Vertebrate Paleontology of Texas Caves

by Rickard S. Toomey, III
Illinois State Museum, Research and Collection Center, 1011 E. Ash St. Springfield, IL 62703

INTRODUCTION

Vertebrate fossils from Texas caves have been studied for over 75 years. In that time few summary treatments of Texas caves and their fossil faunas have been published. The only reviews focusing specifically on Texas cave vertebrate paleontology sites were written over 20 years ago (Frank, 1964; Lundelius and Slaughter, 1971). Much work on cave sites in Texas has occurred since these reviews. Several other summaries contain information on vertebrate remains from both cave sites and open sites in Texas. These include Harris (1985), Holman (1969), Lundelius (1967), Graham (1987), Toomey (1993) and Toomey and others (1993).

The purpose of this summary is twofold. First, it will provide an introduction to the study of vertebrate remains in Texas caves. Second, it will briefly discuss some of the more important fossil vertebrate faunas from Texas caves. This is not intended to be a comprehensive treatment of either subject. Many caves from which bones have been recovered are not mentioned in this summary. In addition, all of the sites mentioned have vertebrate faunas with significant aspects that will not be discussed. Interested readers are encouraged to look in the primary descriptions of the faunas for more information. I also, have chosen not to summarize the Late Quaternary environmental changes which can be derived from the cave faunas, although, in some places I have mentioned specific interpretations of individual taxa or sites.

HISTORY OF CAVE WORK

The caves of Central Texas have long been important because of the fossil vertebrate remains found in many of them. To my knowledge, the earliest scientific collection of bones from a Central Texas cave was made in 1915 by D.V. Schuchardt. This material was reported by Sellards (1919) and more extensively by Hay (1920). Hay identified the cave as Bulverde Cave; it was later renamed Friesenhahn Cave, the name by which it is known today (Evans, 1961).

After this, little or no cave paleontology took place in Central Texas until the summers of 1949 and 1951, when a field party from the Texas Memorial Museum Vertebrate Paleontology Laboratory (TMM) conducted extensive excavations at Friesenhahn Cave. These excavations were reported by Evans (1961), and the material collected during this period was discussed in many important scientific studies (see discussion of Friesenhahn Cave below).

Another hiatus ended in the late 1950s when Dr. Ernest L. Lundelius, Jr. joined the faculty of Geological Sciences at the University of Texas. Since then he and his graduate students have built a strong collection of vertebrate fossils from Central Texas caves. During this latest period, Dr. Walter W. Dalquest and his students at Midwestern State University also greatly improved our knowledge of Central Texas cave faunas.

The caves of Trans-Pecos Texas have also had a long history of work. By the 1930s a group of caves in the Guadalupe Mountains was already referred to as the High or Upper Sloth Caves (Howard, 1932).

A field party from the University Museum, Philadelphia, and the Academy of Natural Sciences, Philadelphia, excavated in Williams Cave in 1934 and 1935 (Van Devender et al., 1977). Between the 1930s and the early 1960s very little cave paleontology appears to have been done in the caves of Trans-Pecos Texas. Since that time a variety of workers have

Toomey, R. S., III. 1994. Vertebrate paleontology of Texas caves. Pp. 51–68, *in* The Caves and Karst of Texas
(W. R. Elliott and G. Veni, *eds.*). National Speleological Society, Huntsville, Alabama. 252 pp.

#	Cave	County	Major Reference(s)
1	Barton Road Shelter	Travis	Lundelius (1967), Graham (1987)
2	Bering Sinkhole	Kerr	Bement (1991)
3	Brooks Cave	Culberson	Jackson (1937)
4	Caldwell Ranch Site 1 (sink)	Culberson	Jackson (1937)
5	**Cave Without A Name**	Kendall	Lundelius (1967), Holman (1969)
6	Cinnabar Mine	Brewster	Harris (1985), Ray and Wilson (1979)
7	Clamp Cave	San Saba	Lundelius (1967)
8	**Cueva Quebrada**	Val Verde	Lundelius (1984)
9	Dust Cave	Culberson	Harris (1985)
10	Felton Cave	Sutton	Lundelius (1967), Graham (1987)
11	Fern Cave	Val Verde	Lundelius (1967)
12	**Fowlkes Cave**	Culberson	Dalquest and Stangl (1984a), Dalquest and Stangl (1986), Parmley (1988b)
13	**Friesenhahn Cave**	Bexar	Graham (1976)
14	**Fyllan-Kitchen Door**	Travis	Taylor (1982), Holman and Winkler (1987)
15	**Hall's Cave**	Kerr	Toomey (1993)
16	Honey Creek Cave	Comal-Kendall	Veni (1994)
17	**Inner Space (Laubach) Cavern**	Williamson	Lundelius (1985), Slaughter (1966)
18	**Longhorn Cavern**	Burnet	Semken (1961)
9	**Lower Sloth Cave**	Culberson	Logan (1977, 1983)
19	**Miller's Cave**	Llano	Patton (1963), Holman (1966)
20	**Pratt Cave**	Culberson	Lundelius (1979), Gehlbach and Holman (1974), McKusick (1983)
21	Rattlesnake Cavern	Kinney	Semken (1967)
22	**Schulze Cave**	Edwards	Dalquest *et al.* (1969), Parmley (1986)
23	Scorpion Cave	Medina	Highley *et al*. (1978)
24	Seminole Sink	Val Verde	Rosenberg (1985)
9	**Upper Sloth Cave**	Culberson	Logan and Black (1979)
9	**Williams Cave**	Culberson	VanDevender *et al.* (1977)
25	Zesch Cave	Mason	Lundelius (1967), Graham (1987)

Table 1. Texas caves known to contain significant vertebrate faunas. Caves with names in bold are discussed below. The numbers in the first column refer to the map in Figure 1.

excavated cave sites in the region. The summary of faunas by Harris (1985) is an important work concerning sites in this area.

In the more than 75 years of study of vertebrate remains from Texas cave, bones have been recovered from probably hundreds of caves. However, few caves are well-studied. Table 1 lists caves that contain the most significant vertebrate faunas. Figure 1 is a map showing the general location of each of the caves listed in Table 1.

WHAT IS FOUND IN CAVES

The remains of an incredible variety of vertebrates occur in Texas caves. In most cases these remains consist of bones of one or more individual animals (often hundreds or thousands of individuals in the case of significant sites). However, sometimes fossilized fecal material such as coprolites (fossilized feces), fossilized owl pellets, or guano are also found. Remains of fish, amphibians, reptiles, birds and mammals are all found in Texas cave deposits. In general, the remains of mammals have received the most scientific attention, although several important papers have been written on amphibian, reptilian and avian remains from Texas caves.

Vertebrate bones are found in many different contexts in caves. The context in which bones occur is important for evaluating the importance and significance of finds. The contexts generally can be divided into two categories: surface occurrences and occurrences within sediments.

