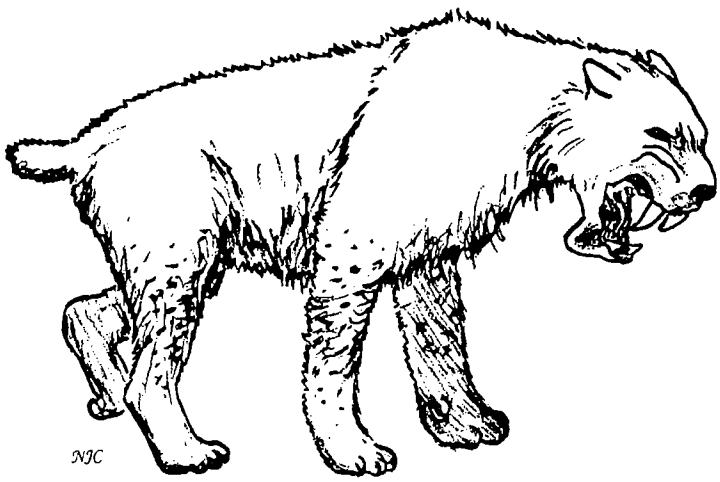
OKLAHOMA GEOLOGICAL SURVEY
Charles J. Mankin, *Director*

BULLETIN 147

ISSN 0078-4389

A Synopsis of the Pleistocene Vertebrates of Oklahoma

Kent S. Smith
Richard L. Cifelli



The University of Oklahoma
Norman
2000

OKLAHOMA GEOLOGICAL SURVEY

CHARLES J. MANKIN, *Director*

SURVEY STAFF

JAMES H. ANDERSON, *Cartographic Drafting Tech III*
RICHARD D. ANDREWS, *Geologist III*
LARRY T. AUSTIN, *Core and Sample Library Assistant*
BETTY D. BELLIS, *Word-Processing Operator II/ Technical Typist*
MITZI G. BLACKMON, *Clerk-Typist I*
RAYMON L. BROWN, *Geophysicist III*
RUTH E. BROWN, *Assistant to the Director*
JOCK A. CAMPBELL, *Geologist IV*
BRIAN J. CARDOTT, *Geologist IV*
JAMES R. CHAPLIN, *Geologist IV*
JANISE L. COLEMAN, *Office Assistant IV*
CHRISTIE L. COOPER, *Editor*
TAMMIE K. CREEL, *Secretary II*
CHARLES R. DYER III, *Drilling Technician*
WALTER C. ESRY, *Manager, Core and Sample Library*
ROBERT O. FAY, *Geologist IV*
AMIE R. FRIEND, *Research Specialist I*
T. WAYNE FURR, *Manager of Cartography*
PATRONALIA M. HANLEY-BROWN, *Chemist*
PRISCILLA A. JOHNSON, *Office Assistant IV*
JAMES W. KING, *Research Specialist I*
JAMES E. LAWSON, JR., *Chief Geophysicist*
KENNETH V. LUZA, *Geologist IV*
TODD S. MCCORMICK, *Electronic Technician*
MICHAEL J. MERCER, *Manager, Log Library*
RICHARD G. MURRAY, *Copy Center Operator*
SUE M. PALMER, *Office Assistant II*
TRACY PEETERS, *Associate Editor*
DAVID O. PENNINGTON, *Operations Assistant II*
CONNIE G. SMITH, *Promotion and Information Specialist*
PAUL E. SMITH, *Supervisor, Offset Press Copy Center*
THOMAS M. STANLEY, *Geologist II*
LLOYD N. START, *Assistant Drilling Technician*
JOYCE A. STIEHLER, *Chief Clerk*
MICHELLE J. SUMMERS, *Technical Project Coordinator*
NEIL H. SUNESON, *Geologist IV*
JANE L. WEBER, *Coordinator, Departmental Computer Systems*
STEPHEN J. WEBER, *Chief Chemist*

Cover Illustration

A restoration of the scimitar cat found in western Oklahoma by a local rancher, Mr. Painter. In 1893, Mr. Painter presented the fossil remains of the scimitar cat to E. D. Cope, who described it as a new taxon of scimitar cat. The scimitar cat was named *Dinobastis serus* (= *Homotherium serum*) by Cope (1893). Based on fossil remains, compared to the more common saber-tooth cat (*Smilodon*), the scimitar cat possessed shorter, flattened, and recurved sabers. In addition, the scimitar cat had shorter hind limbs and longer front limbs, providing for a sloped back. Thus, in life this cat must have differed greatly in appearance to that of the more common saber-tooth cat. In western Oklahoma, the scimitar cat remains were found in association with remains of proboscidean, thought by scientists to have been the cat's favorite prey.

Drawing by Nicholas J. Czaplewski

This publication, printed by the Oklahoma Geological Survey, is issued by the Oklahoma Geological Survey as authorized by Title 70, Oklahoma Statutes, 1981, Sections 231–238. 1,000 copies have been prepared for distribution at a cost of $2,198 to the taxpayers of the State of Oklahoma. Copies have been deposited with the Publications Clearinghouse of the Oklahoma Department of Libraries.

CONTENTS

ILLUSTRATIONS

Figure

Tables

A Synopsis of the Pleistocene Vertebrates of Oklahoma

Kent S. Smith
Richard L. Cifelli
Department of Zoology and
Oklahoma Museum of Natural History
University of Oklahoma
Norman, Oklahoma

ABSTRACT. —The Pleistocene vertebrate fauna of Oklahoma is reviewed based on published reports, including described local faunas, faunules of precisely known ages, notable faunules of imprecisely known ages (some of uncertain exact provenance), and three archeological sites that include diverse vertebrate assemblages. Also included is a provisional listing of known sites producing remains of proboscideans. Most known sites are in western Oklahoma. The vast majority (81%) of the 33 local faunas and faunules included in this volume are from the late Pleistocene (Rancholabrean land-mammal age); three are referred to the early Pleistocene (Irvingtonian land-mammal age). Collectively, 130 vertebrate taxa, including 14 fish, 6 amphibians, 30 reptiles, 4 birds, and 76 mammals have been reported from the Pleistocene of Oklahoma. Of these, 26 are known from the Irvingtonian (6 fish, 0 amphibians, 5 reptiles, 1 bird, and 14 mammals) and 104 from the Rancholabrean (8 fish, 16 amphibians, 25 reptiles, 3 birds, and 62 mammals). The most diverse vertebrate fauna of Irvingtonian age from Oklahoma is that of the Berends, with 35 species (11 fish, 10 reptiles, 1 bird, and 13 mammals). Significant Rancholabrean assemblages include those of Doby Springs, with 36 species (7 fish, 1 amphibian, 5 reptiles, 1 bird, and 22 mammals), and Chickasha with 24 species (4 reptiles, 2 birds, and 18 mammals). Although 20 species have been described as new based on specimens from the Pleistocene of Oklahoma, only seven currently are considered valid.

INTRODUCTION

The fossil record of Oklahoma, like that of many other western states, preserves a rich, diverse assemblage of Pleistocene vertebrates. Bones of Pleistocene mammals are the most commonly encountered fossil vertebrate remains in the State, and they commonly are found and collected by private citizens, amateur rock-hunters, and professional paleontologists alike. The discovery and scientific study of Oklahoma's Pleistocene vertebrates extends back well before statehood, and a large volume of scientific literature has been dedicated in part or exclusively to the description of this rich fauna. Yet many of these publications appear in sources of limited distribution, and, in the absence of a comprehensive overview of this literature, it is often difficult to judge the geographic and temporal significance represented by these ever-increasing discoveries. Uncertainty is forbidding or prohibitive in many cases, and, consequently, the importance of new finds may go unrecognized. Hence, the focus of the present work is a review of the existing literature on Pleistocene vertebrates of Oklahoma. We recognize that this compendium ignores the many unpublished specimens and collections from Oklahoma, whether housed in museums or in private hands. We note that primary identification of such material, which would involve documentary illustrations (among other things), is beyond the scope of this work and is a future goal of the senior author. In the interim, we hope that this review will serve as a useful resource to professionals and amateurs alike. We anticipate that it can be utilized as a point of departure from which additions and emendations can be made

through the publication of additional material, whether this material has long-languished in a collection or has been obtained more recently.

In preparing this review, we have consulted all published sources known to us, as well as a relevant master's thesis completed through the School of Geology and Geophysics, University of Oklahoma. A large body of archeological literature commonly exists as contract reports; these are relevant at least in part to the listing of the Pleistocene–Recent faunas of Oklahoma. Many of these references deal with Holocene material, and, of those dedicated to the Pleistocene, most consist of reports on Proboscidea (mammoths and mastodons) and bison. Because of the enormity of this literature and the impracticality of reporting isolated finds of single, common taxa, we have forgone their inclusion; however, we recognize that a similar review of such sites is urgently needed. We have included only the few archeological sites that possess a diverse assemblage of extinct species or that differ from present-day faunal composition (i.e., Burnham, Domebo, and Hajny). Although no human remains or artifacts were reported from the Hajny mammoth site, the excavation followed controlled archeological methods (Wyckoff and others, 1992b). Therefore, to avoid confusion, we list this fauna with the archeological sites. An early listing (Decker, 1924) of isolated proboscidean remains in Oklahoma included 22 different localities. J. Willis Stovall (1891–1953) of the Department of Geology, University of Oklahoma, evidently planned to publish a more comprehensive list of Oklahoma proboscidean occurrences, but this was never completed and the records and files are apparently lost (N. J. Czaplewski, personal communication, 1998). A later compendium by Northcutt (1984) listed 58 proboscidean sites in the southwestern part of the State. A recent report by Wyckoff and Czaplewski (1997) indicated that there are more than 50 reported Pleistocene proboscidean localities in Oklahoma.

The local faunas included herein range from early Pleistocene (Irvingtonian land-mammal age) to latest Pleistocene (Rancholabrean land mammal age; see Woodburne and Swisher, 1995). These assemblages are dealt with in separate sections according to North American Land Mammal Age (NALMA). Faunules with radiometric dates provided, noteworthy faunules without radiometric dates, and archeological sites are presented in the sections following that of the local faunas. For each important fossil locality, we present an historic overview, faunal list, and commentary where relevant. Unfortunately, definitive geochronologic or biostratigraphic evidence remains to be published for many sites. Where possible, we have included a few relevant comments based on faunal composition.

With the paucity of stratigraphic data for most of the fossil localities reported herein, we will follow Dalquest and Schultz (1992) when referring to the term "local fauna." In part, they suggested application of the term "local fauna" to assemblages of animals that may or may not have lived together but were close enough geographically to have been preserved in the same sedimentary rock (see Tedford and others, 1987, p. 155). In contrast, we follow Dalquest and others (1990) when using the term "faunule." They suggested use of this term when taxonomic lists for single localities are small. Thus, we recognize 33 localities in this report, including nine local faunas, 21 faunules, and three archeological sites.

The Quaternary of North America includes two land-mammal ages, the Irvingtonian and the Rancholabrean. As recognized by Woodburne and Swisher (1995), the Irvingtonian ranges from ca. 1.9 Ma (mega-annum or millions of years ago) to 0.15 Ma, and the Rancholabrean began about 0.15 Ma and lasted until approximately 10,000 YBP (years before present). Traditionally, Pleistocene deposits have been correlated with inferred glacial maxima (glacials) and minima (interglacials) (Flint, 1957). Thus, Pleistocene deposits (and their included faunas) in North America were referred to either glacial (cold-climate) or interglacial (warm-climate) stages. Therefore, a glacial or interglacial stage was assigned traditionally for the occurrence of the local fauna. The Pleistocene glacial stages Kansan, Illinoian, and Wisconsinan were separated chronologically by the climatically warmer interglacial stages, the Yarmouthian and the Sangamonian. If either a glacial or an interglacial stage overlapped with a faunal zone, the subunits early or late were placed in front of the appropriate stage. For example, the Kansan glacial stage overlaps with the Blancan and Irvingtonian faunal zones. Therefore, the early Kansan is associated with the older zone of the Blancan, and the late Kansan subunit denotes the younger faunal zone of the early Pleistocene (Irvingtonian). Likewise, the early Rancholabrean faunal zone incorporates the late Illinoian and Wisconsinan glacial stages (separated chronologically by the Sangamonian interglacial stage).

During the Irvingtonian, two glacial stages and one interglacial stage are represented—the

late Kansan, early Illinoian, and the Yarmouthian, respectively. Recent research utilizing oxygen isotopes has revealed 10 or more glacial/interglacial episodes involving the Pleistocene climatic events in North America (Dalquest and Schultz, 1992). Unless a radiometric date, an index fossil, or reliable stratigraphic information is provided, we will indicate the NALMA or glacial/interglacial stage for the fauna based on the original published information.

HISTORY, OVERVIEW, AND CONVENTIONS

The first published record of Pleistocene vertebrates from Indian Territory (Oklahoma) is that of Leidy (1852), who described the skull of an extinct musk ox *Bootherium cavifron*, reportedly discovered along the Arkansas River near Fort Gibson by T. Kite. Additional reports were not forthcoming until 39 years later, when E. D. Cope described a new taxon of a Pleistocene saber-tooth cat (*Homotherium serum*) from near Hennessey (Cope, 1893). Thirty years later, J. W. Gidley described a faunule from the vicinity of Long Horn Mountain (Gidley, 1925) in what is now Kiowa County. Knowledge of Oklahoma's Pleistocene increased dramatically in the rest of the 20th century. By the middle 1960s, five local faunas (Afton, Berends, Chickasha, Doby Springs, and Holloman) and 16 faunules (Bar M, Braden, Crescent, Deer Creek, Durham, Fort Gibson, Fort Sill, Gould, Hennessey, Hydro, Lawton/Cheyenne, Long Horn Mountain, Mulhall, Nye Sink, and Yukon) were reported. Since the 1960s, four local faunas (Elm Creek, Quinlan, Tesequite, and Washita), five faunules (Botone, Canton Lake, Gittin' Down Mountain, Grandfield, and Howard Gully), and three archeological sites (Burnham, Hajny, and Domebo) were reported. Among the local faunas, Chickasha includes three separate localities (Smith Pit, Casady Pit, and Bowles Pit) described by Strain (1937).

Geographically, most of the major sites yielding Pleistocene vertebrates in Oklahoma are located in the western and panhandle counties in the State, where a number of faunules also have been reported (Fig. 1). To date, only three faunules of imprecisely known age and one Rancholabrean local fauna have been published from the eastern counties of Oklahoma. Ongoing investigations promise to improve coverage from this part of the State, notably along the drainage of the Canadian and Arkansas Rivers (D. G. Wyckoff, personal communication, 1998).

