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Bulletin 28 December 1, 2011

Paleontology papers in honor of Douglas E. Jones

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Late Pleistocene Mammals of Alabama: A Comprehensive Faunal Review with 21 Previously Unreported Taxa

By Jun A. Ebersole and Sandy M. Ebersole

A Review of the Chondrichthyans from the Mississippi System of Northern Alabama, USA

By Chuck Ciampaglio, David J. Cicimurri, Leigh H . Deuter, and Michael A. Taylor

A Review of the Non-Avian Dinosaurs from the Late Cretaceous of Alabama, Mississippi, Georgia and Tennessee

By Sandy M. Ebersole and James L. King

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THE UNIVERSITY OF ALABAMA
TUSCALOOSA, ALABAMA
DECEMBER 1, 2011

Dedicated to
Dr. Douglas E. Jones

PALEONTOLOGY PAPERS IN HONOR OF DR. DOUGLAS E. JONES

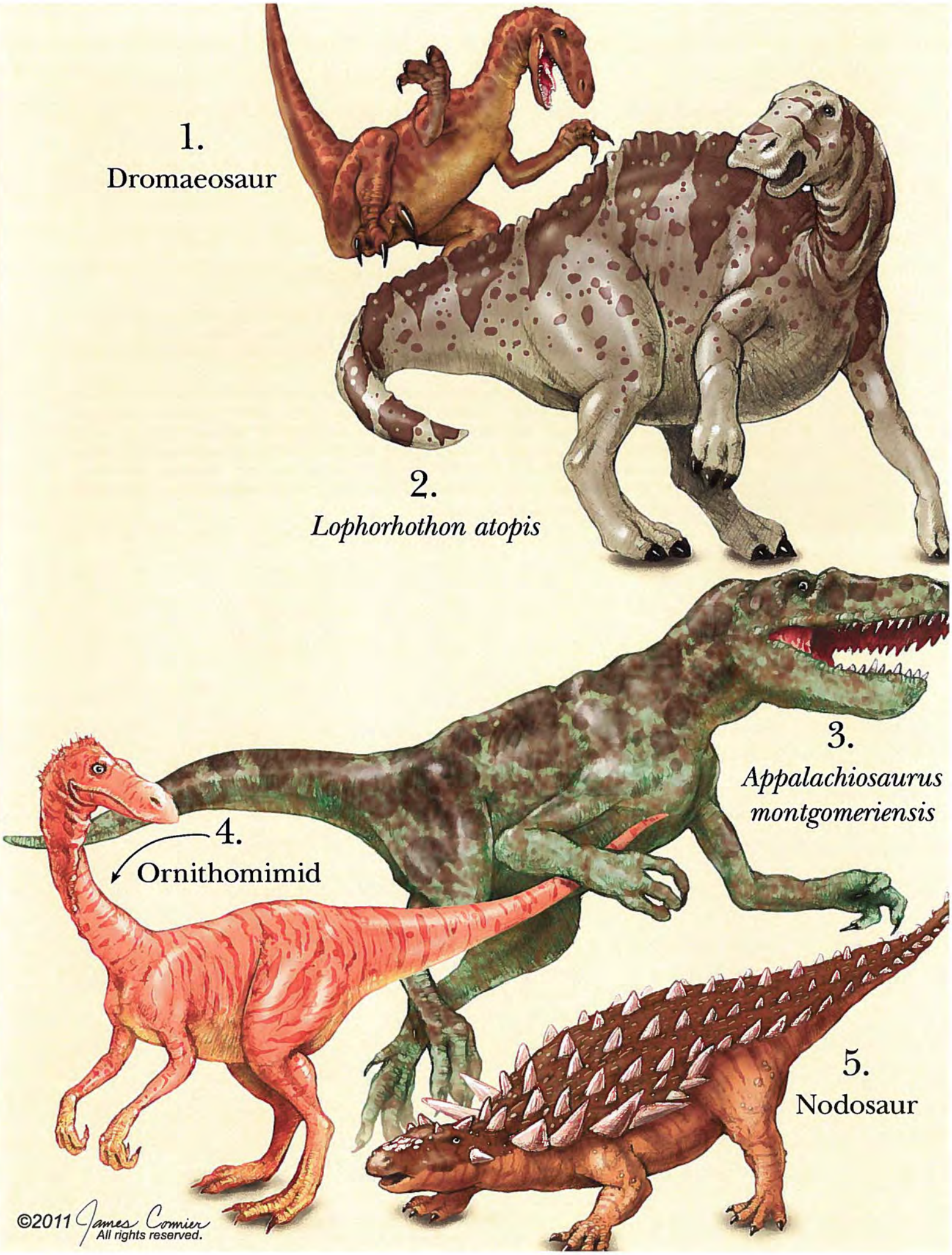
We are proud to announce the publication of the latest Bulletin of the Alabama Museum of Natural History, "Paleontology Papers in Honor of Douglas E. Jones." This Bulletin of the Alabama Museum of Natural History came about due to an unexpected chain of events. The first link was the untimely loss of a singular outstanding individual with lifelong service to the University of Alabama, a dedicated paleontological researcher and former director of the University of Alabama Museums, Dr. Douglas Epps Jones. The second event in the chain was the recent hiring of Dr. James Parham as Curator of Vertebrate Paleontology at the University of Alabama Museums. The third link was a generous donation to the University Museums from the Dr. and Mrs. James D. Yarbrough family who wished to commemorate the life and dedication of their good friend, Doug.