Surface occurrences, as the name suggests, are those in which the bones are not buried by sediment. Examples of this type of occurrence include bone found unburied on the cave floor, bone found in cave streams,

Toomey, R. S., III. 1994. Vertebrate paleontology of Texas caves. Pp. 51–68, *in* The Caves and Karst of Texas (W. R. Elliott and G. Veni, *eds.*). National Speleological Society, Huntsville, Alabama. 252 pp.

and bone found on ledges. Although vertebrate remains found on the surface can be of paleontological importance, they are often difficult to evaluate. The bones may represent an animal that recently died in the cave or may be much older. An additional complication is that all of the surface material in a single cave may not be the same age; a raccoon skeleton from two years ago may be mixed in with a 10,000 year old raccoon skeleton. Surface occurrences may also represent material that had been buried but has eroded out. This is especially common in the case of bone found in cave streams.

The Honey Creek Cave system is perhaps the most intriguing Texas cave, with bone only known from surface contexts. Bones are frequently recovered from stream passages in the cave. These bones are usually extensively water-worn and are found lying in and along the streams. Extinct species are commonly recovered, including *Equus* (horse), *Camelops* (an extinct camel), *Mammut americanum* (American mastodon), *Tapirus* (extinct tapir), and *Canis dirus* (dire wolf); however, saw cut cow (*Bos taurus*) bones are sometimes found in the same collections with the bones of extinct taxa. If an in-place source of the Pleistocene bones found in the stream passages is located and studied, Honey Creek Cave will probably join the ranks of caves with highly significant vertebrate remains.

The occurrence of bone within sediment includes a great range of possible settings. Some of the more common bone occurences include the following: talus cones or talus piles associated with entrances, cave fluvial deposits (deposits made by cave streams), guano, burial by colluvial material washed into the cave by sheet wash, and encasement in speleothem deposits. Caves are often very complex depositional settings; often, more than one type of context can occur in a single deposit. It is frequently difficult to sort out how and when sedimentary units formed. In spite of this, bones within sediments are generally more important than are surface occurrences. The reason is that bones covered by sediments are easier to separate by age. This is especially important when using the bones to study the changes in animals and environment over time.

AGE OF MATERIAL

With the exception of bone from one cave system, all of the well-studied bone from Texas caves appears to been deposited during the last 40,000 years. In fact, very few sites in the area contain material older than about 20,000 years old. The one important exception is the Fyllan-Kitchen Door cave system. The sediments and bone in this system were deposited between 1.8 million years ago and 750,000 years ago (see discussion of Fyllan-Kitchen Door Cave system below).

Many of the caves with important Late Pleistocene and Holocene deposits have been dated using the radiocarbon method. In many cases this method has provided dates that are thought to be accurate. However, in some cases the radiocarbon ages on a site are in conflict with other information from that site or other sites. In these cases it is important to carefully evaluate the reliability of both the radiocarbon dates and the other evidence.

HOW ANIMAL REMAINS GET INTO CAVES

Vertebrate remains in caves usually come from four sources: 1) animals that lived and died in the cave, 2) animals that lived outside the cave but died in the cave, 3) animals whose remains washed into the cave, and 4) animals that were brought into the cave by other animals and humans (see for example Sutcliffe, 1970; Andrews, 1990). Each of these sources is complex and, in most caves, all four sources are represented. Much of the difference among caves faunas lies in the differing balances of these sources.

Animals who lived and died in a cave are frequently found in cave deposits. Many types of vertebrates live in or occasionally frequent caves. In Texas caves, salamanders, frogs, cave swallows, owls, bats, rodents (especially woodrats), and carnivores (notably raccoons, ringtails and skunks) would be common cave residents that might be found in fossil deposits. In addition, large carnivores, such as bears and *Homotherium* (scimitar cat) probably utilized Texas caves in the past. The large number of the extinct *Platygonus compressus* (flat-headed peccary) skeletons of all ages found in some cave sites suggests to some authors that they may also have denned in caves (Slaughter, 1966).

Animals who usually live outside of a cave, but die within it, can be an important source of remains. The most obvious case in which these are important is a cave that acts as natural trap. In a natural trap surface-dwelling animals enter or fall into the cave and are unable to escape. These animals then starve or they are killed by predators that blunder in after them. Natural trapping of this sort does not appear to be a major source of bone in Texas caves (Lundelius and Slaughter, 1971). The abundance and importance of remains of vertebrates that die outside a cave and subsequently wash into a cave from outside varies with many factors. The two most critical are probably the entrance geometry and distance of the deposit from the entrance.

This mode of accumulation is probably not a major factor in most Texas caves (Lundelius and Slaughter, 1971). However, in the case of deposits in entrance talus cones, this can be an important source of bone.

Bone brought in by other animals is probably the most common way in which bone gets into Texas caves. A number of types of animals bring animal carcasses, parts of carcasses, and/or bones into a cave. The most obvious groups are carnivores and scavengers. Animals from these groups would bring animals into the cave in at least one of two ways. First, they can bring in carcasses to eat or to feed young. Second, having eaten vertebrates elsewhere, they might excrete them within the cave. Mammalian carnivores and raptors both are common sources of vertebrate remains in caves (for example, Andrews, 1990). Rodents, such as *Neotoma* (woodrats) (Van Devender, *et al*., 1991) and *Erethizon* (porcupines) also habitually collect small bones and inhabit caves. Humans also may collect remains for food, for ritual purposes or for use in making artifacts. These remains may be left in the cave.

Raptor (probably owl) pellet remains probably are the single most significant source of small animal bones deposited in Texas caves. Owls eat most small vertebrates whole but cannot digest bone, teeth, hair, and scales. They rid themselves of these nondigestible materials by regurgitating them as pellets (see for example Andrews, 1990). Raptor roosts, which are often located in caves and cave entrances, are usually littered with these pellets and with bone derived from them.

Another important source of bone in Texas caves is the remains of mammalian carnivore meals. Small carnivores, such as coyotes, bobcats, skunks, weasels and raccoons, may drag the remains of rodents and rabbits into caves. Larger carnivores such as modern *Ursus americanus* (black bear), *Felis concolor* (cougar), and *Panthera onca* (jaguar); and extinct *Homotherium serum* (scimitar cat), *Arctodus simus* (short-faced bear), *Panthera leo atrox* (American lion), and *Canis dirus* (dire wolf) may have brought the remains of larger animals such as *Odocoileus* (deer), *Equus* (horse) and *Bison* (bison) and *Mammuthus* (mammoth) into caves. Humans also bring carcasses and bones into caves. Reasons that people would bring carcasses or bone into a cave include for uses as food, for ceremonial purposes, or for use in making artifacts. See Turpin's chapter in this volume for a more thorough discussion of human utilization of caves.

WHY VERTEBRATE FOSSILS FROM CAVES ARE IMPORTANT

The fossil vertebrate remains from Texas caves are important for many reasons. They are used to reconstruct past animal communities, to reconstruct changing environments and climates, to study the anatomy of extinct and extant animals, and to infer the behavior of extinct animals. At least four species and one subspecies of fossil vertebrate have been described based on material from Texas caves. In addition, fossil material from Texas caves has been used to educate and inform many people in displays in museums and at caves.