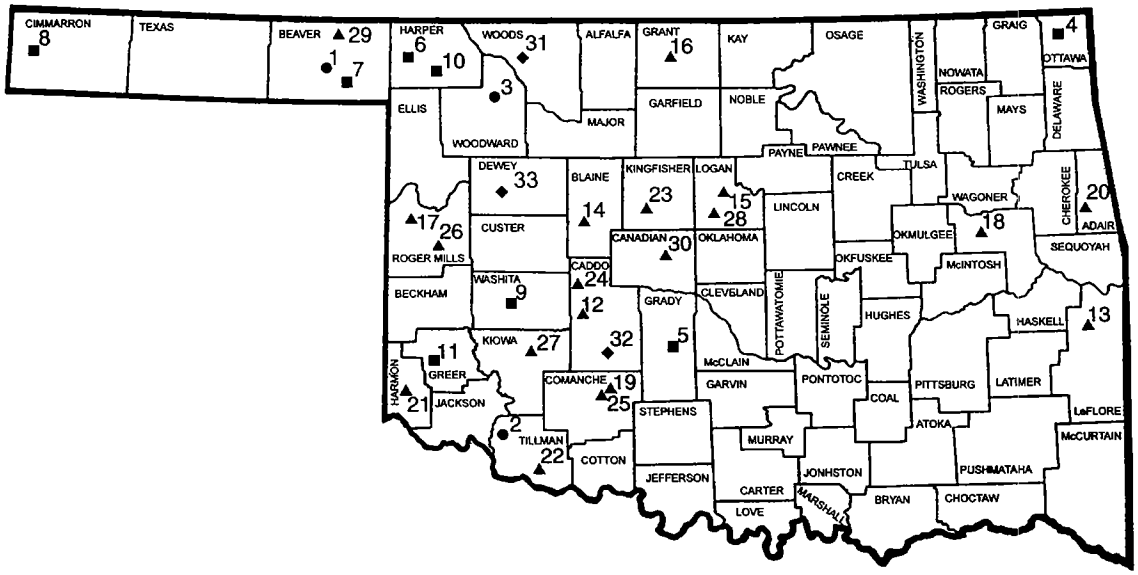


Figure 1. Map of Oklahoma Pleistocene vertebrate localities. Four different symbols are displayed and numbered on map. *Circles* (●)—Irvingtonian (1 Berends, 2 Holloman, 3 Quinlan). *Squares* (■)—Rancholabrean (4 Afton, 5 Chickasha, 6 Doby Springs, 7 Elm Creek, 8 Tesequite, 9 Washita, 10 Bar M, 11 Howard Gully). *Triangles* (▲)—imprecisely known age (12 Botone, 13 Braden, 14 Canton Lake, 15 Crescent, 16 Deer Creek, 17 Durham, 18 Fort Gibson, 19 Fort Sill, 20 Gittin' Down Mountain, 21 Gould, 22 Grandfield, 23 Hennessey, 24 Hydro, 25 Lawton, 26 Cheyenne, 27 Long Horn Mountain, 28 Mullhall, 29 Nye Sink, 30 Yukon). *Diamonds* (◆)—archeological excavation (31 Bunham, 32 Domebo, 33 Hajny).

In a temporal context, the vast majority of published vertebrates from the Pleistocene of Oklahoma are late Pleistocene. Of the 33 sites included in this review, 30 are considered to be Rancholabrean age (late Pleistocene); the remaining three—Holloman, Berends, and Quinlan—are referred to the Irvingtonian (early Pleistocene). The Chickasha local fauna was compared favorably with that from the Holloman local fauna by Strain (1937), who thus believed the former to be early Pleistocene based on the included taxa. We herein regard the Chickasha assemblage to be Rancholabrean in age.

Vertebrate taxonomy has changed considerably through the years. Where appropriate, we have updated scientific names from those used in the original articles, based on more recent, widely used sources. These sources include Wright and Wright (1957), Webb (1970), Ernst and Barbour (1972), Goin and others (1978), Kurtén and Anderson (1980), Robins and others (1980), American Ornithologists Union (1983), Frost (1985), Jones and others (1986), Banks and others (1987), Carroll (1988), McDonald and Ray (1989), Ernst (1991), Hubbs and others (1991), Nowak (1991), Hulburt and Morgan (1993), Wilson and Reeder (1993), Holman (1995), McDonald (1995), and McKenna and Bell (1997). Where taxonomy is in dispute, we have attempted to use either the most current or consensus opinion. For example, Ray and Sanders (1984) suggested that *Tapirus copei* is synonymous with *T. haysii*; in this case, we follow the more recent identification of Pleistocene species by Dalquest and Schultz (1992), who followed Simpson (1945) and Kurtén and Anderson (1980). Dalquest and Schultz (1992) stated that, if there were only two Pleistocene-age tapirs, then the larger Irvingtonian species is *T. copei*, and the smaller Rancholabrean species is *T. veroensis*.

The bibliography includes only entries that are pertinent to Pleistocene vertebrate localities. For complete listings of Pleistocene and Recent taxa, together with other references, we refer the reader to other secondary sources. For mammals, a list and bibliography are given by Owen and Schnell (1989). For amphibians and reptiles, useful sources include Carpenter and Krupa (1989) and Holman (1995).

IRVINGTONIAN SITES

Berends Local Fauna

The Berends local fauna is from near Gate, Beaver County (Fig. 1). In the summer of 1942, C. W. Hibbard and his field crew from the University of Michigan prospected the Gate ash pit (a commercial ash quarry) and nearby area for fossil vertebrates, but found only mollusc shells. They collected more than 1,000 kg of rock matrix above one of the Pearlette Ash beds, in an effort to recover a fauna comparable to that of the Borchers site in Meade County, Kansas. Screenwashing of the matrix yielded only molluscs and isolated fish remains (Rinker and Hibbard, 1952). A molluscan fauna collected below the Pearlette Ash at this site was described later by Frye and others (1948) and Leonard (1950). During the summers of 1950 and 1951, Hibbard's field parties collected the fauna in the course of their examination of post-Pearlette Ash deposits (Starrett, 1956). Recently, the Lava Creek ash beds (Pearlette Family Ash Beds) present at the Berends site were correlated with the Yellowstone Plateau Volcanic Field (Ward, 1991). Ward and others (1993) provided a date of 0.61 Ma for the Lava Creek Ash from Berends. It is important to note that the date of 0.61 Ma is a *maximum date* for the Berends fauna because the fossils were collected *above* the Lava Creek B ash beds.

Kurtén and Anderson (1980) summarized the sequence of volcanic ashes present in the central Great Plains that have been dated by radiometric methods. These ashes are the Pearlette "B" (Borchers fauna, Meade County, Kansas, at 2.0 Ma), Pearlette "S" (Sappa fauna, Harlan County, Nebraska, at 1.2 Ma), and Pearlette "O" (Vera fauna, Baylor and Knox Counties, Texas; and Cudahy fauna, Meade County, Kansas, at 0.6 Ma). It is unclear presently how the Lava Creek B ash fits into the scheme that Kurtén and Anderson (1980) used in describing the volcanic ashes of the central Great Plains.

Hibbard (1953) compared the assemblage at Berends to the Saw Rock Canyon fauna and concluded that the mammals indicated the Illinoian glacial stage (late Irvingtonian to early Rancholabrean). The assemblage was later termed the Berends local fauna (Smith, 1954; Taylor, 1954). However, Kurtén and Anderson (1980) regarded the fauna as "terminal Irvingtonian."

Further collecting by Hibbard and his field crew in the summers of 1951–52 resulted in the discovery of additional fossil vertebrates. Notable among these is a mammal later named as a new species of beaver, *Paradipoides stovalli* (see Rinker and Hibbard, 1952). Other taxa from the site include a perch (*Perca* cf. *P. flavescens*), an indeterminate canid about the size of the coyote (*Canis latrans*), pond and river turtles (unidentified), fragmentary bird bones (unidentified), mammoth (*Mammuthus* cf. *M. columbi*), horse

(*Equus* sp.), and a white pelican (*Pelecanus erythrorhynchos*), described by Mengel (1952). The white pelican was found about 200 m east of the main fossil-vertebrate-bearing site discussed by Rinker and Hibbard (1952). The specimens at the main site reportedly were found in a large basin, perhaps representing an ancient lake deposit, well above the Pearlette Ash. Therefore, the age of these fossils is uncertain.

Another investigator of the Berends site was Starrett (1956). His study of the Berends local fauna achieved three goals: (1) it compiled previously reported mammal records; (2) it presented additional records of the fossil mammals not previously reported, and (3) it included a new taxon from a site of similar age close to the Berends locality. The taxon he named from the additional site was *Burosor efforsorius* (= *Castoroides ohioensis*), a giant beaver. He based this new taxon on the distal end of an incisor.

In agreement with Kurtén and Anderson (1980), we support the Irvingtonian age for the Berends local fauna based on fossil evidence. Most important in this respect are the presence of *Peromyscus berendsensis*, which may be conspecific with *P. progressus* from the Mt. Scott local fauna of southwest Kansas (Kurtén and Anderson, 1980) and *Ondatra triradicatus* (= *O. nebrascensis*) at Berends. The latter species is of Irvingtonian age and is not known from the Rancholabrean of North America (Kurtén and Anderson, 1980; Dalquest and Schultz, 1992).

Dalquest and Schultz (1992) suggested a Rancholabrean arrival in north-central Texas for *Microtus pennsylvanicus*, based on fossil evidence from the Easley Ranch local fauna in Foard County, Texas. If the Irvingtonian age for the Berends local fauna is accurate, then the appearance of *M. pennsylvanicus* in the Oklahoma panhandle antedates that of *M. pennsylvanicus* in north-central Texas.

The fauna of Berends was suggested by Starrett (1956) to include two types of habitat—lowland swamp and upland—collectively indicating a cooler, more mesic climate than at present, with a summer paleoclimate resembling that of present-day South Dakota and a winter paleoclimate colder than that of present-day Kansas. On the same basis, Hibbard (1953) had earlier proposed that the fauna corresponded temporally to a glacial stage. Support for these paleoenvironmental interpretations is offered by the ichthyofauna from the Berends locality. The distribution of 12 fish taxa from the site corresponds with a current zoogeographic distribution from New York to Minnesota (Smith, 1954).

Later mention of the Berends fauna appears in Schoff (1954). Among the reptiles from Berends, studies of the snakes were published by Brattstrom (1967) and Holman (1986), and the presence of the semi-box turtle (*Emydoidea blandingii*) at Berends was noted by Preston and McCoy (1971) in their study of the distribution of this species. The fauna was also mentioned in Preston (1979) and Holman (1995), who stated that *E. blandingii* currently occurs no closer than central Nebraska.

The vertebrate fossils from the Berends local fauna are listed in Table 1.

Holloman Local Fauna

This fauna was discovered by Mr. Holloman (owner of the property on which it occurred) in the early 1920s. The Holloman locality is near the town of Frederick, Tillman County (Fig. 1). The first substantial research on the Holloman fauna was published by H. J. Cook, of the Colorado Museum of Natural History (now Denver Museum of Natural History), who visited the site in 1927. These early collections led to papers describing the fauna and geology of the site (Hay and Cook, 1930; Sellards, 1932). Interest in the site was spurred by an apparent association of the fauna—recognized to be of relatively great antiquity—with human artifacts (Cook, 1927a,b, 1928, 1931; Hay, 1928, 1929). In October of 1927, an interdisciplinary team from the University of Oklahoma, including C. E. Decker (Department of Geology), L. Spier (Department of Anthropology), and Lois and C. N. Gould (Oklahoma Geological Survey) visited the site as well. One of the most important discoveries made by this expedition was that of a glyptodont carapace, including approximately 350 rosette plates (another 100 plates apparently were found downstream), about 1.5 m long and 1 m wide (see Gould, 1929a). This specimen was not identified by Simpson (1929), although he suggested that it probably represented a new taxon based on the plates, which he considered to be unlike those of any other known species. In a more recent review of North American glyptodonts, Gillette and Ray (1981) identified the glyptodont remains from the Holloman gravel pit as *Glyptotherium arizonae*. They stated that the reconstruction of the carapace was improper and that the scutes were not placed in proper order (Gillette and Ray, 1981).

The initial faunal list for the Holloman site (Hay and Cook, 1930) included 24 species of mammals and two turtles. The list was later published unmodified, except for the addition of the Columbian mammoth, by Meade (1950, 1953).

TABLE 1.—Vertebrate Fossils from the Berends Local Fauna

Class	Order	Family	Taxon
Osteichthyes	Seminotiformes	Lepisosteidae	*Lepisosteus* sp.
	Salmoniformes	Esocidae	*Esox masquinogny* Mitchill
	Cypriniformes	Cyprinidae	*Notemigonus crysoleucas* (Mitchill)
			Semotilus sp.
			Semotilus cf. *S. atromaculatus* (Mitchill)
		Catostomidae	*Catostomus commersoni* (Lacépède)
	Siluriformes	Ictaluridae	*Ictalurus melas* Rafinesque
			I. punctatus (Rafinesque)
	Perciformes	Centrarchidae	*Lepomis* cf. *L. cyanellus* Rafinesque
		Percidae	*Perca flavescens* (Mitchell)
		Sciaenidae	*Aplodinotus grunniens* Rafinesque
Reptilia	Testudines	Emydidae	*Emydoidea blandingii* (Holbrook)
		Testudinidae	*Geochelone* sp.
	Squamata	Colubridae	*Coluber* or *Masticophis*
			Elaphe vulpina (Baird and Girard)
			Heterodon nasicus Baird and Girard
			H. platyrhinos Latrille
			Lampropeltis triangulus (Lacépède)
			L. getula (Linnaeus)
			Nerodia sp.
			Pituophis melanoleucus (Daudin)
			Thamnophis cf. *T. radix* (Baird and Girard)
Aves	Pelecaniformis	Pelecanidae	*Pelecanus erythrorhynchos* Gmelin
Mammalia	Insectivora	Soricidae	*Sores* cf. *S. cinereus* Kerr
			Blarina cf. *B. brevicauda* (Say)
	Carnivora	Canidae	*Canis latrans* Say
	Rodentia	Geomyidae	*Geomys* sp.
		Heteromyidae	*Chaetodipus hispidus* Baird
		Castoridae	*Castor canadensis* Kuhl
		Muridae	*Peromyscus berendsensis* Starret
			Ondatra nebrascensis (Hollister)
			Microtus pennsylvanicus (Ord)
			Microtus cf. *M. ochrogaster* (Wagner)
	Lagomorpha	Leporidae	*Sylvilagus* or *Lepus*
	Perissodactyla	Equidae	*Equus* sp.
	Proboscidae	Elephantidae	*Mammuthus* cf. *M. columbi* Falconer

Another mammoth from Holloman, identified by Maglio (1973) as *Mammuthus meridionalis,* subsequently was referred to *M. imperator,* based on the number of tooth plates in the last lower molar (Dalquest and Schultz, 1992).