Dr. Douglas Epps Jones was a tireless researcher who spent his last days identifying a myriad of uncatalogued invertebrate paleontological specimens in the collections of the University of Alabama Museums. A friend, colleague and mentor, Dr. Jones spent his career at the University of Alabama as a teacher, dean, and administrator with a life-long dedication to the promotion of scientific research and its dissemination for its educational significance and the betterment of the state and citizens of Alabama. His interests spanned the breadth of the University's collections from geology to biology to archaeology. This volume honors the legacy of Douglas E. Jones by bringing attention to important fossils in the University of Alabama, as well as other, collections in the region.

Connecting these links, Jim Parham and his colleague Jun Ebersole, of the McWane Science Museum, worked with paleontologists currently researching the Alabama fossil record to pull their investigations into publishable form for this volume of the Bulletin in honor of Dr. Douglas Jones. Bringing together current research on the paleontological record is a fitting tribute to a man who spent his professional career dedicated to the research of the paleontological record of Alabama and the Deep South.

This volume includes three original scientific papers about extinct vertebrates from the state of Alabama. A wide range of time and diversity is covered, ranging from 300+ million year old sharks, a review of dinosaurs from the southeastern United States (some 80-65 million years old), and a comprehensive review of Ice Age mammals from the last 100,000 years including over 20 records of species that have never been reported from Alabama before. This issue of the Bulletin contains articles summarizing new research by Sandy M. and Jun A. Ebersole on fossil mammals; Chuck Ciampaglio, David J. Cicimurri, Leigh H. Deuter and Michael A. Taylor on fossil sharks; and a final article by Sandy M. Ebersole and James L. King on non-avian dinosaurs. Capping off this issue is the handsome, original artwork by James Cormier depicting known dinosaurs from Alabama.

We at the Alabama Museum of Natural History are most grateful to James Parham and Jun Ebersole for their efforts to bring these works together into this issue. We are also thankful for the donated scientific illustrations that adorns the cover of this issue provided by professional illustrator James Cormier. And lastly, we are grateful for the generosity of the Doug's friends, Donjette and Jim Yarbrough, who helped to underwrite this special issue as a tribute to him.


1.
Dromaeosaur
2.
Lophorhothon atopis
3.
Appalachiosaurus montgomeriensis
4.
Ornithomimid
5.
Nodosaur
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JAMES CORMIER BIOGRAPHICAL SKETCH

James Cormier received his MS degree in Medical Illustration from the Medical College of Georgia in 2008. He also holds a MFA in sculpture from Tulane University in New Orleans, Louisiana (1995) and a BFA in sculpture from the University of Montevallo in Montevallo, Alabama (1989).

James is a multidisciplinary artist with a diverse professional background. He has taught art on the elementary, secondary and post secondary levels and science on the lower and middle school levels. Additionally, he spent seven years as the McWane Science Center's Senior Exhibits Fabricator and Prototyper. His experience at the museum inspired him to incorporate science more deeply into his artwork and to make science education and literacy the focus of his evolving career. Currently he is an instructor of art and science at Spring Valley School in Birmingham, AL.