The most common scientific study of vertebrate material from Texas caves involves the use of the fossils to reconstruct past communities, environments and climates. This is done in several ways. The most straightforward way is to use the occurrences of animals to reconstruct their changing geographic ranges. The past geographic ranges, combined with data on the animal's modern range and environmental preferences, is then used to determine past environments in an area. A second way cave faunas are used is to look at the changing abundance of various animals in a deposit. This is more complicated than looking at the simple presence-absence data used for reconstructing past ranges. The reason for the complication is that more factors determine the abundance of an animal in a deposit than influence its presence. A third way to use vertebrates to reconstruct past environments is to examine changing morphology, size and chemistry of animals in deposits. Graham and Semken (1976) studied changing *Blarina* (short-tailed shrew) size as related to environmental change. Toomey (in prep.) used *Myotis velifer* size changes from Central Texas caves to reconstruct changing environments. Toomey and others (1992) used isotopic ratios in bone from Hall's Cave for reconstructing vegetation characteristics. A fourth way of using fauna to reconstruct environments involves looking at the character of the whole fauna.

The study of the anatomy of extinct and extant vertebrates from cave sites is a necessary prerequisite for identifying animals and using them to reconstruct environments. However, cave faunas often preserve animal remains well enough that this study can itself be the subject of research. A few examples of this from Texas caves include studies of *Homotherium* (scimitar cat) (Meade, 1961; Rawn-Schatzinger, 1992), and of *Mylohyus nasutus* (long-nosed peccary) (Lundelius, 1960) based on material from Friesenhahn Cave. One distinctive type of anatomical study of fossil remains is the description of a new taxon. As mentioned above, four species and one subspecies have been described based on materials from Texas caves. These are discussed individually in the summaries of the cave faunas.

Toomey, R. S., III. 1994. Vertebrate paleontology of Texas caves. Pp. 51–68, *in* The Caves and Karst of Texas (W. R. Elliott and G. Veni, *eds.*). National Speleological Society, Huntsville, Alabama. 252 pp.

Sometimes fossil material provides insight into the behavior of the animals that are found in the caves. Central Texas sites provide excellent examples. The reconstruction of *Homotherium* diet and denning behavior based on the remains from Friesenhahn Cave (Evans, 1961; Graham, 1976; Rawn-Schatzinger, 1992) is a classic example.

SUMMARY OF TEXAS CAVES WITH IMPORTANT VERTEBRATE REMAINS

Cave Without A Name

Cave Without A Name is a show cave located near Boerne in Kendall County (see description and map in Texas Show Caves in this volume). The deposits and fauna of this cave are largely unstudied. Lundelius (1967) published a list of mammals from the site and Holman (1969) reported the reptiles and amphibians. The deposit consists of a red clay unit at the bottom of the vertical sinkhole entrance. The deposit probably represents sediment and animals that fell into the sinkhole entrance. Lundelius (1992, personal communication) thinks that the bone-bearing clay was deposited over a limited time period. Materials from this cave are reposited at the TMM.

The deposit contains a number of taxa that no longer occur in Central Texas, most notably *Mustela erminea* (ermine), *Synaptomys cooperi* (bog lemming), *Microtus pennsylvanicus* (meadow vole), *Sorex cinereus* (masked shrew), *Tamias striatus* (eastern chipmunk), *Blarina brevicauda* (short-tailed shrew), *Lampropeltis calligaster* (prairie kingsnake), and *Eumeces tetragrammus* (four-lined skink). These are interpreted as indicating generally cooler and moister conditions (Lundelius, 1967). The fauna does not have a modern analog. That is, pairs of animals like *Sorex cinereus* with *Myotis velifer* (cave myotis) and *Notiosorex crawfordi* (desert shrew) with *Synaptomys cooperi* do not co-occur today but apparently did so in the past

The age of the deposit is problematic. A radiocarbon determination of 10,900 ± 190 radiocarbon years before present (RCYBP) is based on bone (Tx-250) from the deposit (Lundelius, 1967). Tamers and Pearson (1965) found that dates on bone run with preparation procedures of the time tended to be younger than associated dates on charcoal. For this reason Pearson and others (1966) indicated that the bone date could only be thought of as a minimum age. Correlation with the faunal changes at Hall's Cave supports the idea that the radiocarbon age is at least 2,000 years too young.

Cueva Quebrada

Cueva Quebrada is a paleontological and archeological site in Val Verde County. The mammalian fauna and stratigraphy of the site was reported by Lundelius (1984). It was excavated as part of salvage work associated with the construction of the Amistad Reservoir. This site provides one of the few well-dated Pleistocene faunas. The well-studied, bone-bearing deposits of this cave have been radiocarbon dated to around 12,000 to 14,000 RCYBP Three radiocarbon dates have been obtained 12,280 ± 170 (Tx-879, charcoal), 13,920 ± 210 (Tx-880, wood) and 14,300 ± 220 (Tx-881, wood). Materials from this cave are reposited at the TMM.

The Cueva Quebrada fauna contains only one extant taxon that does not occur in the area today— *Baiomys taylori* (pygmy mouse), which may indicate slightly moister conditions than today. The deposit contains a number of extinct taxa including *Arctodus simus* (short-faced bear), *Equus* cf *E. scotti* (extinct large horse), *Equus francisci* (extinct small stilt-legged horse), cf. *Camelops* sp. (extinct camel), *Navajoceros fricki* (mountain deer), and *Stockoceros* sp. (extinct pronghorn). The limited paleoenvironmentally sensitive fauna suggests the presence of " open country, grasslands or savanna on the uplands" (Lundelius, 1984, p. 461).

Much of the bone from Cueva Quebrada is extensively burned (hence the cave's name). The high degree of bone breakage and extensive burning indicate that humans were an important agent in the deposition of the bones at the site (Lundelius, 1984; Turpin, this volume).

Fowlkes Cave

Fowlkes Cave is located in the Apache Mountains in Culberson County. Two depositional units in the site contain bone, and each was excavated and analyzed as a single faunal unit. The mammalian fauna of the Late Pleistocene unit was reported by Dalquest and Stangl (1984a); the frogs and toad of that unit were reported by Parmley (1988b). The mammals of the "Recent silts," thought to be Holocene in age, were reported by Dalquest and Stangl (1986). Neither of the units has been dated radiometrically. The material from the cave is reposited in the Vertebrate Paleontology Collection at Midwestern State University.

The faunas from the two units are extremely different. Of the 32 mammals from the " Recent silts," only two, *Peromyscus difficilis* (rock mouse) and *Reithrodontomys fulvescens* (fulvous harvest mouse), are not found near the cave today. Dalquest and Stangl (1986) attribute the absence to drying or increased temperatures since deposition of the silts. Of the 42 mammals in the Pleistocene deposit, two are extinct, *Mylohyus* sp. (long-nosed peccary) and *Capromeryx* cf. *C. furcifer* (extinct pronghorn). At least eight species are found in this deposit outside of their modern range. The fauna contains a number of taxa, which today occur only in areas significantly cooler and moister than the modern conditions near the cave. Some of these include *Sorex palustris* (water shrew), *Sorex vagrans* (vagrant shrew), *Marmota flaviventris* (yellow-bellied marmot), and *Eutamis cinericollis* (gray-collared chipmunk). Like many other Pleistocene faunas, this one has no modern analog.