In the interim, many other publications on the Holloman quarry appeared (Figgins, 1927; Cook, 1928; Hay and Cook, 1928; Renaud, 1928; Spier, 1928a,b; Gould, 1929b,c; Hay, 1929; Evans, 1930; Romer, 1933; Sellards, 1932, 1936; Wood, 1933; Antevs, 1935, 1940). Most of the literature on Holloman deals with the supposed association of human artifacts with early Pleistocene fossils, in which Mr. Holloman firmly believed (Hay, 1928). According to Hay (1928), the controversy surrounding the association of an artifact (arrowhead) with the vertebrate fossils from this locality was the basis of a misunderstanding between Mr. Holloman and L. Spier, who reported (Spier, 1928b) that an arrowhead was collected by Mr. Holloman from loose material at the front of the quarry. Mr. Holloman wrote three letters to Hay and also told Figgins several times that he had not picked up the arrowhead from the loose material on the quarry floor, but instead collected the arrowhead from the hard conglomer-

ate of the quarry floor. In response to Spier's (1928b) report, Hay (1928) implied that Mr. Holloman was misquoted by Spier. Although no scientist witnessed the collection of the artifact from the quarry, Hay (1928) thought it was plausible that Mr. Holloman found the artifact in the rock beds that would indicate an association with the fossil vertebrates. Dalquest (1977) stated that A. S. Romer told him that, during a visit to the Holloman quarry, he witnessed an artifact (a metate) derived from surface deposits at the very edge of the quarry. This suggested that the cooccurrence represented a pseudoassociation explainable by geomorphologic processes. The total count of artifacts discovered by Mr. Holloman at the quarry includes seven metates and two flint arrowheads (Gould, 1929b). Because of the growing disbelief on the part of the scientific community regarding the association of artifacts with early Pleistocene mammals, Mr. Holloman closed this important locality to scientific collecting sometime between 1927 and 1932. The pit remained closed until his death in the 1970s (Dalquest, 1977). The quarry is now partially filled with slump so that further collecting may be problematic. Dalquest (1977) provided an updated faunal list for the Holloman site (21 species), listed museum collections that currently house these fossils, and provided a useful summary of the controversies relating to the site and of the distribution of vertebrate fossils collected from the rock quarry. According to Dalquest (1977), some of the original specimens cannot be located, but the major holdings from this site are deposited at the Denver Museum of Natural History, Texas Memorial Museum, and Midwestern State University (MWSU), the latter of which inherited Holloman's private collection (formerly on display at the Frederick High School) following his death. Recently, Dalquest (personal communication, 1999) stated that one of the lost specimens, the skull of an elephant, was found at the Denver Museum of Natural History by Garry Madden. The skull originally was identified as *Stegomastodon*, but Dalquest (personal communication, 1999) suggested this may be in error. Recently, Dalquest donated all of the fossil vertebrate material from the Holloman local fauna to the University of Texas, Texas Memorial Museum (W. W. Dalquest, personal communication, 1998). Czaplewski and others (1994) reported that the dentary of a fossil camel (*Hemiauchenia macrocephala*) from the Holloman locality described by Sellards (1932) is in the collection of the Oklahoma Museum of Natural History (OMNH).

Wood (1933) identified a small mammal dentary from Holloman as that of a prairie dog (*Cynomys ludovicianus*). The prairie dog is the only small mammal that was collected from this locality. A complete list of vertebrate fossils from the Holloman local fauna is given in Table 2.

Quinlan Local Fauna

Fossil vertebrates were collected near the towns of Curtis and Quinlan, Woodward County, by J. W. Gidley of the Smithsonian Institution. Akersten and McDonald (1991), who described the sloth *Nothrotheriops shastensis* from the site and named the local fauna for the nearby town, noted that the only field data associated with the Smithsonian specimens indicated that they had been collected in 1927 from a place said to be 6.4 km east of Curtis.

Akersten and McDonald (1991) judged the Quinlan fauna to be late Irvingtonian, based on two premises. First, the presence of a large *Geochelone* indicated a warm climate such as an interglacial of the late Irvingtonian. Second, the climate had changed dramatically from the Irvingtonian to the Rancholabrean, causing a great reduction in the zoogeographic distribution of *Nothrotheriops*. Thus, by Rancholabrean times, *Nothrotheriops* did not occur east of the Rocky Mountains. Therefore, the sloth was apparently restricted to the North American Cordillera during the ensuing Rancholabrean landmammal age. Based on the evidence provided by Akersten and McDonald (1991), we find it difficult to agree with a late Irvingtonian age for this fauna. For example, Hofman and others (1991) identified a *Geochelone crassiscutata* from a fossil locality in Greer County, Oklahoma, that is associated with an accelerated mass spectrometry date for the fauna at 10,810 ± 110 YPB. Numerous Rancholabrean localities in Texas as well as the Nye Sink in Oklahoma also include "large" *Geochelone* (Holman, 1995). Until further investigations reveal a more accurate age for the Quinlan fauna, we tentatively consider it to be late Irvingtonian.

The faunal list from the Quinlin site is presented in Table 3.

RANCHOLABREAN SITES

Afton Local Fauna

Approximately 150 specimens of vertebrate fossils reportedly were found near Afton, Ottawa County, in extreme northeastern Oklahoma, by R. H. Harper of Afton in 1901. Teeth of mastodon and mammoth from this assemblage, together

TABLE 2.—Vertebrate Fossils from the Holloman Local Fauna

Class	Order	Family	Taxon
Mammalia	Xenarthra	Glyptodontidae	*Glyptotherium arizonae* Gidley
		Megalonychidae	*Megalonyx jeffersoni* (Desmarest)
		Mylodontidae	*Paramylodon harlani* (Owen)
	Carnivora	Felidae	*Felis* sp.
	Perissodactyla	Equidae	*Equus calobatus* Troxell
			E. complicatus Leidy
			E. conversidens Owen
			E. tau Owen
			E. scotti Gidley
			E. giganteus Gidley
		Tapiridae	*Tapirus copei* Simpson
	Artiodactyla	Tayassuidae	*Platygonus* sp.
			Platygonus cf. *P. vetus* Leidy
		Camelidae	*Titanotylopus* sp.
			T. spatulus (Cope)
			Camelops sp.
			C. niobrarensis Hay and Cook
			Hemiauchenia macrocephala (Cope)
		Cervidae	*Odocoileus* sp.
		Bovidae	*Bootherium* sp.
	Rodentia	Sciuridae	*Cynomys ludovicianus* (Ord)
	Proboscidea	Elephantidae	*Mammuthus columbi* (Falconer)
			M. imperator (Leidy)
		Gomphotheriidae	*Stegomastodon* cf. *S. mirificus* (Leidy)

TABLE 3.—Vertebrate Fossils from the Quinlan Local Fauna

Class	Order	Family	Taxon
Reptilia	Testudines	Emydidae	*Pseudemys* sp.
		Testudinidae	*Geochelone sp.*
Mammalia	Xenarthra	Mylodontidae	*Paramylodon* cf. *P. harlani* (Owen)
		Megatheriidae	*Nothrotheriops shastensis* (Sinclair)
	Carnivora	Felidae	*Homotherium* sp.
	Perissodactyla	Equidae	cf. *Equus*
	Artiodactyla	Camelidae	cf. *Camelops*

with flint artifacts found at the same location, were reported to W. H. Holmes of the Smithsonian Institution. Later in the same year, A. Stewart, under the direction of the Smithsonian's F. A. Lucas, visited Afton and found more material of Proboscidea. Because the bones were disassociated and fragmentary, he abandoned the site. However, the possible co-occurrence of extinct mammals with human artifacts at Afton prompted Holmes to visit the site himself (Holmes, 1902). The site is located at a clear spring, and Holmes (1902) reported that Native Americans, as well as domestic and wild animals, gathered there regularly prior to 1900. Unsurprisingly, Holmes found a great abundance of flint artifacts, together with bones and teeth of horse, bison, deer, and wolf within 1 m of the surface; further down, he recovered fossils of Pleistocene mammals, including about 100 mastodon teeth, 20 mammoth teeth, and specimens of bison and horse. Holmes (1902) offered several explanations for the occurrence of fossil with recent

TABLE 4.—Vertebrate Fossils from the Afton Local Fauna

Class	Order	Family	Taxon
Mammalia	Carnivora	Canidae	*Canis lupus* Linnaeus
			C. latrans Say
	Rodentia	Castoridae	*Castoroides ohioensis* Foster
	Perissodactyla	Equidae	*Equus complicatus* Leidy
			E. excelsus Leidy
			E. laurentius Hay
			E. niobrarensis Hay
	Artiodactyla	Camelidae	*Camelops kansanus* Leidy
			C. nitidus
		Cervidae	*Odocoileus virginianus* (Zimmerman)
			Cervus elaphus Linnaeus
			C. scotti (Lydekker)
		Bovidae	*Bootherium cavifrons* (Leidy)
			Bison sp.
			B. bison (Linnaeus)
	Proboscidea	Mammutidae	*Mammut americanum* (Kerr)
		Elephantidae	*Mammuthus columbi* (Falconer)

bones and artifacts at Afton, including *in situ* deposition of bones of now extinct taxa watering at the spring, transport of fossils weathering from another outcrop, and accumulation of fossil bones by humans. As the result of a letter written to R. H. Harper by O. A. Mitscher, "Indian agent at Pawhuska," Holmes strongly believed that the native people placed the Recent and fossil animals and implements in the spring. The letter indicated that an Osage Indian known as Red Eagle, then the oldest man of the tribe, distinctly recalled the spring as a ceremonial meeting place for the medicine men when he was younger. Red Eagle said the spring was thought of as a holy place and spearheads and other tokens were deposited there to appeal to the gods. Hay (1918) found this explanation for the occurrence of fossils at the spring unimaginable. He (1918, p. 23) went on to note it is impossible to refute this opinion, but questioned why the testimony of a "superannuated Indian" should be given precedence over that of an "honest white man." Of the 19 species identified, Hay (1918) noted that two-thirds were extinct, and assigned the fauna to the Aftonian interglacial stage. Soon thereafter, Hay (1920) described new taxa based on fossils from Afton, including a musk ox (*Symbos promptus* = *Bootherium cavifrons*). He also identified several other taxa, including a camel (*Camelops kansanus*), deer (*Odocoileus virginianus*), bison (*Bison bison*), and a giant beaver (*Castoroides ohioensis*). In contrast to Hay (1918, 1920), we agree with Kurtén and Anderson (1980) in suggesting a Rancholabrean age for this fauna.

A list of vertebrate fossils identified from the Afton local fauna is given in Table 4.

Chickasha Local Fauna

The Chickasha local fauna originates from several sites, mainly commercial gravel pits, located on terraces of the Washita River, Grady County. Contemporaneity of the respective sites remains to be established, and, lacking evidence of different ages, the sites are grouped here for convenience as the Chickasha local fauna.

As described by Strain (1937), the principal sites are Bowles Pit (named for R. Bowles, the operator of the pit), Casady Pit (name of unknown origin), and C. E. Smith Pit (named for the farmer who owned the pit). Strain (1937) also mentioned two isolated occurrences that are included here in the Chickasha local fauna: (1) a single bison tooth found 5 m below the surface in a water well located at 520 South 7th Street in Chickasha; and (2) the left mandible of a young mammoth, possibly discovered near Minco.

Bowles Pit

Bowles and his workmen recovered several fossils from this pit, donating them to the College for Women (subsequently renamed The University of Science and Arts of Oklahoma), under the care of M. Shackleford. The specimens were trans-

TABLE 5.—Vertebrate Fossils from the Chickasha Local Fauna (List from R. Bowles Pit)

Class	Order	Family	Taxon
Reptilia	Testudines	Emydidae	*Trachemys scripta* (Schoeff)
		Testudinidae	*Gopherus* sp.
Aves	Galliformes	Phasianidae	*Meleagris gallopavo* (Linnaeus)
Mammalia	Xenarthra	Megalonychidae	*Megalonyx* sp.
		Mylodontidae	*Mylodon* sp.
	Perissodactyla	Tapiridae	*Tapirus copei* Simpson
		Equidae	*Equus* cf. *E. laurentius* Hay
			E. excelsus Leidy
			E. complicatus Leidy
			E. giganteus Gidley
	Artiodactyla	Camelidae	*Camelops* sp.
		Cervidae	*Odocoileus* sp.
			O. virginianus (Zimmerman)
		Bovidae	*Bootherium cavifrons* (Leidy)
	Proboscidae	Mammutidae	*Mammut americanum* (Kerr)
		Elephantidae	*Mammuthus columbi* (Falconer)

ferred later to the University of Oklahoma, presumably in the mid-1930s. Strain (1937) reported that the Bowles Pit was located on the third terrace above the present level of the Washita River.

Noteworthy among reptiles from Bowles Pit is a gopher tortoise (*Gopherus*) thought by Strain (1937) to represent a previously unrecognized species. However, he did not formally name or describe this taxon. Sandoz and Stovall (1935) described a meleagridid (= Phasianidae) bird from Bowles Pit as *Parapavo oklahomensis* (= *Meleagris californica*), based on a tarsometatarsus. In later reviews (e.g., Rea, 1980; Steadman, 1980), *P. californica* was synonymized with *M. californica* primarily because the osteological and external differences that were utilized traditionally to characterize the taxa are exclusively secondary sexual characteristics (e.g., position, angle, and length of the metatarsal spur). Therefore, we agree with the synonymy of *P. californica* and *M. californica*. Among mammals from Bowles Pit, one of the most significant specimens referable to a previously known taxon is a nearly complete palate and a metatarsal of the extinct tapir *Tapirus copei*. At the time, this was the most complete of only four specimens known from the State; it was described (under the name *T. haysii*) by Stovall and Johnston (1934) and later mentioned by Strain (1937) and Lundelius and Slaughter (1976). However, this species was overlooked in the review published by Ray and Sanders (1984). Other tapir specimens recently have been reported from the State (Rippy and Wyckoff, 1994).

Another notable mammal from Bowles Pit is an extinct muskox *Bootherium cavifrons*, initially described by Stovall and Self (1936a,b). In ensuing years, the genus was reported from further west in New Mexico (Harris, 1985, 1993; McDonald and Ray, 1989), Utah, Idaho, California, Canada, and Alaska (McDonald and Ray, 1989), and from farther south in Texas and Louisiana (McDonald and Ray, 1989).

The complete list of vertebrate fossils from the Bowles Pit is given as Table 5.

Casady Pit

The Casady Pit is the least productive in terms of vertebrate fossils of the Chickasha localities. Nonetheless, it is the only one of the three sites to have produced a rodent (the prairie dog, *Cynomys*), suggesting the possibility that screen-washing (not widely employed in the 1930s) might yield a microfauna. Strain (1937) believed the age of Casady Pit to be the same as that of Bowles Pit because of similar occurrence on the third terrace of the Washita River. In turn, he interpreted these terraces as reflecting changes in stream energy due to Pleistocene climatic change.

The vertebrate faunal list from the Casady Pit is presented as Table 6.

TABLE 6.—Vertebrate Fossils from the Chickasha Local Fauna (List from Casady Pit)

Class	Order	Family	Taxon
Reptilia	Testudines	Emydidae	*Chrysemys* cf. *C. picta*
		Testudinidae	*Gopherus* sp.
Aves	Passeriformes	Family indet.	Genus indet.
	Galliformes	Phasianidae	Genus indet.
Mammalia	Rodentia	Sciuridae	*Cynomys ludovicianus* (Ord)
	Perissodactyla	Equidae	*Equus* sp.
	Artiodactyla	Cervidae	*Odocoileus* sp.
	Proboscidea	Elephantidae	*Mammuthus columbi* (Falconer)

TABLE 7.—Vertebrate Fossils from the Chickasha Local Fauna (List from C. E. Smith Pit)

Class	Order	Family	Taxon
Reptilia	Testudines	Testudinidae	*Gopherus* sp.
			G. agassizii (Cooper)
			Gopherus cf. *G. laticauda*
Mammalia	Carnivora	Mustelidae	*Mephitis mephitis* (Schreber)
		Felidae	Genus indet.
	Perissodactyla	Equidae	*Equus laurentius* Hay
			E. excelsus Leidy
			Equus cf. *E. niobrarensis* Hay
			Equus cf. *E. complicatus* Leidy
	Artiodactyla	Tayassuidae	*Platygonus* sp.
		Camelidae	Genus indet.
		Bovidae	*Bison* sp.
	Proboscidea	Mammutidae	*Mammut americanum* (Kerr)
		Elephantidae	*Mammuthus columbi* (Falconer)

C. E. Smith Pit

Most of the specimens from this site were collected by a Works Progress Administration crew; the material is exceptionally well preserved, which Strain (1937) ascribed to quick burial. Strain (1937) reported two felids from the C. E. Smith Pit. These include (1) a specimen of large body size, represented by the proximal end of a phalanx that could belong to either a true cat or a saber-tooth cat; and (2) a smaller specimen, represented by a proximal ulna about the size of that of a bobcat (*Lynx rufus*). Strain's (1937) identification of a vertebral centrum as belonging to "*Glyptodon floridanum*" deserves special comment. Restudy indicated that the specimen belongs to a small cetacean (Czaplewski and others, 1994). This vertebra is probably from the marine Calvert Formation, from which the University of Oklahoma also obtained specimens in the 1930s and was inadvertently placed among the materials from C. E. Smith Pit.