Late Pleistocene Mammals of Alabama: A Comprehensive Faunal Review with 21 Previously Unreported Taxa

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ABSTRACT: Presented here is a comprehensive study of Late Pleistocene mammals from Alabama that reviews taxa from both Pleistocene and archaeological sites. Over 50 Late Pleistocene localities have been identified in Alabama, most of which are concentrated in the Black Prairie region of the Gulf Coastal Plain and the Highland Rim physiographic sections. These Pleistocene localities have produced faunas from one land mammal age, the Rancholabrean, and nearly all date to and just after the Wisconsinan glaciation. To date, 66 distinct Late Pleistocene mammals have been confirmed from Alabama. Among these are Late Pleistocene forms that are extinct, currently extant in the state, or have been extirpated from their former range in Alabama. Within the comprehensive faunal overview in this paper, we present 21 taxa previously unreported from Alabama. From the numerous taxa reported here and the abundance of Alabama Pleistocene localities, it is evident that further field investigations could significantly add to our understanding of Pleistocene fauna, paleoecology, and paleobiogeography of Alabama and North America.

INTRODUCTION

Alabama has a remarkable and rich diversity of Late Pleistocene plants and animals which rival that of other states in North America. Over the years, however, Late Pleistocene deposits in Alabama have received relatively little scientific attention and have gone relatively unnoticed by the larger Quaternary research community. Only a handful of mainstream publications mention Alabama Late Pleistocene faunas; most related works have been non peer-reviewed abstracts, posters, field trip guides, unpublished manuscripts, dissertations, and open-file reports. Due, in part, to the paucity of publications, there has been a near exclusion of Alabama's Late Pleistocene taxa from national authoritative reviews such as Kurtén and Anderson (1980) and the 1994 FAUNMAP project. Presented here is a comprehensive review of Late Pleistocene mammals of Alabama that compiles scattered information from historical accounts, scientific publications, gray literature, museum collections, unpublished manuscripts, taxonomic revisions, and archaeological faunal reports. This study will serve as a prelude to more in-depth studies of Alabama's Late Pleistocene deposits and the rich biodiversity of mammals contained within.

Institutional Abbreviations:

ANSP: Academy of Natural Sciences of Philadelphia, PA; **AUMP**: Auburn University Museum of Paleontology, Auburn, AL; **BC**: Berry College, Mt. Berry, GA; **ETSU**: Eastern Tennessee State University, Johnson City, TN; **GSA**: Geological Survey of Alabama, Tuscaloosa, AL; **MMNS**: Mississippi Museum Museum of Natural Science, Jack-

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son, MS; **McWSC:** McWane Science Center, Birmingham, AL; **RMM(RCC):** Red Mountain Museum (now McWane Science Center), Birmingham, AL; **UAM:** University of Alabama Museums, Tuscaloosa, AL; **UF:** University of Florida, Gainesville, FL. **USNM:** U.S. National Museum, Washington, D.C.

A Brief History of Late Pleistocene Mammal Research in Alabama

The history of Alabama Pleistocene research dates back to Leidy (1855a). His publication figures a lone *Megalonyx jeffersonii* molar discovered in the vicinity of Tuscumbia in Colbert County. Near this time, Alabama's first state geologist, Michael Tuomey of the GSA, was shown a series of "bone caves" in the same region near Tuscumbia (Tuomey, 1858). From within these caves, Tuomey acquired some of the first Alabama Pleistocene mammals which included parts of a mastodon from one cave, and bones from a cervid, dire wolf, and *Megalonyx* (ground sloth) from another (Tuomey, 1858). Tuomey shipped the latter remains to the ANSP to be examined by Leidy (Anonymous, 1856) and made brief mention of these discoveries in an 1858 report on the geology of the state. Shortly after, Leidy (1860) described and figured the metatarsals of this *Megalonyx*. Two other important publications appeared around this time: Warren (1855) and Falconer (1868). These two works both discussed the state's first mammoth discovery said to be discovered along the Gulf Coast of Alabama.