Friesenhahn Cave

As noted above, Friesenhahn Cave was probably the first Texas cave from which bones came to the attention of the scientific community. It is a one- room cave (Figure 2) located near Cibolo Creek in northern Bexar County. This site was extensively studied by Graham (1976, 1987). Its deposits contain one of the most diverse vertebrate faunas in Central Texas, with over 40 mammalian taxa. The birds, reptiles and amphibians from this site are largely unstudied. However, Milstead (1956) described *Geochelone wilsoni* (a tortoise) and, Mecham (1958) described a subspecies of Woodhouse's toad (*Bufo woodhousei bexarensis*) from the Friesenhahn Cave deposit. Bone-bearing deposits at the cave cluster into three temporal units. These units are 17,000-19,000, 8,000-9,000, and <300 years old. Materials from this cave are reposited at the TMM and the United States National Museum.

In addition to containing one of the more diverse faunas in Central Texas, Friesenhahn Cave contains one of the most spectacular faunas (Graham, 1976). During the Late Pleistocene, the site was a den for the extinct *Homotherium serum* (scimitar cat) (Figure 3). The site contains the remains of several individuals, including young cubs. The cave also contains the remains of many animals that are thought to have been brought into the cave as *Homotherium* prey. The most notable prey item is juvenile *Mammuthus* cf. *M. columbi* (Columbian mammoth), found in abundance in the deposit.

The oldest deposits (17,000-19,000 years old) contain a diverse, extinct megafaunal assemblage but generally lack abundant remains of small taxa. This is the deposit that contains the material associated with *Homotherium* denning. The assemblage contains a mixture of grassland taxa (i.e. *Equus* sp. (horse), *Bison* sp. (bison), *Platygonus compressus* (flat-headed peccary), and *Mammuthus* sp. (mammoth) and woodland taxa (i.e. *Tapirus veroensis* (extinct tapir), *Mylohyus nasutus* (long-nosed peccary), and *Mammut americanum* (American mastodon). Graham (1987) interpreted this mixture as indicating a grassland environment with extensive riparian woodlands. The Late Pleistocene units also contain a large number of fossil turtle shells of both the extinct *Geochelone wilsoni* and the extant *Terrapene carolina* (eastern box turtle). Graham (pers. comm., 1994) interpreted the cave as a turtle hibernaculum.

The younger two units lack extinct taxa and contain abundant and diverse microfaunal assemblages (Graham, 1976, 1987). The early Holocene units (8,000-9,000 years old) contain a diverse assemblage with many taxa no longer found in Central Texas. The fauna has no modern analog, in that it contains animals, such as *Synaptomys cooperi* (bog lemming) and *Notiosorex crawfordi* (desert shrew), that are not found together in modern environments. Other extralimital taxa, in addition to *Synaptomys*, include *Blarina carolinensis* (southern short-tailed shrew) and *Tamias striatus* (eastern chipmunk). The Black Fill (<300 years old), which may be of historic age (Graham 1987), contains a small mammal fauna essentially identical to themodern fauna; however, it does contain *Microtus* sp. (vole), which is extralimital (Graham, 1987).

Fyllan-Kitchen Door Cave System

Fyllan-Kitchen Door Cave System is sediment- filled and located in northwestern Austin, Travis County. The red-clay-filled passages of this paleo-cave were intersected by limestone quarrying. Although much of the cave system has undoubtedly been removed by the quarrying, remnant-filled passages are still visible in the walls of the quarry. Taylor (1982) summarized the mammalian fauna of Fyllan Cave and, Holman and Winkler (1987) discussed its amphibians and reptiles. Materials from this cave system are reposited at the TMM with Fyllan Cave and the Kitchen Door site as separate sites.

The Fyllan-Kitchen Door system is one of Texas' more interesting caves from a paleontological standpoint. Unlike the other cave deposits discussed here, the sediments in the Fyllan-Kitchen Door system were not deposited in the Late Pleistocene or Holocene. The deposition of these sediments occurred in the Early to Middle Pleistocene between approximately 750,000 and 1.8 million years ago. Taylor (1982) indicates that faunal correlation suggest an age in the younger portion of this range.

Approximately 40 species of mammals were recovered from the cave system. Most of these belong to genera that are extant; however, both extinct genera and species are known from the deposit. One extinct species of vole has been described from Fyllan Cave, *Atopomys texensis* (Patton, 1965); the species is also present in the Kitchen Door fauna (Winkler and Grady, 1987). The deposit contains at least 24 species of amphibians and reptiles. It is one of the largest mid-Pleistocene herpetofaunas known from the United States. Interestingly, the fauna is strikingly similar to Late Pleistocene and Holocene faunas of the region. This suggests that the ecotonal nature of the environment of east-central Texas was established by at least one million years before present.

Guadalupe Mountains Sloth Caves

Four caves in the Guadalupe Mountains in northwestern Culberson County are interesting because they contain the dung of *Nothrotherium shastense* (an extinct ground sloth) in addition to bones. These four caves are Dust Cave, Lower Sloth Cave, Upper Sloth Cave, and Williams Cave. These sites have been studied by a variety of workers. Important references for these caves are as follows: Dust Cave (Van Devender and others, 1977), (Harris, 1985); Lower Sloth Cave (Logan, 1977, 1983), (Harris, 1985); Upper Sloth Cave (Logan and Black, 1979), (Harri, 1985); and Williams Cave (Van Devender and others, 1977), (Harris, 1985). Radiocarbon dates have been obtained on each of the sites (Van Devender *et al*., 1977): Dust Cave at 13,000 ± 730, Lower Sloth Cave at 11,590 ± 230, Upper Sloth Cave at 11,760 ± 610 and 13,060 ± 280, and Williams Cave at 12,040 ± 210 RCYBP Material from all four caves is reposited in the Vertebrate Paleontology collection of The Museum, Texas Tech University.

Nothrotherium shastense is the only extinct taxon that has been definitely identified from Dust Cave, Lower Sloth Cave and Upper Sloth Cave. Williams Cave contains the extinct species *Canis* cf. *C. dirus* (dire wolf) and *Equus conversidens* (Mexican horse) in addition to *Nothrotherium*. Several extralimital taxa are found in one or more of the caves. Some of these include *Opheodrys vernalis* (smooth green snake), *Cryptotis parva* (least shrew), *Sorex cinereus* (masked shrew), *Marmota flaviventris* (yellow-bellied marmot), *Tamiasciurus hudsonicus* (red squirrel), and *Neotoma cinerea* (brushy-tailed woodrat) (Harris, 1985). These extralimital taxa indicate cooler and/or moister climatic conditions.