A list of the vertebrate fauna from the C. E. Smith Pit is given as Table 7.

Doby Springs Local Fauna

The Doby Springs locality, near the town of Doby Springs, Harper County, was first worked by C. W. Hibbard and A. J. Myers, University of Michigan, in the summer of 1955. Surface prospecting yielded fossils of muskrat, horse, vole,

bison, and snails. In the ensuing two field seasons, Hibbard's field parties collected about 13.6 metric tons of rock matrix and recovered fossils through underwater screenwashing (Hibbard, 1949; Cifelli and others, 1996). A diverse, well-sampled assemblage resulted (Stephens, 1960).

The ichthyofauna of Doby Springs was published by Smith (1958), who noted that five of the species are also present at Berends, and that several minnows (Cyprinidae) are not known at the latter site. Smith (1958) suggested that the Doby Springs fossils were deposited in a small body of water (perhaps a pond) or a low-energy stream. Smith (1958) further suggested that the Doby Springs fauna, like that from Berends, has a more northern character than the present assemblage. In other words, a few of the taxa of minnows represented in the Doby Springs fauna do not inhabit northwestern Oklahoma today.

The only record of Amphibia from Doby Springs is the hylid frog *Pseudacris triseriata*, based on an ilium (Tihen, 1960; see also Chantell, 1966). Two reptiles are known from Doby Spring. The turtle *Emydoidea blandingii* was identified by Brattstrom (1967) and subsequently re-examined by Preston and McCoy (1971). The glass lizard (*Ophisaurus attenuatus*) was documented at Doby Springs by Etheridge (1960, 1961) and was based on a caudal vertebra. This fossil occurrence is beyond the current westward limit for the species, with the nearest modern population being some 80 km to the east (Etheridge, 1960).

Notable among the mammals from Doby Springs is the jumping mouse subspecies *Zapus hudsonius transitionalis*, which was described and named on the basis of a single specimen (Klingener, 1963). A comprehensive overview of the vertebrate fauna from this locality was presented by Stephens (1960), who indicated (1) a similar paleoclimate as for Berends; and (2) the presence of four ecological communities—lake and marsh, lowland meadow, shrub and tree, and (further from the site of deposition) grassland prairie.

A list of the vertebrate fossils from the Doby Springs local fauna is given in Table 8.

Elm Creek Local Fauna

In 1986, while searching for a locality from which Hibbard and Rinker (1942) had indicated modern bog lemming (*Synaptomys* sp.) may inhabit, W. W. Dalquest and R. M. Carpenter discovered Pleistocene outcrops along Elm Creek, Beaver County, Oklahoma. Dalquest and J. A. Baskin returned to the site in 1989 and 1990, collecting a total of 1,500 kg of rock matrix from two places (Dalquest and Baskin, 1992). The two localities, approximately 2 km apart, were named the Prairie Dog Town Site and the Gregg Ranch Site. These collectively constitute the Elm Creek local fauna. Radiocarbon dates based on snail shells for the two sites are 11,410 ± 110 and 11,630 ± 90 YBP, respectively (Dalquest and Baskin, 1992). Based on the fauna, they indicated a grassland-prairie habitat with cold-water streams providing habitat for the water shrew (*Sorex palustris*) and for broad-leaved, riparian woodlands suitable for the chipmunk (*Tamias striatus*).

The faunal list for the Elm Creek local fauna is presented in Table 9.

Tesequite Local Fauna

Discovery of the Tesequite site, in northwestern Cimarron County, was made by W. W. Dalquest, L. Choate, and J. Wiggins in 1986, when they found the hind-foot bones (minus the calcaneus and astragalus) of a fossil horse protruding from siltstone deposits in a cut-bank in Tesequite Canyon. Subsequent screenwashing of 1,300 kg of rock matrix resulted in recovery of a diverse mammalian fauna. Radiocarbon dating of gastropod shells from the site resulted in an age determination of 31,360 ± 570 YBP (Dalquest and Stangl, 1989). Based on faunal composition, Dalquest and Stangl (1989) suggested a grassland paleohabitat with a cooler, less arid climate than at present.

The presence of both the water shrew (*Sorex palustris*), which prefers cold-water streams, marshy wetlands, and montane habitats, and the desert shrew (*Notiosorex crawfordi*) in the same assemblage may appear curious. However, Dalquest and Stangl (1989) suggested that the desert shrew is an unreliable taxon for reconstructing paleoenvironments because modern forms occur in a variety of habitats. Although the desert shrew may inhabit a variety of habitats and be widespread (see Hall, 1981), it generally does not inhabit montane environments. Therefore, we find the disharmonious occurrence of these two shrews unique.

Additional Pleistocene mammals, including camel, horse, and mammoth, have been reported from rock shelters in Tesequite Canyon (Schoff and Stovall, 1943). Furthermore, Dalquest and Stangl (1989) identified a cave approximately 200–300 m from the Tesequite fossil site. Although they did not excavate any material from the cave, they suggested it may warrant future investigation.

TABLE 8.—Vertebrate Fossils from the Doby Springs Fauna

Class	Order	Family	Taxon
Osteichthyes	Cypriniformes	Catostomidae	*Catostomus commersoni* (Lacépède)
		Cyprinidae	*Hybopsis* cf. *H. gracilis* (Richardson)
			Pimephales promelas Rafinesque
			Semotilus atromaculatus (Mitchill)
	Siluriformes	Ictaluridae	*Ictalurus melas* (Rafinesque)
	Perciformes	Percidae	*Perca flavescens* (Mitchill)
		Centrarchidae	*Lepomis* cf. *L. cyanellus* Rafinesque
Amphibia	Anura	Hylidae	*Pseudacris triseriata* (Wied-Neuwied)
Reptilia	Squamata	Anguidae	*Ophisaurus attenuatus* (Cope)
		Colubridae	*Coluber constrictor* Linnaeus
			Nerodia sp.
			Pituophis melanoleucus Stejneger
			Thamnophis sp.
Aves	Order indet.		
Mammalia	Insectivora	Soricidae	*Sorex arcticus* Kerr
			S. cinereus Kerr
			S. palustris Richardson
			Blarina hylophaga (Elliot)
	Carnivora	Family indet.	
		Mustelidae	Genus indet.
	Rodentia	Sciuridae	*Spermophilus* cf. *S. richardsonii* (Sabine)
			S. tridecemlineatus (Mitchill)
		Geomyidae	*Thomomys* sp.
			Geomys bursarius (Shaw)
		Castoridae	Genus indet.
		Muridae	*Peromyscus cochrani* Hibbard
			P. oklahomensis Stephens
			Onychomys cf. *O. leucogaster* (Wied)
			Ondatra zibethicus (Linnaeus)
			Microtus pennsylvanicus (Ord)
		Dipodidae	*Zapus hudsonius transitionalis*
	Lagomorpha	Leporidae	*Lepus* sp.
	Perissodactyla	Equidae	*Equus* sp.
			Equus cf. *E. niobrarensis* Hay
	Artiodactyla	Camelidae	*Camelops* sp.
		Antilocapridae	Genus indet.
		Bovidae	*Bison* cf. *B. latifrons* (Harlan)
	Proboscidea	Elephantidae	*Mammuthus* sp.

The vertebrate fossils of the Tesquite local fauna are listed in Table 10.

Washita Local Fauna

While the senior author was working under the direction of W. W. Dalquest, H. Kirkland brought several fossil bones (including the astragalus of a bison and the metatarsal of an extinct horse) from near Weatherford, Washita County, for Dalquest to identify. In 1991, Kirkland reported the fossil bones identified by Dalquest. In addition to the identifiable bones were bone scraps of unstated provenance or identification submitted for a radiometric date. The bone yielded a radiocarbon age of 18,295 ± 270 YBP (Kirkland and others, 1991). The horse was identified as *Equus excelsus* based on size and on the occurrence of that species at a near-

TABLE 9.—Vertebrate Fossils from the Elm Creek Local Fauna

Class	Order	Family	Taxon
Mammalia	Insectivora	Soricidae	*Sorex palustris* Richardson
			Sorex sp.
	Rodentia	Sciuridae	*Tamius striatus* (Linnaeus)
			Cynomys ludovicianus (Ord)
			Spermophilus tridecemlineatus (Mitchill)
			S. franklinii (Sabine)
		Geomyidae	*Geomys bursarius* (Shaw)
			Thomomys talpoides (Richardson)
		Muridae	*Neotoma* cf. *N. micropus* Baird
			Microtus pennsylvanicus (Ord)
			Ondatra zibethicus (Linnaeus)
	Perissodactyla	Equidae	*Equus* sp.
	Artiodactyla	Camelidae	*Camelops* sp.
		Bovidae	*Bison* sp.
	Proboscidea	Elephantidae	*Mammuthus columbi* (Falconer)

TABLE 10.—Vertebrate Fossils from the Tesequite Local Fauna

Class	Order	Family	Taxon
Mammalia	Insectivora	Soricidae	*Sorex palustris* Richardson
			Notiosorex crawfordi (Coues)
	Rodentia	Sciuridae	*Tamias quadrivittatus* (Say)
			Spermophilus franklinii (Sabine)
			Cynomys ludovicianus (Ord)
		Geomyidae	*Thomomys bottae* (Eydoux and Gervais)
		Heteromyidae	*Perognathus flavus* Baird
		Muridae	*Peromyscus maniculatus* (Wagner)
			Neotoma sp.
			Microtus ochrogaster (Wagner)
			M. pennsylvanicus (Ord)
	Lagomorpha	Leporidae	*Sylvilagus* sp.
	Perissodactyla	Equidae	*Equus* cf. *E. conversidens* Owen
	Proboscidea	Family indet.	

by site, Howard Ranch (Dalquest and Hughes, 1965); the bison was not identified to species (Kirkland and others, 1991).

In the mid-1990s, Kirkland discovered a musk ox (*Bootherium bombifrons*), which sparked new interest for finding additional fossil material from this locality. He subsequently sought the assistance of R. L. Cifelli and N. J. Czaplewski to screenwash the fossiliferous matrix from the Washita County site. Screenwashing the Washita County material by Kirkland and Hilliard (1996) revealed several microvertebrates that were identified by W. W. Dalquest. The following microvertebrates were reported: *Geomys bursarius, Chaetodipus hispidus, Reithrodontomys* sp., *Peromyscus* sp., *Sigmodon hispidus,* and *Microtus ochrogaster.* In 1997, Kirkland and others collected and screenwashed additional material from the Washita locality which provided additional taxa, identified by W. W. Dalquest and N. J. Czaplewski. Additional taxa recovered include ?*Sorex* sp., *Sylvilagus* sp., *Cynomys ludovicianus, Thomomys* sp., *Neotoma* sp., and *Synaptomys* or *Neofiber* sp. (see Kirkland and others, 1997).

See Table 11 for a list of the vertebrate fossils of the Washita local fauna.

TABLE 11.—Vertebrate Fossils from the Washita Local Fauna

Class	Order	Family	Taxon
Mammalia	Insectivora	Soricidae	*Sorex* sp.
	Rodentia	Sciuridae	*Cynomys ludovicianus* (Ord)
		Geomyidae	*Geomys bursarius* (Shaw)
			Thomomys sp.
		Heteromyidae	*Chaetodipus hispidus* (Baird)
		Muridae	*Reithrodontomys* sp.
			Peromyscus sp.
			Sigmodon hispidus Say and Ord
			Neotoma sp.
			Microtus ochrogaster (Wagner)
			Synaptomys sp. or *Neofiber* sp.
	Lagomorpha	Leporidae	*Sylvilagus* sp.
	Perissodactyla	Equidae	*Equus excelsus* (Leidy)
	Artiodactyla	Bovidae	*Bootherium bombifrons* (Harlan)
			Bison sp.

FAUNULES OF PRECISELY KNOWN AGE (RANCHOLABREAN)

Bar M Local Fauna

The sites representing the Bar M local fauna are near Buffalo in Harper County. During the summer of 1954, C. C. Branson (Oklahoma Geological Survey) and C. W. Hibbard and A. J. Myers (University of Michigan) discovered a Pleistocene locality along the bank of Willow Creek, and a rock sample was collected for screenwashing. A second site, located 11 km south of Buffalo, had been sampled similarly earlier. Collectively, fossils from these two sites constitute the Bar M local fauna, which consists mainly of gastropods. Taylor and Hibbard (1955) suggested that the gastropod assemblage indicates deposition during a cooler climate than at present (for example, a glacial stage). In order to assess the paleoenvironment of the Bar M fauna, Schaak and Franz (1978) sampled gastropods from five modern freshwater ponds near Buffalo, Harper County. They suggested that the depositional setting at the Bar M site represented a transformation from a loop in a meandering river to an oxbow lake. They concluded that the modern gastropod faunas sampled from ponds near Buffalo are indicative of a warmer climate (interglacial) than currently exists in this part of the State. In contrast to the modern gastropods, the Bar M gastropod fauna indicates a cooler climate (glacial stage) as described by Taylor and Hibbard (1955).

In assessing the age of the Bar M local fauna, Taylor and Hibbard (1955) compared it with three other sites in the region—Jones (Kansas; late Irvingtonian to early Rancholabrean), Jinglebob (Kansas; early Irvingtonian to late Rancholabrean), and Berends (Oklahoma; late Irvingtonian). They judged the Bar M gastropod assemblage to be most similar to the Berends fauna and concluded that it was late Irvingtonian. However, subsequent radiocarbon dating of gastropod shells from Bar M yielded a determination of 21,360 ± 1,250 YBP (Myers, 1965), indicating that it is much younger than previously thought.

The only mammal known from the Bar M local fauna is the beautiful armadillo, *Dasypus bellus*, represented by several scutes, one of only a few Pleistocene occurrences outside of Florida. A snake from Bar M was identified by Brattstrom (1967).

In a review of Pleistocene local faunas of north-central Texas, Dalquest and Schultz (1992) reported the beautiful armadillo from two local faunas (Easley Ranch in Foard County, and Slaton Quarry in Lubbock County) of Rancholabrean age.

The vertebrate fauna of the Bar M local fauna is listed in Table 12.

Howard Gully

Bison remains eroding from the spillway of a small pond along the North Fork of the Red River, Greer County, were discovered in the 1970s; the site was subsequently called Howard Gully (see Hofman and others, 1991). *Bison* was represented by a crushed skull, mandible fragments, and postcranial elements. In addition, the site produced a canid, small undetermined

TABLE 12. – Vertebrate Fossils from the Bar M Local Fauna

Class	Order	Family	Taxon
Reptilia	Squamata	Colubridae	*Nerodia* sp.
Mammalia	Xenarthra	Dasypodidae	*Dasypus bellus* Linnaeus

mammals, and two turtles. One of the turtles is unidentified and the other was referred to the giant tortoise, *Geochelone crassiscutata* (Hofman and others, 1991). An AMS analysis yielded an age determination of 10,810 ± 110 YBP, which may represent the terminal age for *G. crassiscutata* in the region (Hofman and others, 1991).