Falconer (1868) preceded a nearly 26-year hiatus in Pleistocene research in Alabama as the next scientific publication on the subject would be Smith et al. (1894), written by three employees of the GSA. While exploring the geology of the Alabama Gulf Coastal Plain, Smith et al. (1894) noted multiple river deposits they interpreted as Pleistocene. Shortly after, Berry (1906, 1910) published on fossil plant deposits discovered along the Chattahoochee River in Russell County and the Gulf Coastal Plain. During this time of geological exploration in the state, American paleontologist Oliver Perry Hay published two important works. Hay (1916) made references to the *Megalonyx* from Tuscumbia, AL. Hay (1923) reports the first accounts of a Late Pleistocene bison and horse from the state.

During the 1960s, Alabama experienced a growing number of archaeological investigations into Paleo Indian sites in the northern region of the state. Sites such as the Quad site (Cambron and Hulse, 1960), Stanfield Worley (Dejarnette et al., 1962; Parmalee, 1962), and LaGrange (Curren, 1976a) yielded early Holocene mammal remains. At least two sites, Fern Cave (Ray, 1969; Hale, 1970) and Russell Cave (Weigel et al., 1974), produced remains of extinct Late Pleistocene taxa. The mid 1970s marked the beginning of more concentrated efforts to study many of the Late Pleistocene deposits in Alabama. Three landmark works were produced during this time (Kaye, 1974; Curren et al., 1976; Curren, 1977a). For his dissertation at Louisiana State University, Kaye (1974) conducted the first intensive study of sediments and Late Pleistocene faunal associations in the Black Prairie region of Mississippi, a region shared with Alabama. His paper detailed a number of Late Pleistocene taxa not previously known from the region and this research resulted in three publications related to the subject (Jackson and Kaye, 1974a; Jackson and Kaye, 1974b; and Kaye, 1975). The research started by Kaye is continued by George Phillips of the Mississippi Museum of Natural Science in Jackson, MS. Mr. Phillips wrote his master's thesis on the subject (Phillips, 2006) and continues his research in the Black Belt region of Alabama and Mississippi today.

In 1976, Caleb Curren, Charlie Copeland, and Samuel Shannon of the University of Alabama and GSA conducted a multi-month investigation of the Tombigbee River documenting, collecting in, and dating Late Pleistocene deposits feared to be submerged by the construction of dams. Funded by the U.S. Army Corp of Engineers (USACE), these three authors published the results of their investigation in a 1976 USACE report (Curren et al., 1976). Curren continued this research for roughly another year and in 1977 submitted an unpublished manuscript to the Alabama Historical Commission entitled the *Paleo Indian and the Pleistocene of Alabama*. These two works documented the first occurrences of many of the Late Pleistocene taxa found in the state. Muto and Gunn (1985) and Frazier (1985) later conducted an extensive investigation in similar Late Pleistocene deposits discovered along the Tombigbee River.

Womochel and Barnett (1980a) published a short piece in the field trip guide for the Southeastern Section of the Geological Society of America annual meeting. Their paper provided a taxonomic account of the numerous Late Pleistocene mammalian faunas they recovered from site ACb-3 in Colbert County, including many first state records. After learning about this site, personnel from the RMM in Birmingham launched a series of expeditions in the mid 1980s to not only the ACb-3 site, but other nearby Late Pleistocene fossil bearing caves. The material collected during these RMM expeditions resulted in the largest collection of Late Pleistocene remains yet assembled in the state. Currently housed at McWSC in Birmingham, this collection created, for the first time, nation-wide research interest of Alabama Late Pleistocene fossil material. From the mid 1980s to early 2000s, research on this material included a "who's who" of renowned Late Pleistocene researchers. Among these were Elaine Anderson, Paul Parmalee, Alan Holman, Robert Martin, Russell Graham, and C. S. Churcher. Notable works on this material included Parmalee's (1992) description of the Late Pleistocene avifauna from site ACb-2, Holman et al.,'s (1990) paper describing the herpetofauna from ACb-2, Martin and Prince's (1990) discussion on evolutionary trends in *Microtus* teeth from the same site, and Churcher et al.'s (1989) documentation of the southernmost account of caribou. Work on

this material continues today by personnel from McWSC and ETSU in Johnson City, TN.

