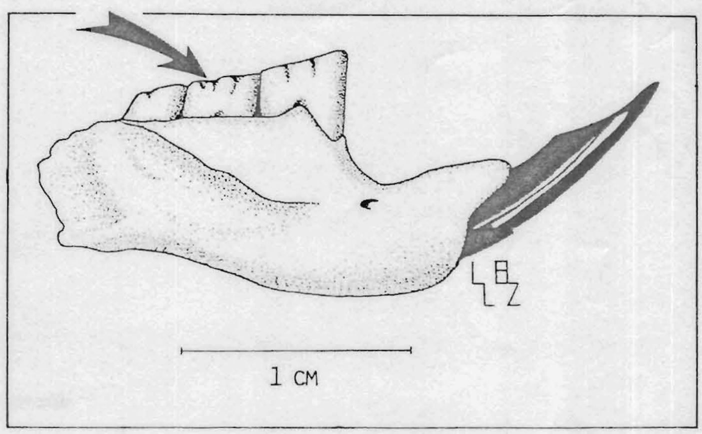
Neotoma mexicana (Baird)—Mexican Woodrat
Material: Three fragmentary right mandibles with M_1 (TTU-P-8520-8522), two fragmentary right mandibles with M_{1-2} (TTU-P-8523-8524), fragmentary left mandible with M_1 (TTU-P-8525), two fragmentary left mandibles with M_{1-2} (TTU-P-8526-8527).
Discussion: Three species of *Neotoma* presently occur sympatrically in the southern Guadalupe Mountains: *N. mexicana*, *N. albigula*, and *N. micropus* (Davis, 1974).

N. cinerea and *N. mexicana* were separated from *N. albigula* and *N. micropus* on the basis of dentine tracts on the antero-external side of the M_1 in the former two species. The dentine tracts on the M_1 extend from one-fourth to one-third the distance from the root to the crown of an unworn tooth, with the dentine tract on the M_2 being shorter.

N. cinerea was separated from *N. mexicana* on the presence of accessory cusps developed in the re-entrant angles on some *N. cinerea* teeth (Fig. 4). This condition was found on one or more teeth per specimen in five out of eight (62.5%) Recent specimens of *N. cinerea* examined. This condition was not observed in any of 33 Recent *N. mexicana* examined. A second condition found on worn teeth of *N. cinerea*, but not in *N. mexicana*, is the presence of enamel islands resulting from the isolation of the inner parts of the re-entrant folds due to wear (Lundelius, 1979).

Neotoma cinerea (Ord)—Bushy-tailed Woodrat
Material: Fragmentary right maxilla with M^{1-2} (TTU-P-8428), right mandible with I_1-M_3 (TTU-P-8429), isolated left M_1 (TTU-P-8430).

Figure 4. Labial view of the right mandible of *Neotoma cinerea*, showing the accessory cusp developed in the second re-entrant angle of the M_2.



Discussion: The methods used to identify *Neotoma cinerea* have previously been discussed in the account of *N. mexicana*.

N. Cinerea occupies a wide variety of habitats in a wide range of climatic conditions in western North America, from the cold winters of the Northern Rocky Mountains to the hot semi-arid summers of northern Arizona (Finley, 1958). *N. cinerea* has been reported from the summit of Pikes Peak, Colorado, at an elevation of 4297 m, in the Artic-Alpine Life-zone (Warren, 1942). The absence of this species from the Lower Sonoran Life-zone is an indication that high summer temperatures in an arid or semi-arid environment may be a limiting factor for this species (Finley 1958).

Finley, (1958) states that the unifying factor throughout the range of *N. cinerea* is the presence of vertical clefts in cliffs or other high rocks; with caves nearly as preferred as clefts. These areas are vastly preferred for denning areas for the Bushy-tailed Woodrat.