FAUNULES OF IMPRECISELY KNOWN AGE (PLEISTOCENE)

Botone

Ferring and Hall (1987) described the geology and paleontology of a Quaternary site approximately 25 km south of the town of Carnegie in Caddo County. The fauna includes two genera of clams, six genera of terrestrial gastropods, and teeth or tooth fragments belonging to *Mammuthus* sp. and *Equus* sp. The assemblage was believed to be late Pleistocene based on composition (Ferring and Hall, 1987), but no radiometric dates were provided. Attempts to recover microvertebrates from this site by the senior author and Bill May (Oklahoma Museum of Natural History) have proven fruitless. However gastropods are abundant at this locality.

At the Botone site, Ferring and Hall (1987) described three informal stratigraphic units based on an 80-m-thick measured section. The vertebrate fossils were obtained from the base of their unit B, which is a lacustrine deposit.

Braden

The discovery of a partial skull of *Symbos bombifrons* (= *Bootherium bombifrons*), a tooth of *Mammuthus* sp., and a partial skull of *Bison* sp. from about 25 km north of Fort Gibson, near the town of Braden in Le Flore County was reported by Hay (1924). However, if the fossils were obtained from the north side of the Arkansas River, the actual site would be in Sequoyah County. According to Hay (1924), the specimens are deposited in the collection of the St. Louis Academy of Science.

Canton Lake

A fossil locality, discovered by L. Anderson in the fall of 1997 on the shore of Canton Lake in Blaine County, revealed remains of the saber-tooth cat (*Smilodon fatalis*) and mammoth (*Mammuthus columbi*) (Gordon and Czaplewski, 1998). The saber-tooth cat is represented by an upper-left deciduous carnassial (dP3), and the mammoth is represented by ribs, tusks, mandible fragments, and a right-lower third molar. Although no radiometric date was provided, Gordon and Czaplewski (1998) suggested that the site was late Pleistocene. The date was based on the mammals collected (N. J. Czaplewski, personal communication, 1998). The saber-tooth cat represents the second reported from Oklahoma and the first associated with a mammoth in the State (Gordon and Czaplewski, 1998).

Crescent

In 1957, a partial skull of a saber-tooth cat, *Smilodon fatalis* (called *S. californicus* by Kitts, 1958; the two species are considered synonymous by Kurtén and Anderson, 1980) was discovered by J. McConnel in an active sand pit about 7 km south of Crescent, Logan County. Unfortunately, the specimen was damaged by machinery used for dredging the sand. Kitts (1958) indicated that the age of the terrace deposits of the Cimarron River where the specimen was discovered is unknown. Based on conjecture, he concluded that the specimen was not older than early Irvingtonian.

Deer Creek

A single specimen, a mandible of a ground sloth, was found on the J. Nelson farm near Deer Creek, Grant County, in beds of sand and gravel overlying Permian bedrock (Savage, 1946). The specimen was designated as the holotype of the subspecies *Megalonyx jeffersoni oklahomensis* (= *Megalonyx jeffersoni*) by Savage (1946).

Durham

The Durham site in Roger Mills County has produced a diverse assemblage of late Tertiary (Miocene) vertebrates from rocks belonging to the Ogallala Group (Kitts and Black, 1959). One specimen, originally identified as belonging to a juvenile of the Miocene camel *Megatylopus* cf. *M. gigas* (Kitts and Black, 1959), actually belongs

to *Bison* sp. (Czaplewski and others, 1994), indicating a mixture of Quaternary and Miocene fossils. The specimen in question was said to have been recovered from the buff sandstone that yielded the Miocene fauna, but we suspect that it weathered from the overlying cross-bedded quartz sandstone, thought to be Pleistocene (Kitts and Black, 1959).

Fort Gibson

The first published Pleistocene vertebrate fossil from what would later become Oklahoma was discovered by T. Kite along the Arkansas River near Fort Gibson, Muskogee County, in 1852. The specimen was sent to J. A. Leidy of the University of Pennsylvania (it is now in the collection of the Academy of Natural Sciences, Philadelphia; Spamer and others, 1995), who later (Leidy, 1852) described it as the then-new species of musk ox, *Bootherium cavifron*.

Fort Sill

Halloran (1975, p. 183) published a photograph of a specimen described as "the four foot-long horn core of the *Bison alleni* that was unearthed near Fort Sill, Comanche County, in 1968 by Museum of the Great Plains and Fort Sill Museum personnel." No other information on this find has been published, but the caption to a photograph on p. 182 of the same article suggested that the specimen may be deposited at the Fort Sill Museum. The status of this bison is in question; Kurtén and Anderson (1980) synonymized *Bison alleni* with *B. latifrons*.

Gittin' Down Mountain Cave

In 1975, W. L. Puckette discovered a right lower molar of the short-faced bear, *Arctodus*, in Gittin' Down Mountain Cave, Adair County. This cave has numerous horizontal entrances and more than 1.6 km of horizontal passageways. The tooth was found near one of the entrances; several circular depressions on the cave floor were interpreted as possible bear beds (Puckette, 1976). Measurements of the tooth suggest that, in size, it is closer to that of *Arctodus simus* than to *A. pristinus* (Puckette, 1976). The specimen in question represents the only known occurrence of the short-faced bear in Oklahoma.

Gould

In 1938, a railroad employee (C. L. Copeland) found fossil bones—later identified as belonging to an extinct ground sloth—near the town of Gould, Harmon County. The material was turned over to the superintendent of the local school system, E. Newberry, and ultimately came into the hands of J. W. Stovall. The site was described by Stovall (1940) as representing an east–west-oriented Pleistocene stream channel. The specimen, including a nearly complete skull, an isolated upper-right third cheektooth, a left scapula, a pelvis, and four fragmentary ribs, was referred to *Megalonyx hogani* by Stovall (1940). This species is now considered a junior synonym of *M. jeffersoni* (Kurtén and Anderson, 1980).

Grandfield

Numerous bones were discovered in 1984 along Cooper Creek near Grandfield, Tillman County, by L. McMahon. Among the fossils collected, W. W. Dalquest identified the remains of a Pleistocene horse (*Equus* sp.), wolf (*Canis lupus*), and mammoth (*Mammuthus columbi*) (Goetze, 1989). Goetze's (1989) study provides insights to the terrace system of the Red River at Cooper Creek, identification of the Quaternary vertebrates collected from this site, and their paleoenvironmental implications. In addition, Goetze (1989) lists several rodents, a rabbit, and a deer from the gray, sandy-clay unit dated at about 2,000 YBP.

Dalquest and Schultz (1992) mentioned that black bears are generally rare in the Pleistocene of north-central Texas. However, they noted the discovery of the jaw from a black bear in a small tributary of the Red River in Tillman County, Oklahoma, collected by Stangl and Dalquest (1986).

As described by Goetze (1989), three stratigraphic layers are exposed at the site—a thin layer of topsoil, sequentially underlain by yellowish sandy loam and thick brownish-gray clay. The lowest unit consists of gray, sandy clay, which produced mineralized bone (including the horn core of an early Holocene bison, *Bison antiquus*) and probably is the source of the specimens originally collected from the site. Mollusc shells collected from this lowest unit yielded a date of 2,000 ± 80 YBP (Goetze, 1989). None of the bones themselves have been dated; the late Holocene determination for the molluscs suggests that the Pleistocene and early Holocene bones were redeposited.

Hennessey

Fossils of a proboscidean and a scimitar-toothed cat were discovered in western Oklahoma by Mr. Painter, a rancher who lived near Hennessey, Kingfisher County (Hay, 1924). In 1893, E. D. Cope obtained from Mr. Painter the following specimens: teeth and isolated bones of

a mammoth and several teeth and skeletal elements of a saber-tooth cat. The remains of the scimitar cat became the type specimen for *Dinobastis serus* (= *Homotherium serum* Cope, 1893). *Homotherium serum*, though less common than the saber-tooth cat, *Smilodon*, occurred over a broad geographic range during the Rancholabrean (Kurtén and Anderson, 1980). Unfortunately, the locality (type locality) for the scimitar cat was not recorded by Cope (1893). He only mentioned that the specimens were from western Oklahoma. Kitts (1958) was unable to find the site from existing records. It is possible, however, that the site is approximately 13 km west of Hennessey, Kingfisher County (see Hay, 1924). The specimens from near Hennessey are housed at the Museum of the Academy of Natural Sciences of Philadelphia (Sparner and others, 1995).

Hydro

In the spring of 1936, J. Kaufman of Norman found the partial skull of what proved to be a shrub ox in a sand-and-gravel pit at Hydro, Caddo County. The specimen came into the hands of J. W. Stovall, who (1937) named it *Euceratherium bizzelli*, a name now considered to be a junior synonym of *E. collinum* (Kurtén and Anderson, 1980). Stovall (1937) also reported other materials from the site, including other bovids (bison and musk ox), equids, and proboscideans. The fossils reportedly came from a high-level, reworked gravel about 30 m above the Canadian River; Stovall (1937) indicated that the fossils were late Pleistocene.

A specimen later found at the same site by W. E. Salter, of the U. S. Geological Survey, proved to be a scute of the giant armadillo, *Holmesina septentrionalis* (see Stovall and Hibbard, 1948). Dalquest and Schultz (1992) reported the pampathere from two Irvingtonian localities from northwest Texas. These localities are the Gilliland local fauna in Knox and Wilbarger Counties, and Slaton Quarry in Lubbock County.

Lawton and Cheyenne

Two geographically distant occurrences—one near Cheyenne in Roger Mills County and the other near Lawton in Comanche County—are grouped together under the same heading. Although they are about 285 km apart, both sites contain only one species, the grizzly bear *Ursus arctos*, the presence of which is highly notable. A nearly complete skull was found at each site, and, at the time of discovery, these occurrences extended the known range for grizzly bears in the Great Plains (Stovall and Johnston, 1935). Although no specimens of this species have been recovered from Quaternary deposits in north-central Texas, Dalquest and Schultz (1992) indicated that the grizzly bear likely inhabited the area during the latest Pleistocene.

The specimen from the vicinity of Lawton reportedly was found about 2 m below the surface in river gravels presumed to be Pleistocene. However, no direct reference to the site was made, and the identity of the river is uncertain.

The other specimen, also from river gravels reportedly occurring about 1 m below the surface, was recovered north of Cheyenne (Stovall and Johnston, 1935). This is the more complete of the two specimens and includes the third-left incisor and the zygomatic arches (which are missing in the specimen from Lawton).

In comparing the two specimens with skulls of modern grizzly bears, Stovall and Johnston (1935) noted minor differences and referred the Oklahoma skulls to a new subspecies, *Ursus horribilis oklahomensis*. Since a holotype was not indicated and no diagnosis was provided, this subspecies is a *nomen nudum* (Czaplewski and others, 1994), and the skulls in question are referred to the living species, *Ursus arctos*.

Graham (1991) examined several morphological features of the dentition of Quaternary black bears in North America. Of the dental characters that he used, the length of the M2 appears to be the most reliable for distinguishing between modern forms of grizzly and black bears. Graham (1991) suggested that the M2 length of any late Pleistocene black bear would be no greater than 32 mm. Based on the length of the M2 (30 mm) provided by Stovall and Johnston (1935), Graham concluded that the two grizzly bear skulls from Oklahoma were actually large black bears. After a close examination of the bear skull from Lawton, housed at OMNH, N. J. Czaplewski (personal communication, 1998) agreed with Graham (1991) that the skull was that of a large black bear *Ursus americanus*. The skull from Cheyenne is housed at the Black Kettle Museum in Cheyenne and was not re-examined by Czaplewski (personal communication, 1998).

Long Horn Mountain

Fossil bones were discovered near Long Horn Mountain, approximately 22.5 km south of Mountain View, Kiowa County, by C. J. Dussome in August 1925. The locality, a spring deposit, was visited that same year by J. W. Gidley, who made a small collection now deposited at the Smithsonian Institution (Gidley, 1925). The assemblage reportedly includes extinct horse,

mammoth, mastodon, and mylodontid sloth, but no species identifications were given (Gidley, 1925).

Mulhall

Pleistocene vertebrates were found by H. F. Sears in a channel-fill deposit near the town of Mulhall, Logan County, in 1911. Troxell (1917) reported the following taxa for this site: mammoth, mastodon, bison (with a 39-cm horn span), deer, tapir, giant ground sloth, and turtle. Hay (1924) stated that no other information had been published from this site by Troxell or C. N. Gould (University of Oklahoma), who had visited the site before Troxell. Where these fossils are housed remains a mystery.

Nye Sink

The Nye Sink, an ancient freshwater basin, is located on the XIT Ranch (formally the east part of the old XI Ranch) in Beaver County, 33.8 km south of Meade, Kansas (Harrell, 1959). Based on a stratigraphic section measured by Smith (1940), diatomaceous earth is present in the Nye Sink. The assemblage includes two birds, *Lophodytes cucullatus* (see Lunk, 1952) and *Mareca americana* (see Harrell, 1959), and the garter snake, *Thamnophis* sp. (Brattstrom, 1967).

Yukon

In the summer of 1922, E. D. Crabb, of the Public Museum, Milwaukee, Wisconsin, discovered skeletal fragments in alluvial redbeds near Yukon, Canadian County. One specimen, consisting of a proximal femur, was identified as belonging to *Bison occidentalis* by Crabb (1924), who donated the bison femur to the University Museum at Norman (Oklahoma Museum of Natural History). Traditionally, bison taxonomy has relied on the horn cores of the male sex (Dalquest and Schultz, 1992). Therefore, we regard the taxonomy of this specimen represented by a femur as indeterminate and furthermore point out that the status of *B. occidentalis* is uncertain. Dalquest and Schultz (1992) suggested that it may be synonymous with *B. bison*.

PRELIMINARY LIST OF THE DISTRIBUTION OF PLEISTOCENE PROBOSCIDEA IN OKLAHOMA

As mentioned previously, Pleistocene proboscideans, generally found as isolated occurrences, are commonly encountered in Oklahoma, as they are in many of the plains states. The first published listing of Pleistocene proboscideans in Oklahoma was that of Decker (1924), who noted 20 sites, named for nearby towns: Afton (Ottawa County), Belva (Woodward County), Carnegie (Caddo County), Chickasha (Grady County), Cordell (Washita County), Eldorado (Jackson County), Fort Cobb (Caddo County), Garber (Garfield County), Haskell (Muskogee County), Hitchcock (Blaine County), Hollis (Harmon County), Kenton (Cimarron County), Lawton (Comanche County), McAlester (Pittsburg County), Miami (Ottawa County), Newkirk (Kay County), Noble (Cleveland County), Ponca City (Kay County), Stigler (Haskell County), and Woodward (Woodward County). Decker (1924) provided a few details for some of the sites and also noted the occurrence of additional sites, for which locality information was unavailable, in the eastern and northeastern part of the State.

Thirty-three localities provided by Lintz (1980) and Northcutt (1984) for the occurrence of elephants in the State are as follows: Allison-Menifee site (Oklahoma County); Bartow site (Woodward County); Binger, Botone site (Caddo County); Burnham #1, Burnham #2 (Woods County); Chickasha (Grady County); Cooperton (Kiowa County); Colony, Cordell (Washita County); Doby Springs (Harper County); Domebo site, Eakley, Ft. Cobb (Caddo County); Geary (Canadian County); Hennessey (Kingfisher County); Hobart (Kiowa County); Holloman (Tillman County); Hajny site (Dewey County); Kingfisher (Kingfisher County); Lawton (Comanche County); Lehoma (Major County); Marshall (Logan County); Maysville (Garvin County); Norman (Cleveland County); Okeene (Blaine County); Rosedale (McClain County); Silvers (Washita County); Stephans site (Comanche County); Stuckey (Cotton County); Tripp (Kay County); Walker (Cleveland County); and a site near the town of Enid (Garfield County).