Hall’s Cave (Klein Cave)

Hall’s Cave, located near Mountain Home in Kerr County, is a one-room cave (Figure 4) containing at least 3.7 m of well-stratified, bone-bearing sediments. Toomey (1993) and Toomey et al. (1993) summarize the deposits and fauna as well as paleoenvironmental reconstructions based on them. A fauna from this cave was also published under the name “Klein Cave” by Fedducia (1972), Parmley (1988a), and Roth (1972). The cave was known as “Old Morris Cave” in the records of the Texas Speleological Survey. The material from Hall’s Cave is reposited at the TMM. The Klein Cave material is reposited in the Vertebrate Paleontology Collection at Midwestern State University.

The sediments in Hall’s Cave were deposited fairly continuously over at least the last 17,000 years. The cave contains the best sequence of latest Pleistocene through Holocene sediments and bone of any Texas cave, and it certainly ranks as one of the excellent sequences in the United States. The temporal control is unrivaled with over 100 radiocarbon determinations from the sequence (Stafford and Toomey, in prep).

The fauna includes the remains of over 60 species of mammals and over 50 species of fish, amphibians, reptiles and birds. The nonmammalian remains from the Hall’s Cave work are largely unstudied. The fauna contains at least 12 extinct taxa (one turtle, three birds and eight mammals) and at least 22 taxa that no longer occur in the area. The faunal remains are dominated by small animals (smaller than a juvenile jackrabbit). Most of the material is probably from owl pellets or small carnivore scat. The faunal changes at the cave provide important information for reconstructing the changing temperature, moisture, seasonality, vegetation and soil conditions in Central Texas over the last 17,000 years (Toomey, 1993; Toomey *et al*., 1993).

Inner Space Cavern (Laubach Cave)

Inner Space Cavern, formerly known as Laubach Cave, is a show cave near Georgetown in Williamson County (see cave description in “Texas Show Caves” in this volume and the map near the back). Lundelius (1985) published a faunal list and a preliminary discussion of the site. In addition, Slaughter (1966) discussed the fauna from one cone of the site. However, the site is in need of an in-depth study. The fossils were deposited in five talus cones, called “bone sinks” by many, representing four or five closed entrances. These cones are designated Laubach I - V. Each of the cones appaently was open at a different time during the Late

Pleistocene. All of the talus cones produced megafauna but two have also produced important microfaunas. Materials from this cave are reposited at the TMM and at the Shuler Museum of Paleontology, Southern Methodist University. The material at the Shuler Museum is from Laubach II (Lundelius, 1993, personal communication).

Radiocarbon determinations are associated with three of the talus cone deposits. Laubach I is dated to 15,850 ± 500 RCYBP (Tx-1137), Laubach II to 13,970 ± 310 RCYBP (Tx-1138), and Laubach III dates to 23,230 ± 490 RCYBP (Tx-1139) (Lundelius, 1985). All of these determinations are on bone, and must be carefully evaluated. The dates are potentially minimum dates; however, these dates are not in conflict with any faunal or depositional evidence and may be accurate. Lundelius (1985) lists 1 amphibian, 9 reptiles and 35 mammals from the 5 sites; however most of these taxa are from Laubach II and Laubach III, the only two cones from which extensive faunas have been recovered. The other three cones have small faunas consisting of four to six taxa. All but Laubach IV contain extinct mammals (Lundelius, 1985).

The fauna from Laubach III is one of the more intriguing in Central Texas—it contains a wide range of both small and large mammals. The deposit contains extralimital species, such as *Blarina carolinensis* (southern short-tailed shrew), which indicate moister conditions. However, unlike most Pleistocene deposits in Texas, there are no species that indicate cooler conditions. In fact, the deposit contains many animals that have modern relatives associated with subtropical climates, including *Didelphis marsupialis* (opossum), *Tadarida brasiliensis* (Brazilian free-tailed bat), *Panthera onca* (jaguar), *Tremarctos floridanus* (spectacled bear), *Dasypus bellus* (beautiful armadillo), and *Glyptotherium floridanus* (glyptodon). The fauna appears to have been deposited under a generally warm climate (inter-stadial or interglacial).

The fauna from Laubach II is similar to the Late Pleistocene faunas from other Central Texas sites, such as Friesenhahn Cave, Miller's Cave and Hall's Cave. Two species of *Myotis* were described based on the material from this cone: *Myotis magnamolaris* and *Myotis rectidentis* (Choate and Hall, 1967). "*Myotis magnamolaris*" is the same species as *Myotis velifer* (Dorsey, 1977; Dalquest and Stangl, 1984b; Toomey, 1993). The validity and affinities of *Myotis rectidentis* has not been adequately studied.

Of the vertebrate remains from Laubach Cave, the large collection of *Platygonus compressus* (flat-headed peccary) may be the material for which the cave is most noted (Slaughter, 1966). The collection contains peccaries of all ontogenetic stages from very young to very old, with the bones of juveniles quite common (Lundelius, 1995). Lundelius (1985) speculated that the peccaries might have been dragged into the cave by jaguars (which are also found in the deposit). Another possibility is that the peccaries denned in the cave entrance.

Longhorn Cavern

Longhorn Cavern, an extensive show cave in Burnet County, was studied by Semken (1961) (see cave description in "Texas Show Caves" in this volume and the map near the back). The cave contains three bone-bearing units: red fill, "longhorn breccia", and black fill. The temporal placement and extent of the units is unknown, due to a lack of radiocarbon determinations. The black fill contains *Mus musculus*, indicating an historic age. Both the red fill and longhorn breccia contain extinct fauna and are presumably of latest Pleistocene age. The stratigraphic relationship between the longhorn breccia and the other units is unknown; Semken (1961) postulated that the longhorn breccia was material reworked from the red fill. Materials from this cave are reposited at the TMM.

The fauna of the Pleistocene red fill, like the Pleistocene fill of Friesenhahn Cave, suggests an Austroriparian type forest with grassland (Semken, 1961). The fauna from the black fill is nearly identical to that of the area today. The differences, such as the presence of pocket gophers (*Geomys* sp.) in the black fill, are attributed to soil loss in the area due to historic overgrazing (Semken, 1961).

Miller's Cave

Miller's Cave is located in Llano County. The mammalian fauna was studied by Patton (1963) and the amphibians and reptiles by Holman (1966). This cave contains two temporally discrete faunules: the Late Pleistocene travertine faunule and the Late Holocene brown clay faunule. Materials from this cave are reposited at the TMM.

The travertine faunule contains one extinct taxon and a variety of extralimital ones. The extinct taxon is *Dasypus bellus* (beautiful armadillo), an animal similar to the modern nine-banded armadillo (*D. novemcinctus*) but somewhat larger. Extralimital taxa include *Synaptomys cooperi* (bog lemming), *Blarina brevicauda* (short-tailed shrew), *Ondatra zibethicus* (muskrat), and *Lampropeltis calligaster* (prairie kingsnake). This faunule has a radiocarbon determination of 7200 ± 300 RCYBP (Tx-326).

Toomey, R. S., III. 1994. Vertebrate paleontology of Texas caves. Pp. 51–68, *in* The Caves and Karst of Texas
(W. R. Elliott and G. Veni, *eds.*). National Speleological Society, Huntsville, Alabama. 252 pp.