N. cinerea is no longer found in the Guadalupe Mountains, occurring no closer than the mountains of northern New Mexico (Findley; *et al.,* 1975). In the Guadalupe Mountains, fossil *Neotoma cinerea* have been recovered from Burnet Cave (Harris, 1979), Pratt Cave (Lundelius, 1979), Upper Sloth Cave (Logan and Black, 1979), and Muskox Cave (Logan, 1981).

The presence of this species is an indicator of less extreme summer temperatures and of a more mesic environment than presently occurs in the southern Guadalupe Mountains.

Neotoma albigula (Hartly)—White-throated Woodrat

Material: Four fragmentary right mandibles with M_1 (TTU-P-8510, 8513-8515), two fragmentary right mandibles with M_{1-2} (TTU-P-8517 and 8509), one fragmentary right mandible with M_{1-3} (TTU-P-8511), fragmentary left mandible with M_{1-2} (TTU-P-8518).

Discussion: The specific identification of *Neotoma* mandibles and teeth is difficult at best, due to the variation in dental morphology that occurs within any given species.

Dalquest, *et al.,* (1969) separated *N. micropus* from *N. albigula* on the basis of the width of the second lophid of the M_1, which in *N. albigula* was always less than 1.93 mm but in *N. micropus* was always more than 1.94 mm. Lundelius (1979) checked this character in 32 specimens of *N. albigula* from the Texas high plains and in 30 specimens of *N. micropus* from south Texas. He found that five specimens (16.7%) of *N. micropus* had the second lophids of the M_1 less than 1.94 mm in width, and three specimens of *N. albigula* (10.7%) had second lophids of the M^1 greater than 1.94 mm in width. Thus, this character is not infallible, and the possibility exists that some specimens may be assigned to the wrong species.

Neotoma micropus (Baird)—Southern Plains Woodrat

Materials: Fragmentary left mandible with M_{1-3} (TTU-P-8519).

Discussion: The criterion used to differentiate this species, as well as ecological preferences and habitat preferences for this species, have been discussed in the previous account of *N. albigula*. *N. micropus* presently occurs in the lowland desert shrub community within 5 km of Lower Sloth Cave.

Microtus mexicanus (Saussure)—Mexican Vole

Material: Three isolated left mandibles with M_1 (TTU-P-8431-8433), two right isolated M_1 (TTU-P-8434-8435), one right mandible with M_2 (TTU-P-8436).

Discussion: *Microtus mexicanus* presently occurs in the higher elevations of the southern Guadalupe Mountains, where it is most common in the grassy meadows (Genoways, *et al.,* 1979; Wilhelm, 1979; and August, *et al.,*(1979). Specimens from Lower Sloth Cave agree closely with modern specimens from the Guadalupe Mountains of Texas and New Mexico in both size and morphology.

The relative rarity of this taxon in the fauna may be partially explained by the fact that the Mexican vole is more diurnal than are most small mammals (Davis, 1974). The bone accumulations in Lower Sloth Cave are apparently the result of scat accumulation from small mammalian predators and pellet accumulation below owl roosts. These predators are primarily nocturnal or crepuscular, thus, the chances for these rodents to fall prey to these predators may be somewhat less than with most other small rodents.

The presence of this species does not necessarily indicate any change from present climatic conditions in the southern Guadalupe Mountains, although *M. mexicanus* does require more mesic conditions than presently occur in the immediate vicinity of Lower Sloth Cave.

Family Erethizontidae

Erethizon dorsatum (Linnaeus)—Porcupine

Material: Quills (TTU-P-8408-8409).

Discussion: The quills from Lower Sloth Cave differ in no way from the quills of Recent porcupines from the southern Guadalupe Mountains. The majority of the quills are of the red-brown color phase that is common in porcupines from many areas of the southwest today.

Porcupines occur in a wide variety of habitats and have been observed within 1 km of Lower Sloth Cave.

ORDER CARNIVORA

Family Canidae—*Canis* sp.

Material: Fragment of right humerus (TTU-P-8495).

Discussion: *Canis latrans* (Harris, 1970b, Hornedo, 1971). *Canis lupus* (Hornedo, 1971), and *Canis dirus* (Ayer,1936; Hornedo, 1971; and Logan, 1981) have all been reported from late Pleistocene deposits in the southern Guadalupe Mountains.