Fossil localities with proboscideans reported herein and not listed by Lintz (1980) and Northcutt (1984) are Afton (Ottawa County), Berends (Beaver County), Braden (Le Flore County), Chickasha (Bowles Pit, Casady Pit, and C. E. Smith Pit—Grady County), Elm Creek (Beaver County), Grandfield (Tillman County), Hydro (Caddo County), Long Horn Mountain (Kiowa County), Mulhall (Logan County), and Tesequite (Cimarron County).

Wyckoff and Czaplewski (1997) discussed the occurrence of fossil proboscideans in Oklahoma. They suggested more than 50 reported localities for proboscideans in Oklahoma, with the possibility of twice as many unreported elephant sites for the State. They suggested Afton and the other

TABLE 13.—Vertebrate Fossils from the Burnham Local Fauna

Class	Order	Family	Taxon
Osteichthyes	Perciformes	Centrarchidae	Genus indet.
Amphibia	Caudata	Ambystomatidae	*Ambystoma* cf. *a. texanum* (Matthes)
			A. tigrinum (Green)
		Ranidae	*Rana catesbeiana* Shaw
			R. pipiens Schreber
Reptilia	Crocodilia	Alligatoridae	*Alligator* cf. *A. mississippiensis* (Daudin)
	Testudines	Chelydridae	*Chelydra serpentina* (Linnaeus)
		Emydidae	*Clemmys* sp.
		Trionychidae	*Trionyx* sp.
	Squamata	Colubridae	*Coluber* cf. *C. constrictor* Linnaeus
			Elaphe obsoleta (Say)
			Lampropeltis cf. *L. calligaster* (Harlan)
			L. getula (Linnaeus)
			Nerodia cf. *N. erythrogaster* (Foster)
			N. rhombifera (Hallowell)
			Regina grahamii Baird and Girard
			Thamnophis cf. *T. proximus* (Say)
			T. radix (Baird and Girad)
		Viperidae	*Crotalus* sp.
Aves	Anseriformes	Anatidae	Genus indet.
Mammalia	Insectivora	Talpidae	*Scalopus aquaticus* (Linnaeus)
	Xenarthra	Megatheriidae	*Nothrotheriops shastensis* (Sinclair)
		Dasypodidae	Genus indet.
	Carnivora	Canidae	Genus indet.
		Felidae	Genus indet.
	Rodentia	Sciuridae	*Cynomys ludovicianus* (Ord)
		Geomyidae	*Geomys* sp.
		Muridae	*Neotoma* cf. *N. floridana* (Ord)
			Synaptomys cf. *S. cooperi* Baird
			Microtus cf. *M. ochrogaster* (Wagner)
	Lagomorpha	Leporidae	*Lepus* sp.
	Perissodactyla	Equidae	*Equus* sp.
	Artiodactyla	Camelidae	*Hemiauchenia* sp.
		Cervidae	*Odocoileus* sp.
		Bovidae	*Bison priscus* (Bojanus)
	Proboscidea	Elephantidae	*Mammuthus* sp.

Ottawa County localities may warrant further study using new techniques for radiometric dating, as well as taphonomic investigations to clear up controversies associated with the fauna (for example, how the fossils were deposited and the ages of the fossil material).

IMPORTANT ARCHEOLOGICAL SITES WITH PLEISTOCENE VERTEBRATES

Burnham

Sediments containing a late Pleistocene fauna were exposed during the reconstruction of a farm pond owned by the Burnham family in Woods County (Wyckoff, Brackenridge, and others, 1991). The fauna includes 36 fish, amphibian, reptile, bird, and mammalian taxa based on more than 550 individual specimens collected over the course of three field seasons. Radiocarbon dates obtained from various stratigraphic horizons range from 11,850 ± 320 to 40,900 ± 1,600 YBP (Wyckoff, Brackenridge, and others, 1991). The fauna is thought to represent a marshy-pond habitat, with associated nearby grassland elements (Wyckoff, Brakenridge, and others, 1991; Wyckoff, Carter, and others, 1991).

Table 14.—Vertebrate Fossils from the Domebo Local Fauna

Class	Order	Family	Taxon
Amphibia	Anura	Hylidae	*Acris crepitans* Baird
		Ranidae	*Rana pipiens* Schreber
Reptilia	Squamata	Colubridae	*Thamnophis sauritus* (Say)
		Crotalidae	Genus indet.
	Testudines	Testudinidae	*Geochelone* cf. *G. wilsoni* (Milstead)
Mammalia	Rodentia	Geomyidae	*Geomys* cf. *G. bursarius* (Shaw)
		Heteromyidae	*Chaetodipus hispidus* (Baird)
		Muridae	*Sigmodon hispidus* Say and Ord
			Microtus ochrogaster (Wagner) or *M. pinetorum* (Le Conte)
			Ondatra zibethicus (Linnaeus)
			Synaptomys cf. *S. cooperi* Baird
	Artiodactyla	Bovidae	*Bison antiquus* (Leidy)
		Proboscidea	*Mammuthus* sp.

The fossil vertebrates from the Burnham local fauna are listed in Table 13.

Domebo Local Fauna

Vertebrate fossils at the Domebo site, located near Apache, Caddo County, were discovered by J. E. "Buck" Patterson in 1961 (Leonhardy, 1966) and were first reported to M. Tong, Museum of the Great Plains, by L. F. Patterson (L. F. Patterson, personal communication, 1996).

Slaughter (1966) obtained a vertebrate fauna (including amphibians, reptiles, and mammals) from Domebo based on screenwashing about 1.4 metric tons of matrix collectively obtained from two localities situated 183 m apart. In addition, a plastron fragment of a turtle and a maxilla of a bison were found in association with mammoth teeth from the site (Slaughter, 1966).

A variety of radiometric dates, based on different organic materials, have been obtained from the Domebo site. Leonhardy and Anderson (1966) listed six different materials that were sampled for dating. Age determinations ranged from 4,952 ± 304 YBP (based on untreated elephant tusk said to be contaminated) to 11,220 ± 500 YBP (based on bone organics). Leonhardy and Anderson (1966) believed that the terminal date for the lower member of the Domebo Formation was 10,123 ± 280 YBP, obtained from a sample of lignitic wood, because the lignitic wood sample was collected during the screenwashing of matrix collected about 0.75 m above the bone-bearing bed. Other dates from Domebo as given by Leonhardy and Anderson (1966) and Davis (1987) are 11,220 ± 500 YBP for bone collagen, 11,020 ± 600 YBP for humic acid, and 9,400 ± 300 YBP organic earth, respectively.

The fossil vertebrates from the Domebo local fauna are listed in Table 14.

Hajny Mammoth Site

The Hajny site, located along the Canadian River in Dewey County, is in a gravel quarry, owned and operated by W. Hajny, where mammoth bones were exposed. Controlled archeological excavation was undertaken in 1985 by D. G. Wyckoff and a group of volunteers (Wyckoff, Carter, and others, 1992). Radiocarbon dates were obtained from a variety of materials from the quarry, including samples of bone, mammoth tooth enamel, sediment, and snail shells. In addition, a uranium/thorium date was obtained from the enamel of a mammoth tooth. Wyckoff, Carter, and others (1992) obtained a radiocarbon date of 8,960 ± 240 YBP from the mammoth bone. However, a uranium/thorium date from tooth enamel from the same animal indicated an age of 143,026 ± 5,500 YBP. They implied that the technique used to determine the date from tooth enamel, uranium/thorium series, was in the experimental stage, and that, therefore, the date was not reliable.

The vertebrate fauna of Hajny includes frog (*Rana* sp.), duck (*Aix* sp.), a turtle (*Terrapene* sp.), and several mammals—pocket gopher (*Geomys* sp.), water rat (*Neofiber leonardi*), mammoth (*Mammuthus* sp.), pronghorn (Antilocapridae), and horse (*Equus* sp.). The mammals collected from Hajny were identified and discussed by Martin (1992).

SUMMARY

The published record of Oklahoma's Pleistocene vertebrates includes 30 paleontological local faunas and faunules, along with three archeological localities. Only four local faunas and five faunules were reported after the middle 1960s. Of the 33 Pleistocene sites listed, three are archeological in nature. All of the archeological excavations occurred during or after the middle 1960s. The numerous finds prior to the middle 1960s may reflect, in part, on the spirit of the paleontologists of the past (H. J. Cook, E. D. Cope, J. W. Gidley, O. P. Hay, C. S. Johnston, J. A. Leidy, and J. W. Stovall), the financial backing of their institutions, or simply the era. These individuals were able to explore fossil discoveries and pursue information first hand concerning new fossils. Although the above-mentioned paleontologists made great contributions to their discipline, they also took the time to publish notes and faunal lists. Unfortunately, the current scientific environment does not promote the publication of faunal lists and notes. These types of publications will not get you recognized, earn you tenure, or build your credentials in order to be competitive for money from national or state-funded agencies. Furthermore, there are presently many amateur paleontologists who collect fossils in Oklahoma. Many of these are reluctant to share their findings with the scientific community partly because they fear having to give up their treasures. Or worse for science, they expect institutions or individuals to pay great sums of money for their fossil finds. In any event, when amateurs do not share information with the scientific community the fossils remain unknown. Thus, they become insignificant as far as science is concerned.

Both North American Land Mammal ages of the Pleistocene, the Irvingtonian and Rancholabrean, are represented in Oklahoma, although fossil-bearing beds of Irvingtonian age are rare in the State. Only three (Holloman, Berends, and Quinlan) of the 33 faunas reviewed are of possible Irvingtonian age. One of the Irvingtonian localities, the Holloman Gravel Pit, probably represents the early Irvingtonian (Kurtén and Anderson, 1980; Dalquest, 1977). A latest Irvingtonian age was determined for the Berends local fauna (Taylor, 1954; Kurtén and Anderson 1980), where the beaver *Paradipoides stovalli*, a single family of fish, a few bird bones, and two additional families of mammals were discovered. The Quinlan fauna discovered in the early 1920s was re-examined in part by Akersten and McDonald (1991), who considered the fauna to be Irvingtonian in age. Although a fourth fossil locality at Chickasha (specifically, the Robert Bowles Gravel Pit) was considered to be of the same age as the Holloman site by Strain (1937), we listed the locality with the late Pleistocene (Wisconsinan) faunas, based on the range (Rancholabrean) of included taxa.

The published fossil vertebrates of Irvingtonian age from Oklahoma represent a diverse variety of forms, including five extant classes of vertebrates (fish, amphibians, reptiles, birds, and mammals). At the Holloman site, two turtles were the only non-mammalian vertebrates discovered. If the identification of the elephant from this site as *Stegomastodon* is correct, this site is the only locality in the State to produce that genus. Based on Kurtén and Anderson's (1980) work, *Stegomastodon* is a taxon of New World gomphotheres that was present from the Blancan through the early Irvingtonian. More recently, Dalquest and Schults (1992) suggested that the presence of *Stegomastodon* indicated an early Pleistocene or Blancan age. In addition to other proboscideans, the macrofossils exhumed included llama, tapir, camel, and horse, whereas only one microfossil (*Cynomys ludovicianus*) was recovered. The Berends local fauna consisted of five orders and eight families of fish, a single genus of bird, and six orders and 10 families of mammals, including four new species of rodents. The Quinlan local fauna was considered tentatively to be Irvingtonian based on the co-occurrence of *Geochelone* and the Shasta ground sloth. Another turtle, scimitar cat, horse, and camel were also recorded from Quinlan. The Chickasha local fauna consists of three different sites: (1) the Robert Bowles Pit, which contained two turtles, two birds, and four orders and 10 families of mammals; (2) the C. E. Smith Pit, which produced a single family of turtles and four orders and eight families of mammals; and (3) the third gravel pit at Chickasha, Casady, which yielded a single family of turtles, one family of birds, and four orders and families of mammals.

Faunas and faunules representing the Rancholabrean land-mammal age are the most frequent Pleistocene occurrences in the State. More than 90% of the 33 Pleistocene vertebrate local faunas and faunules described are from Rancholabrean deposits. Six of nine local faunas, 21 faunules, and three archeological sites discussed herein are considered late Pleistocene.

One of the most diverse Rancholabrean faunas is that of Doby Springs. This fauna includes three orders and five families of fish, a single am-

phibian, one reptile, unidentified birds, and seven orders (including 10 families) of mammals. The deer mouse (*Peromyscus oklahomensis*) and the only Pleistocene State record of a jumping mouse (*Zapus hudsonius*) are from Doby Springs. To date, the nearest records in Oklahoma for modern forms of the jumping mouse are from Tulsa County and southeast Kansas (Jones and others, 1986; Blair, 1938). Therefore, these fossil zapodids represent a more westerly distribution than that displayed by the jumping mouse today. These mice prefer a wetter cooler climate; thus, the paleoenvironment of western Oklahoma may have been cooler and wetter than it is today. Dalquest and Schultz (1992) stated that there were no records of zapodids for northwest Texas; however, their discovery in the area would not be surprising. The Afton fauna includes both Recent and fossil remains of four orders and seven families of mammals, including the only record of a stag moose (*Cervalces scotti*) for the State. Five orders and seven families of mammals were collected from the Tesequite local fauna, with the first Pleistocene chipmunks (*Tamias quadrivitattus* and *T. minimus*) collected from the State. At Bar M, a single colubrid snake and a single mammalian specimen, an extinct armadillo (*Dasypus bellus*), are the only vertebrates reported. The Elm Creek local fauna includes five orders and eight families of mammals.

Numerous faunules of imprecisely known age containing one or several vertebrate fossils from Pleistocene deposits have been reported from Oklahoma. A spring from Long Horn Mountain yielded three orders and four families of mammals. Only two families of birds and a snake, as well as a large tortoise (*Gopherus* sp.) that no longer occurs in the area today, were collected from Nye Sink. The Deer Creek locality includes a new subspecies of ground sloth (*Megalonyx jeffersonii oklahomaensis* = *M. jeffersonii*). A new ungulate for Oklahoma was discovered at Hydro and was described as a new species *Euceratherium bizzelli* (= *E. collinum*). In Gittin' Down Mountain Cave, the only State record of a giant short-faced bear was reported. From Crescent, a saber-tooth cat (*Smilodon*) was discovered. The first scimitar cat *Dinobastis serus* (= *Homotherium serum*) was discovered from western Oklahoma, possibly near Hennessey. Cooper Creek near Grandfield, produced three taxa of large mammals (mammoth, horse, and bison). At Washita, near Weatherford, three taxa of large mammals (musk ox, bison, and horse) and several small mammals (Geomyidae, Heteromyidae, and Muridae) have been reported. Although the vertebrates reported from Durham were thought to be Pliocene, they evidently include a mixture of taxa of different ages, at least one of which is Pleistocene. At Yukon the remains of a single bison were collected. More than 30 proboscidean localities have been reported for the State. Near the town of Mulhall, one turtle, four orders and five families of mammals (mammoth, mastodon, bison, deer, tapir, and a giant ground sloth) have been collected.

Three archeological excavations that included vertebrate faunas were reviewed. The Burnham local fauna contains one fish, two families of amphibians, three orders and six families of reptiles (including the only Pleistocene report of an alligator for the State; today they inhabit the swamps in the southeastern corner of Oklahoma), one family of birds, and eight orders and 12 families of mammals. The Domebo local fauna consists of one order and two families of amphibians, two orders and three families of reptiles, and three orders and five families of mammals. Artifacts were found in association with a mammoth at Domebo. Although no artifacts were found at Hajny, remains of several vertebrates were collected, including one amphibian, one reptile, a bird, and four orders and five families of mammals with the first report of a water rat (*Neofiber leonardi*) for the Pleistocene of Oklahoma. With the presence of the water rat and alligators in northwestern Oklahoma, the past environment for this area must have been very wet with pools of standing water. In addition, the temperature was likely warmer in the winter than present-day northwestern Oklahoma. Alligators inhabit southeastern Oklahoma today, however the winter temperatures in this area are still too cool for the water rat. The only living species of water rat is found in Georgia and Florida.