However, this determination, like the one from Cave Without A Name, is on bone and should be considered a minimum age (Tamers and Pearson, 1965; Graham and Mead, 1987). Both *Dasypus bellus* and *Synaptomys* are present; each suggests an age of greater than approximately 11,000 years ago. The fauna of the travertine faunule generally indicates moist, grassland conditions (Patton, 1963; Graham, 1987).

With the exception of *Microtus ochrogaster* (prairie vole) the brown clay faunule contains only species found in the area today. Charcoal from the brown clay provides an age of 3008 ± 410 RCYBP (SM-596). Patton (1963) concluded that the fauna indicates that modern climatic and environmental conditions had been reached in Central Texas by 3,000 RCYBP.

Pratt Cave

Pratt Cave, located in the Guadalupe Mountains in Culberson County, contains abundant archeological and paleontological materials. It is a dry cave in which perishable materials like plant remains are well preserved. For this reason, feather fragments are found in the deposits as well as bone. The mammalian remains were analyzed by Lundelius (1979), the avian bones by McKusick (1983), the amphibians and reptile remains by Gehlbach and Holman (1974), and the feathers by Messinger (1983). Most of the bone at the site is thought to have come from owl pellet remains (Lundelius, 1979; McKusick, 1983). Materials from this cave system are reposited at the TMM and in the Michigan State University Vertebrate Paleontology Collection.

The deposit is interpreted to be late Holocene in age. This age assignment is supported by five radiocarbon dates between 1,000 and 3,000years ago (Lundelius, 1979). However, the presence of the extinct *Geococcyx californianus conklingi* (Conkling's roadrunner) suggests that older material may also be present (McKusick, 1983).

The mammalian fauna of the Pratt Cave deposits contains at least 35 taxa. Of these, *Marmota flaviventris* (yellow-bellied marmot) and *Neotoma cinerea* (brushy-tailed woodrat) are not found in the area of the cave today and suggest more mesic conditions in McKittrick Canyon during deposition of the sediments. The presence of *Geomys bursarius* (plains pocket gopher), which is absent today, suggests recent soil loss in the region (Lundelius, 1979). The herpetofauna contains eighteen species, all of which are found in the region today. However, there is some evidence of moister conditions during deposition of the lower levels and of dry conditions at the top of the deposit (Gehlbach and Holman, 1974). The avifauna is dominated by birds that occur in the area.

Schulze Cave

Schulze Cave, located in eastern Edwards County, is one of the more important cave sites in terms of a small vertebrate remains in Central Texas. The fossiliferous deposits are associated with the pit type entrance. Dalquest et al. (1969) analyzed the mammalian fauna in detail. The reptiles and amphibians were analyzed by Parmley (1986). The deposits contain an abundant and diverse megafauna and microfauna. The analyzed deposits consist of two apparently Pleistocene units (C1 and C2) and one Holocene unit (B). Materials from this cave are reposited in the Vertebrate Paleontology collection at Midwestern State University.

Units C-1 and C-2 contain similar faunas and were treated by Dalquest and others (1969) as essentially one unit. They contain two extinct species (*Mammuthus columbi* and *Equus* sp.) and numerous extralimital taxa, including *Sorex cinereus* (masked shrew), *Sorex vagrans* (vagrant shrew), *Blarina carolinensis* (southern short-tailed shrew), *Tamias striatus* (eastern chipmunk), *Synaptomys cooperi* (southern bog lemming) and *Oryzomys palustris* (marsh rice rat). Like other faunas, this one has no modern analog. However, the way in which it is nonanalogous is fundamentally different than other Central Texas sites. It contains widely nonsympatric species pairs (species that occur only far from each other), i.e. *Sorex vagrans* with *Tamias striatus* and *Oryzomys palustris* with *Lepus townsendi*. Other Central Texas sites contain only marginally nonsympatric species pairs (of species that do not co-occur but whose ranges are close to one another), such as *Notiosorex crawfordi* with *Synaptomys cooperi* and *Myotis velifer* with *Sorex cinereus*.

The timing of the deposition of Units C-1 and C-2 is extremely problematic. Unit C-1 is associated with a radiocarbon determination of 9680 ± 700 RCYBP (SMU-807), and Unit C-2 with a date of 9310 ± 300 RCYBP (I-2741A). Both of these are older determinations derived from analysis of bone and are suspect. The presence of *Equus* sp. in both units suggests that the deposits may be older than the radiocarbon assays indicate (see Mead and Meltzer, 1984 for discussion of timing of *Equus* extinction). In addition, correlation of faunal changes with those at Hall's Cave, suggests an age several thousand years older than the determinations. The safest course of action is to regard the Schulze Cave radiocarbon determinations from unit C as minimum ages.

Unit B contains an essentially modern fauna for the area. A radiocarbon determination of 3826 ± 208 RCYBP (SM-893) on charcoal provides a reasonable estimate for the timing of deposition of Unit B. It is interpreted as indicating that modern conditions prevailed by the time of deposition of Unit B (Dalquest *et al*., 1969).

SUMMARY AND CONCLUSIONS

Caves provide many of the most important sites for the study of late Quaternary vertebrate remains. The FAUNMAP database (compiled under the directorship of E. L. Lundelius and R. W. Graham and housed at the Illinois State Museum) lists the most significant Quaternary mammal faunas of the coterminous United States. Of the almost 3,000 sites listed in the database approximately 11.5 percent (341 sites) are from caves and another 10.5 percent (309 sites) are from rock shelters. Texas caves make an important contribution to this total. The 29 Texas cave faunas in the database (sites listed in Table 1 except Honey Creek Cave, Bering Sinkhole and the Fyllan-Kitchen Door system) represent approximately 8.5 percent of all cave faunas in the database. Cave faunas are even more significant within Texas. Of the 143 FAUNMAP listed sites in Texas, 20.3 percent (29) are from caves and an additional 17.5 percent (25) are from rock shelters.

In addition to the number of cave vertebrate paleontology sites, Texas is famous for the quality of its sites. The sites have provided some of the most important Quaternary vertebrate paleontology finds in the southern United States. The incredible *Homotherium*, *Mylohyus* and turtle material from Friesenhahn Cave, the peccary "herd" from Laubach Cave, and the virtually complete small animal-bearing stratigraphic sequence from Hall's Cave are just a few of the examples of the important aspects of Texas cave sites discussed above.

The vertebrate paleontology work in Texas caves is far from finished. Work by Dalquest, Graham, Lundelius, Stangl, Toomey, and many others continues to further our knowledge of the material recovered from Texas caves. More analysis can be pursued at all of the caves discussed in this report. All of the caves listed in Table 1 have produced vertebrate remains which indicate that they deserve further study. The Laubach Cave and Zesch Cave deposits are notably in need of in-depth analysis. In addition, continued cave exploration in Texas constantly brings new sites to the attention of scientists. It is important to be aware of potentially significant vertebrate remains within caves and to address them when designing exploration, conservation, and management plans for caves. If the significance of vertebrate remains in a cave is not known, it is important to have a qualifed scientist evaluate their significance (or to have someone who is qualified do so) in order to have the necessary information for planning. Fossil vertebrate remains are an important, irreplaceable resource found in Texas caves.