C. latrans may be ruled out on the basis of size, because TTU-P-8495 clearly belongs to a larger animal. However, this specimen is within the size range of both *C. lupus* and *C. dirus*. TTU-P-8495 is nearly identical to *C. lupus*, the only difference being in a greater development of the rugosity in the area defined by the pectoral ridge and the deltoid ridge in the Lower Sloth Cave specimen. This particular character varies greatly from individual to individual, generally increasing with age. When compared to the two available *C. dirus* specimens from Rancho La Brea, TTU-P-8495 is slightly smaller, but the size of the humerus is apparently not a valid criterion for separating these two species.

Family Procyonidae

cf. *Bassariscus astutus* (Lichtenstein)—Ringtail

Material: Atlas (TTU-P-8406) and isolated left P_2 (TTU-P-8502).

Discussion: *Bassariscus astutus* is an inhabitant of the more rocky areas of the southern Guadalupe Mountains, where it feeds on a wide variety of small mammals, birds, insects, and plants. The small carnivore scat found in the upper levels of trenches five and six was of the right size and texture to have been deposited by this species.

Family Mustelidae

Mustela frenata (Lichtenstein)—Long-tailed Weasel

Material: Isolated right M_3 (TTU-P-8497).

Discussion: Although *M. frenata* has not been taken from Guadalupe Mountains National Park in recent times (Genoways, *et al.,* 1979), it occurs widely throughout much of the United States and Mexico. It has been recorded from Culberson County, Texas (Davis, 1974).

Fossil Long-tailed Weasels have previously been reported from Upper Sloth Cave (Logan and Black, 1979) and Pratt Cave (Lundelius, 1979) within the boundaries of the Guadalupe Mountains National Park.

Spilogale gracilis (Merriam)—Western Spotted Skunk

Material: Left maxilla with M^{2-3} (TTU-P-8407).

Discussion: This specimen is referred to *S. gracilis* instead of *S. putorius* on purely geographic grounds. Lower Sloth Cave is located over 480 km southwest of the present known range of *S. putorius*, while *S. gracilis* has been collected from Culberson County, Texas (Davis, 1974). Spotted skunks are inhabitants of rocky and bushy areas (Findley, *et al.,* 1975) and are found throughout Trans-Pecos Texas (Davis, 1974).

ORDER ARTIODACTYLA

Family Cervidae

Odocoileus sp.—Deer

Material: Partial left navicular (TTU-P-8500).

Discussion: Both *O. heminous* and *O. virginianus* have been reported as fossils from Williams Cave (Ayer, 1936). Lundelius (1979) has also reported *Odocoileus* sp. from Pratt Cave. Both species of *Odocoileus* presently occur in the Guadalupe Mountains (Davis, 1974), with *O. virginianus* occupying the foothills and *O. heminous* being more common in the higher and more rugged country.

Due to the fragmentary nature of this specimen, specific identification is not possible.

Family Bovidae

Ovis canadensis Shaw—Bighorn Sheep

Material: Left horn sheath (TTU-P-8404); fragmentary left astragalus (TTU-P-8405).

Discussion: *O. canadensis* formerly occurred throughout Trans-Pecos Texas in suitable habitat (Davis,1974), but this native sheep has been extirpated from Texas. Bighorn sheep inhabit rough, rocky, mountainous terrain (Davis, 1974), making the southern Guadalupe Mountains ideal habitat. The presence of *O. canadensis* in the fauna gives no indication of climatic change.

Ovis canadensis catclawensis Hibbard and Wright—Pleistocene Bighorn Sheep

Material: Fragmentary right mandible with dP_2-M_1 (TTU-P-8496).

Discussion: *O. c. catclawensis* was originally described as *O. catclawensis* from Catclaw Cave, Mojave County, Arizona (Hibbard and Wright, 1956). Harris and Mundel (1974) argued convincingly that *O. catclawensis* should be recognized as a Pleistocene temporal sub-species of *Ovis canadensis*, not as a separate species.