Currently, D. G. Wyckoff and W. W. Dalquest are collecting Pleistocene fossil vertebrate remains from the eastern part of the State along the Canadian River (D. G. Wyckoff, personal communication, 1998). Their work should provide additional fossils from eastern Oklahoma, thus filling a void for Pleistocene fossils in that region.

Excluding the list of proboscidean localities in the State, the faunas and faunules represented encompass a total of 22 counties, most from the panhandle and western part of the State. With many tributaries, pond deposits, gravel pits, old stream terraces, and caves throughout the State and few localities reported or described, more Pleistocene deposits containing vertebrate fos-

sils undoubtedly will be discovered in the future. Only a few of the faunas and faunules listed were collected with the aid of screenwashing techniques. With improvements for screenwashing and the architecture of the screen-boxes (Cifelli and others, 1996), many additional fossil discoveries should be generated in Oklahoma.

ACKNOWLEDGMENTS

We thank P. B. Smith and N. J. Czaplewski for reviewing an earlier version of this manuscript. We thank D. G. Wyckoff for leading us through the archeological literature. The senior author thanks W. W. Dalquest for introducing him to the challenges of Quaternary research.

REFERENCES CITED

American Ornithologists Union, 1983, Check-list of North American birds [6th edition], 877 p.

Akersten, W. A.; and McDonald, H. G., 1991, *Nothrotheriops* from the Pleistocene of Oklahoma and paleogeography of the genus: Southwestern Naturalist, v. 36, p. 178–185.

Antevs, Ernst, 1935, The spread of aboriginal man to North America: Geographic Review, v. 25, p. 302–309.

Banks, R. C.; McDonald, R. W.; and Gardner, A. L. (eds.), 1987, Check-list of vertebrates of the United States, the U.S. Territories, and Canada: U.S. Department of the Interior, Fish and Wildlife Service Resource Publication 166, Washington, D.C., 79 p.

Brattstrom, B. H., 1967, A succession of Pliocene and Pleistocene snake faunas from the High Plains of the United States: Copeia, v. 1967, p. 188–202.

Blair, W. F., 1938, Ecological relationships of the mammals of Bird Creek region, northeastern Oklahoma: American Midland Naturalist, v. 20, p. 473–526.

Carpenter, C. C.; and Krupa, J. J., 1989, Oklahoma herpetology: an annotated bibliography: University of Oklahoma Press, Norman, 258 p.

Carroll, R. L., 1988, Vertebrate paleontology and evolution: W. H. Freeman and Company, New York, 698 p.

Chantell, C. J., 1966, Late Cenozoic hylids from the great plains: Herpetologica, v. 22, p. 259–264.

Cifelli, R. L.; Madsen, S. K.; Larson, E. M., 1996, Screenwashing and associated techniques for the recovery of microvertebrate fossils, *in* Cifelli, R. C. (ed.), Techniques for recovery and preparation of microvertebrate fossils: Oklahoma Geological Survey Special Publication 96-4, p. 1–24.

Cook, H. J., 1927a, New geological and paleontological evidence bearing on the antiquity of mankind in America: Natural History, v. 7, p. 240–247.

_____ 1927b, New trails of early man in America: Scientific American, v. 137, p. 114–117.

_____ 1928, Further evidence concerning man's antiquity at Frederick, Oklahoma: Science Newsletter Series, v. 67, p. 371–373.

_____ 1931, The antiquity of man as indicated at Frederick, Oklahoma: a reply: Journal of the Washington Academy of Sciences, v. 21, p. 161–166.

Cope, E. D., 1893, A new Pleistocene sabre-tooth: American Naturalist, v. 27, p. 896–897.

Crabb, E. D., 1924, The occurrence of *Bison occidentalis* in Oklahoma: Proceedings of the Oklahoma Academy of Science, v. 4, p. 124.

Czaplewski, N. J.; Cifelli, R. L.; and Langston, Wann, Jr., 1994, Catalog of type and figured fossil vertebrates, Oklahoma Museum of Natural History: Oklahoma Geological Survey Special Publication 94-1, 35 p.

Dalquest, W. W., 1977, Mammals of the Holloman local fauna, Pleistocene of Oklahoma: Southwestern Naturalist, v. 22, p. 255–268.

Dalquest, W. W.; and Baskin, J. A., 1992, Mammals of the Elm Creek local fauna, late Pleistocene of Beaver County, Oklahoma: American Midland Naturalist, v. 127, p. 13–20.

Dalquest, W. W.; and Hughes, J. T., 1965, The Pleistocene horse, *Equus conversidens*: American Midland Naturalist, v. 74, p. 408–417.

Dalquest, W. W.; and Schultz, G. E., 1992, Ice Age mammals of northwestern Texas: Midwestern State University Press, Wichita Falls, Texas, 309 p.

Dalquest, W. W.; and Stangl, F.B., Jr., 1989, Late Pleistocene mammals from the northwestern corner of the Oklahoma panhandle: The Texas Journal of Science, v. 41, p. 35–47.

Dalquest, W. W.; Stangl, F. B., Jr.; and Kocurko, M. J., 1990, Zoogeographic implications of Holocene mammal remains from ancient beaver ponds in Oklahoma: Southwestern Naturalist, v. 35, p. 105–110.

Davis, L. C., 1987, Late Pleistocene/Holocene environmental changes in the central plains of the United States: the mammalian record, *in* Graham, R. W.; Holmes, S. A., Jr.; and Graham, M. A. (eds.), Late Quaternary mammalian biogeography and environments of the Great Plains and Prairies: Illinois State Museum Scientific Papers, v. 22, p. 88–143.

Decker, C. E., 1924, A preliminary list giving the distribution of Proboscidea in Oklahoma: Proceedings of the Oklahoma Academy of Science, v. 4, p.123–124.

Etheridge, Richard, 1960, The slender glass lizard,

Ophisaurus attenuatus, from the Pleistocene (Illinoian Glacial) of Oklahoma: Copeia, no. 1960, p. 46–47.

_____ 1961, Late Cenozoic glass lizards (*Ophisaurus*) from the southern great plains: Herpetologica, v. 17, p. 179–186.

Ernst, C. H., 1991, Systematics, taxonomy, variation, and geographic distribution of the slider turtle, *in* Gibbons, J. W.; and Sheffield, R. (eds.), Life history and the ecology of the slider turtle: Smithsonian Institution Press, Washington, D.C., p. 57–67.

Ernst, C. H.; and Barbour, R. W., 1972, Turtles of the United States: University Press of Louisville, Kentucky, 347 p.

Evans, O. F., 1930, The antiquity of man as shown at Frederick, Oklahoma, a criticism: Journal of the Washington Academy of Sciences, v. 20, p. 475–479.

Ferring, C. R.; and Hall, S. A., 1987, Botone locality, *in* Ferring, C. R. (ed.), Late Quaternary stratigraphy, neotectonics and geoarcheology of southwestern Oklahoma: Guidebook for the Fifth Annual Field Trip, Institute of Applied Sciences, North Texas State University, Denton, p. 80–88.

Figgins, J. D., 1927, The antiquity of man in America: Natural History, v. 27, p. 229–239.

Flint, R. F., 1957, Glacial and Pleistocene geology: John Wiley and Sons, New York, 553 p.

Frost, D. R., 1985, Amphibian species of the world: a taxonomic and geographic reference: Allen Press, Lawrence, Kansas, 732 p.

Frye, J. C.; Swineford, Ada; and Leonard, A. B., 1948, Correlation of Pleistocene deposits of the central Great Plains with the glacial section: Journal of Geology, v. 56, p. 501–525.

Gidley, J. W., 1925, Exploration of a Pleistocene spring-deposit in Oklahoma: Smithsonian Miscellaneous Contributions, v. 78, p. 7–28.

Gillette, D. D.; and Ray, C. E., 1981, Glyptodonts of North America: Smithsonian Contributions to Paleobiology, no. 40, 255 p.

Goetze, J. R., 1989, Mammalian faunas of a late Pleistocene–Holocene terrace of the Red River, Tillman County, Oklahoma: The Texas Journal of Science, v. 41, p. 205–209.

Goin, C. J.; Goin, O. B.; and Zug, G. R., 1978, Introduction to herpetology [3rd edition]: W. H. Freeman and Company, San Francisco, 378 p.

Gordon, C. L.; and Czaplewski, N. J., 1998, Second record of the Pleistocene saber-toothed cat *Smilodon fatalis* in Oklahoma: Proceedings of the Oklahoma Academy of Science, v. 78, p. 133–135.

Gould, C. N., 1929a, The fossil Glyptodon in the Frederick gravel beds: Proceedings of the Oklahoma Academy of Science, v. 8, p. 148–150.

_____ 1929b, Fossil bones and artifacts at Frederick: Proceedings of the Oklahoma Academy of Science, v. 9, p. 90–92.

_____ 1929c, On the recent finding of another flint arrow-head in the Pleistocene at Frederick, Oklahoma: Journal of the Washington Academy of Science, v. 19, p. 66.

Graham, R. W., 1991, Variability in the size of North American Quaternary black bears (*Ursus americanus*) with the description of a fossil black bear from Bill Neff Cave, Virginia, *in* Purdue, J. W.; Klippel, W. E.; and Styles, B. W. (eds.), Beamers, bobwhites, and blue-points: tributes to the career of Paul W. Parmalee: Illinois State Museum Scientific Papers, v. 23, p. 237–250.

Hall, E. R., 1981, The mammals of North America: John Wiley and Sons, New York, v. 1, 181 p.

Halloran, A. F., 1975, Wildlife sanctuary of the forests and plains mammals of the Wichitas: The Great Plains Journal, v. 14, p. 175–209.

Harrell, B. E., 1959, Notes on fossil birds from the Pleistocene of Kansas and Oklahoma: Proceedings of the South Dakota Academy of Science, v. 38, p. 103–106.

Harris, A. H., 1985, Late Pleistocene vertebrate paleoecology of the West: University of Texas Press, Austin, 293 p.

_____ 1993, Quaternary vertebrates of New Mexico, *in* Lucas, S. G.; and Zidek, Jiri (eds.), Vertebrate paleontology in New Mexico: New Mexico Museum of Natural History and Science Bulletin, v. 2, p. 179–197.

Hay, O. P., 1918, Further consideration of the occurrence of human remains in the Pleistocene deposits at Vero, Florida: American Anthropology, new series, v. 20, p. 21–23.

_____ 1920, Descriptions of some Pleistocene vertebrates found in the United States: Proceedings of the United States National Museum, v. 58, p. 83–146.

_____ 1924, The Pleistocene of the middle region of North America and its vertebrated animals: Carnegie Institution of Washington Publication 322a, p. 4–256.

_____ 1928, On the antiquity of relics of man at Frederick, Oklahoma: Science, v. 27, p. 442–444.

_____ 1929, On the recent discovery of a flint arrow-head in early Pleistocene deposits at Frederick, Oklahoma: Journal of the Washington Academy of Science, v. 19, p. 93–98.

Hay, O. P.; and Cook, H. J., 1928, Preliminary descriptions of fossil mammals recently discovered in Oklahoma, Texas, and New Mexico: Proceedings of the Colorado Museum of Natural History, v. 8, p. 1–33.

_____ 1930, Fossil vertebrates collected near,

in association with, human artifacts at localities near Colorado, Texas; Frederick, Oklahoma; and Folsom, New Mexico: Proceedings of the Colorado Museum of Natural History, v. 9, p. 4–40.

Hibbard, C. W., 1939, A new *Synaptomys* from the Pleistocene: University of Kansas Science Bulletin, v. 26, p. 367–371.

_____ 1949, Pleistocene stratigraphy and paleontology of Meade County, Kansas: Contributions of the Museum of Paleontology, University of Michigan, v. 7, p. 63–90.

_____ 1953, The Saw Rock Canyon fauna and its stratigraphic significance: Papers of the Michigan Academy of Science, Arts and Letters, v. 38, p. 387–411.

Hibbard, C. W.; and Rinker, G. C., 1942, A new bog lemming (*Synaptomys*) from Meade County, Kansas: University of Kansas Science Bulletin, v. 48, p. 25–35.

Hofman, J. L.; Todd, L. C.; Graham, R. W.; and King, F. B., 1991, Howard Gully: a terminal Pleistocene record from southwestern Oklahoma: Current Research in the Pleistocene, v. 8, p. 33–36.

Holman, J. A., 1986, Snakes of the Berends local fauna (Pleistocene, early Illinoian) of Oklahoma: Copeia, v. 1986, p. 811–812.

_____ 1995, Pleistocene amphibians and reptiles in North America: Oxford Monographs in Geology and Geophysics, no. 32, Oxford University Press, New York, 243 p.

Holmes, W. H., 1902, Flint implements and fossil remains from a sulphur spring at Afton, Indian Territory: American Antropologist, new series, v. 4, p. 108–129.

Hubbs, Clark; Edwards, R. J.; and Garrett, G. P., 1991, An annotated check list of the fresh water fishes of Texas with keys to species identification: The Texas Journal of Science Supplement, no. 43, 56 p.

Hulbert, R. C., Jr.; and Morgan, G. S., 1993, Quantitative and qualitative evolution in the giant armadillo *Holmesina* (Edentata: Pampatheriidae) in Florida, *in* Martin, R. A.; and Barnosky, A. D. (eds.), Morphological change in Quaternary mammals of North America: Cambridge University Press, United Kingdom, p. 134–177.

Jones, J. K., Jr.; Carter, D. C.; Genoways, H. H.; Hoffman, R. S.; Rice, D. W.; and Jones, Clyde, 1986, Revised checklist of North American mammals north of Mexico: The Museum of Texas Tech, Occasional Papers, no. 107, p. 1–22.

Kirkland, Henry, Jr.; and Hilliard, Julian, 1996, Extinct musk ox from western Oklahoma: Southwestern Naturalist, v. 41, p. 190–191.

Kirkland, Henry, Jr.; Dill, J. D.; and Selfridge, Wendy, 1991, Some late Pleistocene vertebrates from western Oklahoma: Proceeding of the Oklahoma Academy of Science, v. 71, p. 55.

Kirkland, Henry, Jr.; Davis, Michael; Wood, Janet; Devine, Dustin; and Giblet, Kyle, 1997, Some late Pleistocene fossils from the Washita local fauna: Proceedings of the Oklahoma Academy of Science, v. 77, p. 113–115.

Kitts, D. B., 1958, A saber-tooth cat, *Smilodon californicus* Bovard, from Logan County, Oklahoma: Oklahoma Geology Notes, v. 18, p. 19–23.

Kitts, D. B.; and Black, C. C., 1959, A Pliocene vertebrate local fauna from Roger Mills County, Oklahoma, *in* Kitts, D. B., Cenozoic geology of northern Roger Mills County, Oklahoma: Oklahoma Geological Survey Circular 48, part 2, p. 27–47.

Klingener, David, 1963, Dental evolution of *Zapus*: Journal of Mammalogy, v. 44, p. 248–260.

Kurtén, Bjorn; and Anderson, Elaine, 1980, Pleistocene mammals of North America: Columbia University Press, New York, 442 p.

Leidy, J. A., 1852, Memoir upon the extinct species of fossil ox: Smithsonian Contribution to Knowledge, v. 8, p. 8–19.