Late Pleistocene Localities in Alabama

To date, over 50 Late Pleistocene localities containing mammalian remains have been discovered in Alabama. These Late Pleistocene localities are scattered across the state in every physiographic section with the exception of the Piedmont Upland (Fig. 1). While Late Pleistocene fossil bearing localities have been discovered in the Valley and Ridge, Cumberland Plateau, and Gulf Coastal Plain sections of the state, the Black Prairie region within the Gulf Coastal Plain and the Highland Rim contain the highest concentrations of these Late Pleistocene localities (Fig. 1). Throughout this paper, many of these localities are referred to by state site designation. For more detailed site locality data, qualified researchers should contact the Office of Archaeological Research in Moundville, AL for archaeological sites and McWSC and UAM for data relating to Late Pleistocene localities.

Most of the Late Pleistocene fossil localities in the Gulf Coastal Plain section are located within stream deposits. The major waterways within this section all flow in a southerly direction and cut through Mesozoic and Cenozoic formations. Of the Late Pleistocene localities in this section, the majority are concentrated within the Black Prairie, an area that is better known for its Cretaceous marine fossils (Thurmond and Jones, 1981). Pleistocene deposits in the Black Prairie and Gulf Coastal Plain take the form of a "blue-gray clayey silt" layer that can be found along nearly all the waterways in this section (Curren et al., 1976; Curren, 1977a). A large unconformity exists in the Black Prairie where these blue-gray deposits rest directly on top of Late Cretaceous (70 to 80 ma) chalk formations. It has been suggested that the relatively high concentration of Late Pleistocene fossils in the Black Prairie may be attributed to the alkalinity of these underlying Cretaceous chalks which likely aid in their preservation (Phillips, 2006). On rare occasions, Pleistocene faunal material has surfaced in Cretaceous-aged chalk gullies that are scattered across the Black Prairie. While the exact origin of this material has not been determined, it is likely it is eroding out of weathered blue-gray deposits or other deposits similar to those found along the waterways in the section. More detailed information of these and the blue-gray deposits can be found later in this review.

The Highland Rim physiographic section can be described as a limestone plateau with moderate relief (Raymond et al., 1988). With the exception of two sites, all Late Pleistocene localities within this section are cave sites concentrated within the western half of this section near the Tennessee River. All the caves in this section have been carved over the millennia through Mississippian age limestone and sandstone formations. The accumulation of the

Figure 1. Distribution of Alabama Late Pleistocene fossil localities and species abundance. Triangles denote approximate locations of Late Pleistocene localities. Numbers denote the number of different Late Pleistocene species identified from each county. County abbreviations: Bu: Butler; Che: Cherokee; Cho: Choctaw; Cl: Clark; Co: Colbert; Da: Dallas; De: DeKalb; Gr: Greene; Ha: Hale; Ja: Jackson; Je: Jefferson; La: Lauderdale; Li: Limestone; Ma: Madison; Mg; Marengo; Mo: Montgomery; Pe: Perry; Pi: Pickens; Ru: Russell; Su: Sumter; Wi: Wilcox.

Late Pleistocene fossil assemblages within these caves can be attributed to one or more of the following: sinkhole traps, natural cave openings that allow fauna to enter, or fluvial or colluvial transport (Lively et al., 1992; Churcher et al., 1989; Parmalee, 1992). Notable sites in this section include the two most prolific Late Pleistocene fossil bearing localities yet known in the state, sites ACb-2 and ACb-3 in Colbert County. These two caves have produced the greatest diversity of Pleistocene taxa and highest number of specimens collected from any localities known in the state. The Highland Rim is also known for its large concentration of archaeological sites containing Paleo Indian deposits.