O. c. catclawensis, the late Pleistocene bighorn sheep of western North America, is characterized by a larger size than modern *O. canadensis* (Hibbard and Wright, 1956; Stokes and Condie, 1961), closer to the size of *Ovis ammon* (Marco Polo Sheep) from Eurasia.

The dental morphologies of TTU-P-8496 and of USNM 14010, a modern *O. c. canadensis* from Montana, are nearly identical, with the exception of the large size difference (Table 2).

CONCLUSIONS

The mammalian fauna of Lower Sloth Cave spans the transition from late Wisconsinan to Recent time. Remains of extinct mammals make up 4.8% of the mammalian fauna, and extant, but extralimital, species make up an additional 21.4% of the faunal remains; thus, 26.2% of the 37 mammalian taxa recorded from Lower Sloth Cave no longer occur in the southern Guadalupe Mountains. The majority of these extralimital mammals presently occur within 100 km to 450 km of Lower Sloth Cave in the mountains of western and northern New Mexico; *Cryptotis parva* represents the only eastern influence in the fauna.

All extralimital species are indicators of conditions more mesic than the present environment of the Guadalupe Mountains. This transition from more mesic to the present xeric conditions is reflected by the distribution of the extirpated species within the trenches. Both species diversity and absolute numbers of more mesic-adapted taxa increased with depth. This is in keeping with the distribution of more mesic taxa found in Upper Sloth Cave (Logan and Black, 1979). Harris (1979b) suggests that a minimum increase of two inches of winter precipitation in the southern Guadalupe Mountains would be necessary for *Marmota flaviventris* to survive the period immediately after hibernation and before the spring rains.

The paleobotanical reconstruction of the area by Van Devender, *et al.* (1979a;b) corresponds closely with the present habitat preferences of the majority of the extralimital species. In the light of the available evidence, the best paleobotanical

Based on available mammalian and botanical evidence, the climate in the southern Guadalupe mountains at the end of the Pleistocene was probably very similar to the climate today in the southern Rocky Mountains of New Mexico and Colorado. Winter temperatures may have been more equitable, as suggested by Graham (1976), allowing the more boreal species to co-exist with the more desert-adapted species.

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Table 2. Comparative measurements in millimeters of the deciduous premolars of *Ovis canadensis*, *O. ammon*, *O. aries*, and TTU-P-8496 (*O. canadensis catclawensis* Hibbard and Wright).

	O. canadensis	*O. ammon*	*O. aries*	TTU-P-8496
Length dP_{2-4}	27.0-36.7 (N = 6) *31.3*	35.0-38.3 (N = 3) *36.5*	31.1-34.4 (N = 3) *33.1*	41.4 (N = 1
Length dP_2	4.8-6.2 (N = 6) *5.6*	7.0-7.6 (N = 2) *7.3*	5.3-6.8 (N = 3) *6.07*	6.7 (N = 1)
Width dP_2	2.9-4.3 (N = 6) *3.5*	4.7 (N = 1) *4.7*	3.6-4.2 (N = 3) *3.9*	3.9 (N = 1)
Length dP_3	7.8-10.3 (N = 6) *9.1*	9.7-10.9 (N = 3) *10.4*	8.2-10.1 (N = 3) *9.2*	11.6 (N = 1)
Width dP_3	4.9-6.0 (N = 6) *5.4*	5.0-5.4 (N = 3) *5.1*	5.3-6.1 (N = 3) *5.7*	6.2 (N = 1)
Length dP_4	15.0-21.3 (N = 6) *19.0*	19.1-21.1 (N = 3) *20.1*	17.8-19.4 (N = 3) *18.9*	24.4 (N = 1)
Width dP_4	6.8-8.3 (N = 6) *7.5*	8.4-8.5 (N = 3) *8.4*	6.9-8.1 (N = 3) *7.3*	8.6 (N = 1)

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