Leonard, A. B., 1950, A Yarmouthian molluscan fauna in the Midcontinent region of the United States: University of Kansas Paleontology Contribution, Mollusca, v. 3, p. 1–48.

Leonhardy, F. C., 1966, Introduction, *in* Leonhardy, F. C. (ed.), Domebo: a Paleo-Indian mammoth kill in the Prairie-Plains: Contributions of the Museum of the Great Plains, no. 1, p. 1–2.

Leonhardy, F. C.; and Anderson, A. D., 1966, Archaeology of the Domebo site, *in* Leonhardy, F. C. (ed.), Domebo: a Paleo-Indian mammoth kill in the Prairie-Plains: Contributions of the Museum of the Great Plains, no. 1, p. 14–26.

Lintz, Christopher, 1980, Excavation of mammoth remains within impoundment #36, Turkey Creek watershed, Major County, Oklahoma: Oklahoma Conservation Commission Miscellaneous Report 11, Oklahoma City, p. 15.

Lundelius, E. L., Jr.; and Slaughter, B. H., 1976, Notes on American Pleistocene tapirs, *in* Churcher, C. S. (ed.), Athlon: essays on palaeontology in honour of Loris Shano Russell: Royal Ontario Museum, Life Sciences Miscellaneous Publications, p. 225–243.

Lunk, W. A., 1952, A hooded merganser from the late Pleistocene of Oklahoma: Condor, v. 54, p. 316–317.

Maglio, V. J., 1973, Origin and evolution of the Elephantidae: Transactions of the American Philosophical Society, v. 63, p. 1–149.

Martin, L. D., 1992, The Hajny local fauna, *in* Wyckoff, D. G., and others, Interdisciplinary studies of the Hajny mammoth site, Dewey County, Oklahoma: Oklahoma Archeological Survey, Studies of Oklahoma's Past No. 17, University of Oklahoma, Norman, p. 97–100.

McDonald, H. G., 1995, *Gravigrade xenarthrans* from the early Pleistocene Leisey Shell Pit 1A, Hillsborough County, Florida, *in* Julbert, R. C.; Morgan, G. S.; and Webb, S. D. (eds.), Paleontology and geology of the Leisey Shell Pits, early Pleistocene of Florida: Florida Museum of Natural History, University of Florida, Gainesville, v. 37, part 2, nos. 11–20, p. 345–373.

McDonald, J. N.; and Ray, C. E., 1989, The autochthonous North American musk oxen *Bootherium*, *Symbos*, and *Gidleya* (Mammalia: Artiodactyla: Bovidae): Smithsonian Institution Contributions in Paleobiology, v. 66, p. 1–77.

McKenna, M. C.; and Bell, S. K., 1997, Classification of mammals above the species level: Columbia University Press, New York, 631 p.

Meade, G. E., 1950, Early Pleistocene fauna from Frederick, Oklahoma: Geological Society of America Bulletin, v. 61, p. 1485.

_____ 1953, An early Pleistocene vertebrate fauna from Frederick, Oklahoma: Journal of Geology, v. 61, p. 452–460.

Mengel, R. M., 1952, White pelican from the Pleistocene of Oklahoma: The Auk, v. 69, p. 81–82.

Myers, A. J., 1965, Late Wisconsinan date for the Bar M local fauna: Oklahoma Geology Notes, v. 25, p. 168–170.

Northcutt, J. D., 1984, A review of mammoth and mastodon bone locations in southwestern Oklahoma: Research report presented at the 42nd Plains Conference of Lincoln, Nebraska, p. 1–19.

Nowak, R. M. (ed.), 1991, Walker's mammals of the world [5th edition]: Johns Hopkins University Press, Baltimore, 1629 p.

Owen, R. D.; and Schnell, G. D., 1989, Oklahoma mammalogy: an annotated bibliography and checklist: University of Oklahoma Press, Norman, 230 p.

Preston, R. E., 1979, Late Pleistocene cold-blooded vertebrate faunas from the midcontinental United States, I. Reptilia; Testudine, Crocodilia: University of Michigan Museum of Paleontology, Papers on Paleontology, v. 19, p. 1–53.

Preston, R. E.; and McCoy, C. J., 1971, The status of *Emys twentei* Taylor (Reptilia: Testudinidae) based on new fossil records from Kansas and Oklahoma: Journal of Herpetology, v. 5, p. 23–30.

Puckette, W. L., 1976, Notes on the occurrence of the short-faced bear (*Arctodus*) in Oklahoma: Proceedings of the Oklahoma Academy of Science, v. 56, p. 67–68.

Ray, C. E.; and Sanders, A. E., 1984, Pleistocene tapirs in the United States, *in* Genoways, H. H.; and Dawsen, M. R. (eds.), Contributions in Quaternary vertebrate paleontology: a volume in memory to John E. Guilday: Carnegie Museum of Natural History, Pittsburgh Special Publication 8, p. 283–315.

Rea, A. M., 1980, Late Pleistocene and Holocene turkeys in the southwest: Contributions to Science Natural History Museum of Los Angeles County, v. 330, p. 209–224.

Renaud, E. B., 1928, L'antiquité de l'homme dans l'Amérique du Nord: Anthropologie (Paris), v. 38, p. 23–49.

Rinker, G. C.; and Hibbard, C. W., 1952, A new beaver, and associated vertebrates, from the Pleistocene of Oklahoma: Journal of Mammalogy, v. 33, p. 98–101.

Rippy, Charles; and Wyckoff, D. G., 1994, Woodland musk oxen in Oklahoma: Current Research in the Pleistocene, v. 11, p. 95–97.

Robins, C. R.; Bailey, R. M.; Bond, C. E.; Brooker, J. R.; Lachmer, E. A.; Lea, R. N.; and Scott, W. B., 1980, A list of common and scientific names of fishes from the United States and Canada [4th edition]: American Fisheries Society Special Publication 12, 174 p.

Romer, A. S., 1933, Pleistocene vertebrates and their bearing on the problem of human antiquity in North America, *in* Jenness, David (ed.), The American aborigine: University of Toronto Press, Ontario, p. 49–84.

Sandoz, O. N.; and Stovall, J. W., 1935, A new species of fossil turkey-peacock of Oklahoma: Proceedings of the Oklahoma Academy of Science, v. 15, p. 77.

Savage, D. E., 1946, A mandible of *Megalonyx* from the Pleistocene of Oklahoma: Journal of Mammalogy, v. 27, p. 388–390.

Schaak, G. D.; and Franz, Richard, 1978, Faunal succession and environments of deposition of Pleistocene Lake Buffalo, northwestern Oklahoma: Oklahoma Geology Notes, v. 38, p. 175–190.

Schoff, S. L., 1954, Pliocene and Pleistocene fossils from Beaver County, Oklahoma: Proceedings of the Oklahoma Academy of Science, v. 35, p. 94.

Schoff, S. L.; and Stovall, J. W., 1943, Geology and ground water resources of Cimarron County, Oklahoma: Oklahoma Geological Survey Bulletin 64, p. 1–132.

Sellards, E. H., 1932, Geologic relations of deposits reported to contain artifacts at Frederick, Oklahoma: Geological Society of America Bulletin, v. 43, p. 783–796.

_____ 1936, Recent studies of early man in the southwestern part of the United States: Ameri-

can Naturalist, v. 70, p. 361–369.

_____ 1940, Early man in America: an index to localities and selected bibliography: Geological Society of America Bulletin, v. 51, p. 373–432.

Simpson, G. G., 1929, Pleistocene mammalian fauna of the Seminole field, Pinellas County, Florida: Bulletin of the American Museum of Natural History v. 26, p. 561–599.

_____ 1945, Notes on Pleistocene and Recent tapirs: Bulletin of the American Museum of Natural History, v. 86 p. 33–81.

Slaughter, B. H., 1966, The vertebrates of the Domebo local fauna, Pleistocene of Oklahoma, *in* Leonhardy, F. C. (ed.), Domebo: a Paleo-Indian mammoth kill in the Prairie-Plains: Contributions of the Museum of the Great Plains, no. 1, p. 31–35.

Smith, C. L., 1954, Pleistocene fishes of the Berends fauna of Beaver County, Oklahoma: Copeia, v. 1954, p. 282–289.

_____ 1958, Additional Pleistocene fishes from Kansas and Oklahoma: Copeia, v. 1958, p. 176–180.

Smith, H. T., 1940, Geological studies in southwestern Kansas: Kansas Geological Survey Bulletin, v. 34, 212 p.

Spamer, E. E.; Daeschler, Edward; and Vostreys-Shapiro, L. G., 1995, A study of fossil vertebrate types in the Academy of Natural Science of Philadelphia: taxonomic, systematic, and historic perspectives: The Academy of Natural Sciences of Philadelphia, Special Publication 16, 434 p.

Spier, Leslie, 1928a, A note on reputed ancient artifacts from Frederick, Oklahoma: Science, no. 68, p. 184.

_____ 1928b, Concerning man's antiquity at Frederick, Oklahoma: Scientific News Letter, no. 67, p. 160–161.

Stangl, F. B., Jr.; and Dalquest, W. W., 1986, Two noteworthy records of Oklahoma mammals: Southwestern Naturalist, v. 31, p. 123–124.

Starrett, Andrew, 1956, Pleistocene mammals of the Berends fauna of Oklahoma: Journal of Paleontology, v. 30, p. 1187–1192.

Steadman, David, 1980, A review of the osteology and paleontology of turkeys (Aves: Meleagridinae): Contributions to Science, Natural History Museum Los Angeles County, v. 330, p. 131–207.

Stephens, J. J., 1960, Stratigraphy and paleontology of a late Pleistocene basin, Harper County, Oklahoma: Geological Society of America Bulletin, v. 71, p. 1675–1702.

Stovall, J. W., 1937, *Euceratherium bizzelli*, a new ungulate from Oklahoma: Journal of Paleontology, v. 11, p. 450–455.

_____ 1940, *Megalonyx hogani*, a new species of ground sloth from Gould, Oklahoma: American Journal of Science, v. 238, p. 140–146.

Stovall, J. W.; and Hibbard, C. W., 1948, The giant armadillo, *Holmesina septentrionalis* (Leidy), new to the Pleistocene of Oklahoma: Journal of Mammalogy, v. 29, p. 420.

Stovall, J. W.; and Johnston, C. S., 1934, *Tapirus haysii* of Oklahoma: American Midland Naturalist, v. 15, p. 92–93.

_____ 1935, Two fossil grizzly bears from the Pleistocene of Oklahoma: Journal of Geology, v. 4, p. 208–213.

Stovall, J. W.; and Self, J. T., 1936a, A new specimen of *Symbos* from Chickasha, Oklahoma: Proceedings of the Oklahoma Academy of Science, v. 16, p. 74.

_____ 1936b, A new specimen of *Symbos* from Chickasha, Oklahoma: Journal of Mammalogy, v. 17, p. 422.

Strain, W. S., 1937, The Pleistocene geology of part of the Washita River Valley, Grady County, Oklahoma: University of Oklahoma unpublished M.S. thesis, 102 p.

Taylor, D. W., 1954, A new Pleistocene fauna and new species of fossil snails from the High Plains: Occasional Papers Museum of Zoology, University of Michigan, no. 557, p. 1–16.

Taylor, D. W.; and Hibbard, C. W., 1955, A new Pleistocene fauna from Harper County, Oklahoma: Oklahoma Geological Survey Circular 37, 23 p.

Tedford, R. H; Skinner, M. F.; Fields, R. W. ; Rensberger, J. M.; Whistler, D. P.; Galusha, Theodore; Taylor, B. E.; MacDonald, J. R.; and Webb, S. D., 1987, Faunal succession and biochronology of the Arikareean through Hemphillian interval (late Oligocene through earliest Pliocene Epochs) in North America, *in* Woodburne, M. O. (ed.), Cenozoic mammals of North America: geochronology and biostratigraphy: University of California Press, Berkeley, p. 153–210.

Tihen, J. A., 1960, Notes on late Cenozoic hylid and leptodactylid frogs from Kansas, Oklahoma and Texas: Southwestern Naturalist, v. 5, p. 66–70.

Troxell, E. L., 1917, An Oklahoma Pleistocene fauna: Geological Society of America Bulletin, v. 28, p. 212.

Ward, P. A., III, 1991, Glass shard uranium fission-track ages of volcanic ash deposits in the southern High Plains border region, *in* Carter, B. J.; and Ward, P. A., III (field-trip leaders), A prehistory of the Plains border region; guidebook for the 9th Annual Meeting of the South-Central Friends of the Pleistocene, Woodward, Oklahoma: Oklahoma State University Press, Stillwater, p. 81–82.

Ward, P. A., III; Carter, B. J.; and Weaver, Brian, 1993, Volcanic ashes: time markers in soil parent materials of the southern plains: Soil Science Society American Journal, v. 57, p. 453–460.

Webb, R. G., 1970, Reptiles of Oklahoma: University of Oklahoma Press, Norman, 370 p.

Wilson, D. E.; and Reeder, D. M. (eds.), 1993, Mammal species of the world: a taxonomic and geographic reference [2nd edition]: Smithsonian Institution Press, Washington, D. C., 1206 p.

Wood, A. E., 1933, Pleistocene prairie-dog from Frederick, Oklahoma: Journal of Mammalogy, v. 14, p. 160.

Woodburne, M. O. (ed.), 1987, Cenozoic mammals of North America: geochronology and biostratigraphy: University of California Press, Berkeley, 335 p.

Woodburne, M. O.; and Swisher, C., 1995, Land mammal high-resolution geochronology, intercontinental, overland dispersal, sea level, climate, and vicariance, *in* Berggren, W. A.; Kent, D. V.; Aubry, M.-P.; and Hardenbol, Jan (eds.), Geochronology, time scales and global stratigraphic correlation: Society for Sedimentary Geology Special Publication 54, p. 335–364.

Wright, A. H.; and Wright, A. A., 1957, Handbook of snakes of the United States and Canada: Cornell University Press, Ithaca, New York, v. 2, p. 565–1104.

Wyckoff, D. G.; and Czaplewski, N. J., 1997, Paleontological and archeological perspectives of fossil proboscideans in Oklahoma: Oklahoma Geology Notes, v. 57, p. 72–101.

Wyckoff, D. G.; Brakenridge, G. R.; Buehler, Kent; Carter, B. J.; Wakefield Dort, Jr.; Martin, L. D.; Theler, J. L.; and Todd, L. C., 1991, Interdisciplinary research at the Burnham site (34W073), Woods County, Oklahoma, *in* Carter, B. J.; and Ward, P. A., III (field-trip leaders), A prehistory of the Plains border region; guidebook for the 9th Annual Meeting of the South-Central Friends of the Pleistocene, Woodward, Oklahoma: Oklahoma State University Press, Stillwater, p. 82–121.

Wyckoff, D. G.; Carter, B. J.; Dort, Wakefield, Jr.; Brakenridge, G. R.; Martin, L. D.; Theler, J. L.; and Todd, L. C., 1991, Northwestern Oklahoma's Burnham site: glimpses beyond Clovis?: Current Research in the Pleistocene, v. 7, p. 60–63.

Wyckoff, D. G.; Carter, B. J.; Flynn, Peggy; Martin, L. D.; Bransen, B. A.; and Theler, J. C., 1992, Interdisciplinary studies of the Hajny mammoth site, Dewey County, Oklahoma: Oklahoma Archeological Survey, Studies of Oklahoma's Past No. 17, University of Oklahoma, Norman, 134 p.

INDEX

Boldface indicates primary reference. Figure and Table numbers are in parentheses with page numbers in brackets.