The geology in the Cumberland Plateau is comprised mostly of Paleozoic limestone, shale, and karst topography (Raymond et al., 1988). Although adjacent to the Highland Rim, the Cumberland Plateau contains much fewer Pleistocene localities. Similar to Highland Rim localities however, three of the four Late Pleistocene localities discovered in the Cumberland Plateau are in caves. In the Cumberland Plateau, Highland Rim, and Valley and Ridge sections, a small number of localities have been discovered along waterways. These sites include sites F-12 and F-14 in the Highland Rim, site F-15 in the Cumberland Plateau, and site F-34 in the Valley and Ridge (Curren, 1977a). Curren (1977a) noted blue-gray deposits at three

of these sites (F-12, F-15, and F-34) suggesting they are lithostratigraphically similar to Pleistocene deposits in the Gulf Coastal Plain. Site F-34 is of particular interest as it is the only identified Late Pleistocene locality in the Valley and Ridge (Fig. 1).

The one physiographic section in the state without identified Late Pleistocene localities is the Piedmont Upland located in the east-central part of the state. This section is largely comprised of "intensely deformed" metamorphic rocks (Thurmond and Jones, 1981) and for the most part contains no fossil material of any age. The streams and rivers in this section do however contain later deposits exposed on their banks (Thurmond and Jones, 1981) that may be Late Pleistocene in age.

A REVIEW OF ALABAMA LATE PLEISTOCENE MAMMALS

This taxonomic review of all known Late Pleistocene mammals in Alabama combines data collected from historical reports, mainstream journals, theses and dissertations, abstracts, open-file reports, and other gray literature. Numerous faunal reports from archaeological sites in the state are also reviewed as several have produced extinct Late Pleistocene mammals and others provide important biostratigraphic data for extant forms. Because archaeological faunal reports in the state are too numerous to be reviewed in their entirety, this study is restricted to data from the Journal of Alabama Archaeology, known Paleo Indian deposits, and faunal material captured in the 1994 FAUNMAP study. Current taxonomic information was derived from a number of sources but most notably from the Integrated Taxonomic Information System (ITIS, 2010) and International Commission on Zoological Nomenclature (Melville and Smith, 1987). Due to the complexity of the varying landscapes and environments across the state and the temporal mixing of Pleistocene material from the Gulf Coastal Plain, a statewide paleoenvironmental reconstruction is not within the scope of this project. Researchers interested in Pleistocene paleoenvironments should refer to the reconstructions provided for specific sites and regions by many of the investigators cited herein.