ACKNOWLEDGMENTS

I would like to thank numerous people for their help on this project. First and foremost, I would like to thank Drs. E. L. Lundelius and R. W Graham for their support and advice throughout my work on Central Texas caves. I would also like to thank them for allowing me to use the statistics from the FAUNMAP database (supported by the NSF). I also extend my thanks to Laura Froehlich for information on the Honey Creek Cave fauna. Mona Colburn provided editorial assistance. Viola Rawn-Schatzinger kindly allowed me to reproduce the *Homotherium* skull figure. I also thank Bill Elliott and George Veni for the opportunity to write this summary.

LITERATURE CITED

Andrews, P. 1990. *Owls, Caves and Fossils* Chicago: Univ. Chicago Press. 231pp.

Bement, L. C. 1991. Hunter-Gatherer Mortuary Practices During the Archaic in Central Texas. Unpubl. Ph.D. dissertation: Univ. Texas, Austin. 216 pp.

Choate, J. R and Hall, E.R. 1967. Two new species of bats, genus *Myotis* from a Pleistocene deposit in Texas, *Amer. Midl. Nat.* 78: 531-534.

Dalquest, W. W., E. Roth, and F. Judd. 1969. The mammalian fauna of Schulze Cave, Edwards County, Texas, *Bull. Florida State Mus.* 13: 205-276.

Dalquest, W. W., and Stangl, Jr.. 1986. Post-Pleistocene mammals of the Apache Mountains, Culberson County, Texas, with comments on zoogeography of the Trans-Pecos front range, *Occ. Pap. Mus., Texas Tech Univ.* 104: 1-35.

Dalquest, W. W., and F. B. Stangl, Jr. 1984a. Late Pleistocene and early Recent mammals from Fowlkes Cave, southern Culberson County, Texas *in* H. H. Genoways and M. R. Dawson (eds.), *Contributions in Quaternary Vertebrate Paleontology: a Volume in Memorial to John E. Guilday—Carnegie Mus. Nat. Hist. Spec. Publ. 8*. pp 432-455.

Dalquest, W. W., and Stangl, Jr. F.B. 1984b. The taxonomic status of *Myotis magnamolaris*, Choate and Hall, *J. Mamm.* 65: 485-486.

Dorsey, S. L. 1977. A reevaluation of two new species of fossil bats from Inner Space Caverns, *Texas. J. Sci.*. 28: 103-108.

Evans, G. L. 1961. The Friesenhahn Cave, *Bull. Texas Mem. Mus.* 2: 3-22.

Feduccia, J. A. 1972. The Pleistocene avifauna of Klein Cave, Kerr County, Texas, *Southw. Nat.* 17: 295-296.

Frank, R. M. 1965. Vertebrate paleontology of Texas caves.

Texas Speleol. Surv., 2(3):43 pp.
Gehlbach, F. R. and Holman, J. A. 1974. Paleoecology of amphibians and reptiles from Pratt Cave, Guadalupe Mountains National Park, Texas, *Southw. Nat.*. 19: 191-198.
Graham, R. W. 1976. *Pleistocene and Holocene Mammals, Taphonomy, and Paleoecology of the Friesenhahn Cave Local Fauna, Bexar County, Texas.* Unpublished Ph.D. dissertation: Univ. Texas, Austin.
Graham, R. W. 1987. Late Quaternary mammalian faunas and paleoenvironments of the southwestern plains of the United States, *in* R. W. Graham, H. A. Semken, and M. A. Graham (eds.), *Late Quaternary Mammalian Biogeography and Environments of the Great Plains and Prairies, Illinois State Mus. Sci. Pap.* 22: 24-86.
Graham, R. W. and J. I. Mead. 1987. Environmental fluctuations and evolution of mammalian faunas during the last deglaciation in North America *in*(W.F. Ruddiman and H.E. Wright, Jr., (eds.) *The Geology of North America v. K-3: North America and adjacent oceans during the last deglaciation* Boulder, CO: Geological Society of America. pp. 371-402.
Graham, R. W. and Semken, Jr., H. A. 1976. Paleoecological significance of the short-tailed shrew (*Blarina*) with a systematic discussion of *Blarina ozarkensis,J. Mamm.* 57: 433-449.
Harris, A. H. 1985. *Late Pleistocene Vertebrate Paleoecology of the West*. Austin, TX: University of Texas Press. 293 pp.
Hay, O. P. 1920. Descriptions of some Pleistocene vertebrates found in the United States, *Proceedings of the United States National Museum* 58: 83-146.
Highley, L., C. Graves, C. Land, and G. Judson. 1978. Archeological investigations at Scorpion Cave (41ME7) Medina County, Texas, *Bull. Texas Archeol. Soc.* 49: 139-194.
Holman, J. A. 1966. The Pleistocene herpetofauna of Miller's Cave, Texas panhandle, *Texas Journal of Science* 28: 372-377.
Holman, J. A. 1969. The Pleistocene amphibians and reptiles of Texas, *Publications of the Museum, Michigan State University, Biological Series* 4(5): 161-192.
Holman, J. A. and A. J. Winkler. 1987. A mid-Pleistocene (Irvingtonian) herpetofauna from a cave in southcentral Texas, *The Pearce-Sellards Series, Texas Memorial Museum* 44: 1-17.
Howard, E. B. 1932. Caves along the slopes of the Guadalupe Mountains. *Bull. Texas Archeol. Paleo. Soc.* 4:7-9.
Jackson, A. T. 1937. Exploration of certain sites in Culberson County, Texas, *Bulletin of the Texas Archeological Society* 19: 146-.
Logan, L. E. 1977. The Paleoclimatic Implications of the Avian and Mammalian Fauna of Lower Sloth Cave, Guadalupe Mountains, Texas. Upubl. M.S.. thesis: Texas Tech Univ., 72pp.
Logan, L. E. 1983. Paleoecological implications of the mammalian fauna of Lower Sloth Cave, Guadalupe Mountains, Texas, *Bulletin of the National Speleological Society* 45: 3-11.
Logan, L. E. and Black, C. C. 1979. The Quaternary vertebrate fauna of Upper Sloth Cave, Guadalupe Mountains National Park, Texas. *in* H.H. Genoways and R.J. Baker (eds.), *Biological Investigations in the Guadalupe Mountains, National Park, Texas, National Park Service, Proc. Trans. Series*. 4: 141-158.
Lundelius, Jr., E. L. 1960. Mylohyus nasutus: Long-nosed peccary of the Texas Pleistocene, *Bull. Texas Mem. Mus.* 1: 1-40.
Lundelius, Jr., E. L. 1967. Late-Pleistocene and Holocene faunal history of central Texas *in* P.S. Martin and H.E. Wright ,Jr. (eds.), *Pleistocene Extinctions* New Haven: Yale Univ. Press pp. 287-319.
Lundelius, Jr., E. L. 1979. Post-Pleistocene mammals from Pratt Cave and their environmental significance. *in* H.H. Genoways and R.J. Baker (eds.), *Biological Investigations in the Guadalupe Mountains, National Park, Texas, National Park Service, Proc. Trans. Series*. 4: 239-258.
Lundelius, Jr., E. L. 1984. A Late Pleistocene mammalian fauna from Cueva Quebrada, Val Verde County, Texas *in* H. H. Genoways and M. R. Dawson (eds.), *Contributions in Quaternary Vertebrate Paleontology: a Volume in Memorial to John E. Guilday—Carnegie Mus. Nat. Hist., Spec. Publ. 8*. pp 456-481.
Lundelius, Jr., E. L. 1985. Pleistocene Vertebrates from Laubach Cave *in* Woodruff, Jr., C.M., F. Snyder, L. De La Garza, and R. M. Slade, Jr., (coordinators), *Edwards Aquifer-Northern Segment, Austin Geol. Soc. Guidebook* 8: 41-45.
Lundelius, Jr., E. L. and Slaughter, B. H. 1971. Vertebrate Remains in Texas Caves IN (E.L Lundelius, Jr. and B.H. Slaughter, eds.) *Natural History of Texas Caves* Dallas: Gulf Natural History pp. 15-27.
McKusick, C. R. 1983. Avian remains, Pratt Cave, McKittrick Canyon, New Mexico. *The Artifact, El Paso Archaeol. Soc.*. 21(1-4): 171-182.
Mead, J. I. and Meltzer, D. J. 1984. North American Late Quaternary Extinctions and the Radiocarbon Record. *in* P. S. Martin and R. G. Klein (eds.), *Quaternary Extinctions: A Prehistoric Revolution* Tucson: University of Arizona Press. pp 440-450.
Meade, G. E.. 1961. The saber-toothed cat, *Dinobastis serus, Bull. Texas Mem. Mus.*. 2: 23-60.
Mecham, J. S. 1958. Some Pleistocene amphibians and reptiles from Friesenhahn Cave, Texas, *Southw. Nat.*. 3: 17-27.
Messinger, N. G. 1983. An analysis of feathers from Pratt Cave. *The Artifact, El Paso Archaeol. Soc.* 21(1-4): 167-170.
Milstead, W. W. 1956. Fossil turtles of Friesenhahn Cave, Texas, with the description of a new species of *Testudo, Copeia* 1956 (3): 162-171.
Parmley, D. 1988a. Middle Holoene Herpetofauna of Klein Cave, Kerr County, Texas, *Southw. Nat.* 33: 378-382.
Parmley, D. 1988b. Late Pleistocene anurans from Fowlkes Cave, Culberson County, Texas, *Texas. J. Sci.* 40: 357-358.
Parmley, D. 1986. Herpetofauna of the Rancholabrean Schulze Cave Local Fauna of Texas, *J. Herpetology* 20: 1-10.
Patton, T. H. 1963. Fossil vertebrates from Miller's Cave Llano County, Texas, *Bull. Texas Mem.* 7: 1-41.
Patton, T. H. 1965. A new genus of fossil microtine from Texas, *J. Mamm.* 46: 466-471.Pearson, Jr., F. J., E. M. Davis, and M. A. Tamers. 1966. University of Texas radiocarbon dates IV, *Radiocarbon* 8: 453-466.
Rawn-Schatzinger, V. 1992. The scimitar cat Homotherium serum Cope, *Illinois State Mus., Report of Investigations* 47: 1-80.
Ray, C. E and Wilwon, D. E. 1979. Evidence for Macrotus californicus from Terlingua, Texas, *Occ. Pap., Mus. Texas Tech Univ.* 57: 1-10.
Rosenberg, R. 1985. Appendix I. The mammalian fauna of Seminole Sink IN (S.A. Turpin, compiler) Seminole Sink: excavation of a vertical shaft tomb, Val Verde County, Texas, *Texas Archeol. Surv.,*