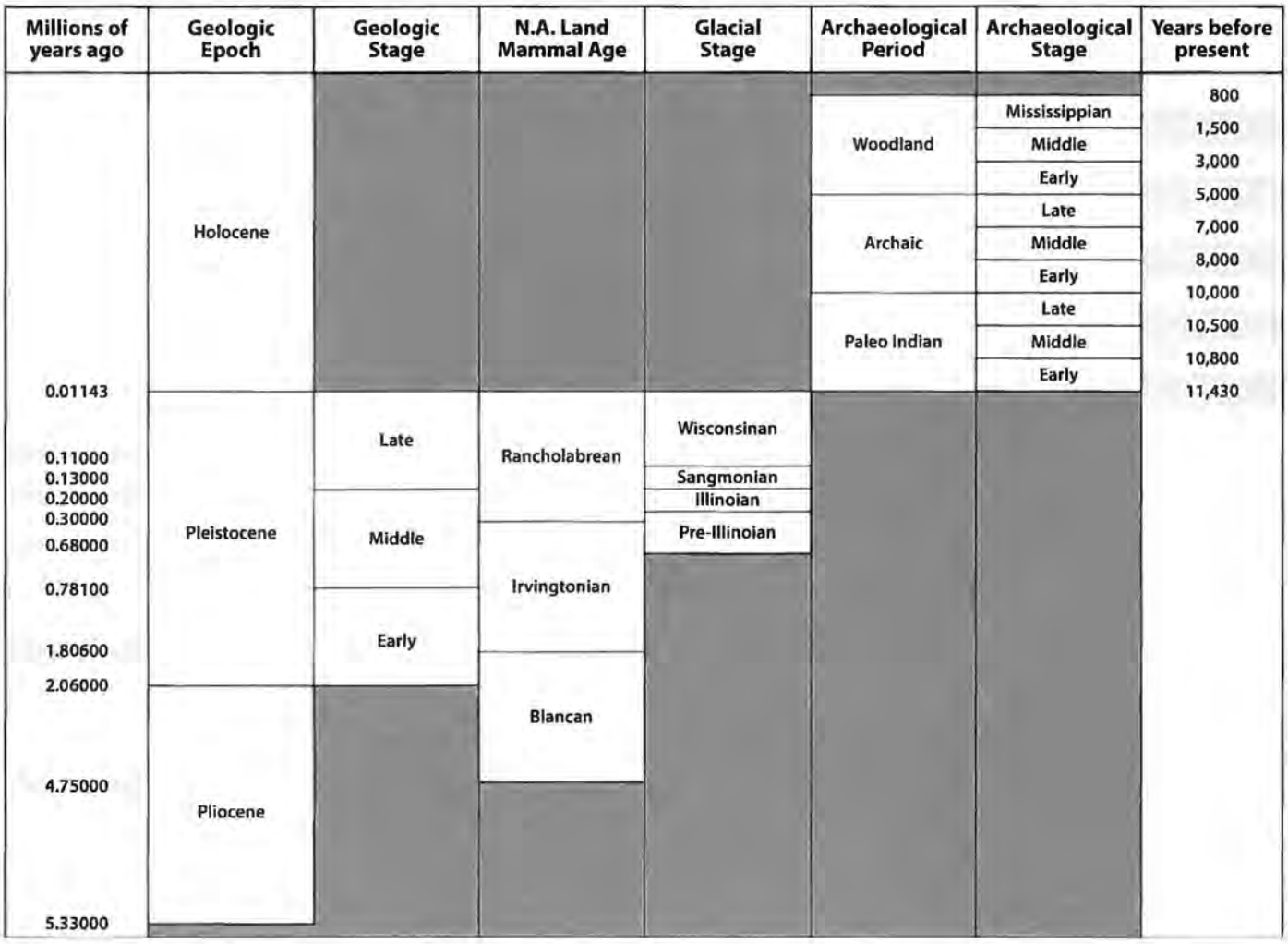


Figure 2. Correlation of southeastern U.S. late Tertiary ages.

Artiodactyla Owen, 1841
Bovidae Gray, 1821
***Bison* sp. Hamilton Smith, 1827 – Bison**

Hay (1923) reports the first record of *Bison* sp. in the Late Pleistocene of Alabama. Later cited by Curren (1977a), this specimen, a lower right last molar, was collected in Hale County in 1914 by J. W. White and is part of the collections of the USNM (unknown catalog number). Curren (1977a) also reports the recovery of isolated teeth belonging to *Bison* sp. from site F-26 in Dallas County (UAM PV 85.13.59) and site F-20 in Montgomery County (UAM PV 85.13.41) and notes additional specimens of *Bison* sp. from Greene, Perry, and Wilcox counties. All reported to be housed in the collection at the UAM (Curren, 1977a), a search through museum records revealed no bison elements from Greene, Perry, or Wilcox counties leaving these accounts unconfirmed. In addition to this find, Frazier (1985) lists *Bison* sp. among the many Late Pleistocene mammals discovered along the Tombigbee River of Alabama and Mississippi.

***Bison antiquus* Leidy, 1852 – Ancient bison**
Fig. 3

Two specimens assigned to the extinct Late Pleistocene *Bison antiquus* (some researchers place *B. antiquus* in *B. bison* as a subspecies; Kurtén and Anderson, 1980) have been reported from Alabama and are in the collections of the UAM (Curren, 1977a). UAM PV 85.13.2, a lower molar from Clarke County, was first reported by Curren (1977a) who assigned the specimen to *B. antiquus*. However, being an isolated molar, UAM PV 85.13.2 is here re- assigned to *Bison* sp. as modern practice generally requires a complete horn core for specific determination of *Bison* specimens (Thurmond and Jones, 1981). A second report of *B. antiquus* was first reported by Curren (1977a) and later discussed by Thurmond and Jones (1981). This specimen, UAM PV 85.13.15, consists of the anterior portion of a cranium with horn cores recovered from Montgomery County (Thurmond and Jones, 1981). Assigned to *B. antiquus* by Curren (1977a), who thoroughly described the specimen, its identification has here been confirmed by relative size of the interior of the horn core span. A horn core measurement of 1,040 mm (Curren, 1977a) falls within the range of a large *B. antiquus* (average span of 881 mm, Thurmond and Jones, 1981). This measurement is only half that of the contemporary Late Pleistocene *Bison latifrons* (maximum span of 2130 mm) and exceeds that of the living *Bison bison* (average span of 660 mm) as described by Kurtén and Anderson (1980). This specimen is significant as it not only confirms the presence of *B. antiquus* in the Late Pleistocene of Alabama, but it also represents the only element yet discovered that can be definitively assigned to this species.