Univ. Texas, Austin, Research Report 93: 197-210.
Roth, E. L. 1972. Late Pleistocene mammals from Klein Cave, Kerr County, Texas, *Texas. J. Sci.* 24: 75-84.
Sellards, E. H. 1919. The geology and mineral resources of Bexar County, *Univ. Texas Bull.* 1932
Semken, Jr., H. A. 1961. Fossil vertebrates from Longhorn Cavern Burnet County, Texas, *Texas. J. Sci.* 13: 290- 310.
Semken, Jr., H. A. 1967. Mammalian remains from Rattlesnake Cave, Kinney County, Texas, *The Pearce-Sellards Series, Texas Mem. Mus.* 7: 1-11.
Slaughter, B. H. 1966. *Platygonus compressus* and associated fauna from the Laubach Cave of Texas, *Amer. Midl. Nat.* 75: 475-494.
Sutcliffe, A. J. 1970. A section of an imaginary bone cave, *Studies Speleol.* 2: 79-80.
Tamers, M., and F .J. Pearson, Jr. 1965. Validity of radiocarbon dates on bone, *Nature* 208: 1053-1055.
Taylor, A. J. 1982. *The Mammalian Fauna from the Mid-Irvingtonian Fyllan Cave Local Fauna, Travis County, Texas.* Unpublished M.A. thesis: Univ. Texas, Austin. 106pp.
Toomey, III, R. S. 1993. Late Pleistocene and Holocene Faunaland Environmental Changes at Hall's Cave, Kerr County, Texas. Unpubl. Ph.D. dissertation: Univ. Texas, Austin. 561pp.
Toomey, III, R. S., Blum, M.D., and S. Valastro, Jr. 1993. LateQuaternary climates and environments of the Edwards Plateau, Texas, *Global and Planetary Change* 7: 299-320.
Toomey, III, R. S., J. A. Huebner, and T. W. Boutton. 1992. Stable carbon isotope ratios of *Equus* sp. and *Bison antiquus* from the Late Pleistocene deposits at Hall's Cave, Kerr County, Texas, *Current Res. in the Pleistocene* 9
Van Devender, T.R., P. S. Martin, A. M. Phillips, III, and W. G. Spaulding. 1977. Late Pleistocene biotic communities from the Guadalupe Mountains, Culberson County, Texas. *in* R.H. Wauer and D.H. Riskind (eds.), Transactions of the symposium on the biological resources of the Chihuahua Desert Region, United States and Mexico. *National Park Service, Proc. Trans. Series*. 3: 107-113.
Van Devender, T. R., A. M. Rea,and W. E. Hall. 1991. Faunal analysis of Late Quaternary vertebrates from Organ Pipe Cactus National Monument, southwestern Arizona, *Southw. Nat.* 36: 94-106.
Veni, G. 1994. Geomorphology, hydrogeology, geochemistry, and evolution of the karstic Lower Glen Rose Aquifer, south-central Texas. Unpubl. Ph.D. diss., Penn. State Univ., 721 pp. + xxvi.
Winkler, A. J. and F. Grady. 1987. The middle Pleistocene rodent *Atopomys* (Cricetidae: Arvicolinae) from the eastern and south-central United States, *J. Vert. Paleo.*10: 484-490

This chapter reprinted with permission from The National Speleological Society..