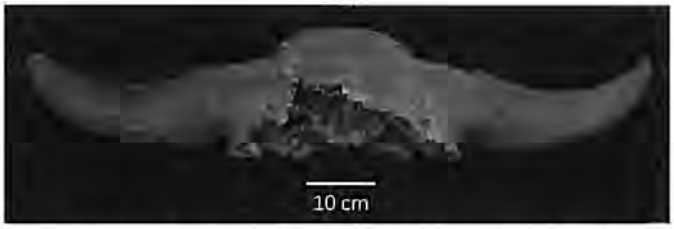


Figure 3. The first record of *Bison antiquus* from Alabama. UAM PV 85.13.15, partial cranium with horn cores, anterior view.

Map 1: Counties with confirmed *Bison* sp. remains.

Map 2: Counties with confirmed *Bison antiquus* remains.

?*Bison bison* (Linneaus, 1758) – American bison

The presence of a third species of bison in Alabama, the recent *Bison bison*, has been debated by historians, archaeologists, and paleontologists in the state for decades. Although currently extirpated from the state, many scholars believe *B. bison* once had a statewide distribution in Alabama (Rostlund, 1960; Meagher, 1986; Choate et al., 1994; Mirarchi, 2004). While historical accounts support this claim (Rostlund, 1957; 1960), physical remains of this species within state lines have been close to absent. Frazier (1985) makes the only reference to *B. bison* from the Alabama Pleistocene by noting this species among many recovered during a survey of the Tombigbee River. Although not examined as part of this study, this specimen was recently rediscovered among uncataloged samples housed at the MMNS (G. Phillips, 2011, pers. comm.). To date, only three archaeological records of *B. bison* remains could be found, all of which discovered in Mississippian-culture mounds in Hale County. Knight (2010) reports three elements discovered from Mound G at Moundville that he notes as "possibly bison" based on comparisons with specimens from the American Museum of Natural History in New York. While discernibly a large mammal, Knight (2010) described the elements as too young for definitive identification but are not that of an "intrusive cow" based on skinning marks on one of the elements. Knight also reports two fragments of a large animal from Mound Q at Moundville that he concluded are likely bovid as the surface texture of the elements is different from that of a bear and that the remains fall outside the geographic range of Holocene elk (Knight, 2010). While further study may indeed confirm these finds as *B. bison*, Knight (2010) suggests these remains were not native to Moundville; rather they were bison products that made it to the area by trade. Alternatively, these remains may in fact indicate a local population of bison.

Rostlund (1960) reports a third discovery of *B. bison* in the state by referencing strips of bison horn found four feet underground in a mound in Hale County. These horn strips, reportedly identified by F. A. Lucas of the USNM, are significant as they represent the only elements yet known from the state that can definitively be assigned to *B. bison*. While the occasional bison may have wandered into the state, Rostlund (1960) concludes the main migration of *B. bison* into the southeastern U.S. began in the middle of the 16th century and, as suggested by historical accounts, the bison herds were in steady decline in the region by 1750 A.D. As for the Late Pleistocene presence of *B. bison* in the southeastern U.S., records of this species have been confirmed from Late Pleistocene deposits in Florida and numerous states to the north and west of Alabama (FAUNMAP, 1994). While definitive confirmation of Late Pleistocene *B. bison* in Alabama remains elusive, these neighboring records would place Alabama well within the biogeographic range of *B. bison* during the Wisconsinan glacial.

Map 3: Counties with confirmed *Bison bison* remains.

Camelidae Gray, 1821
cf. *Palaeolama mirifica* (Simpson, 1931) – Stout-legged llama
Fig. 4

Palaeolama mirifica, the extinct stout-legged llama, was first reported in Alabama by Curren (1977a) who listed this taxon among many discovered during a survey of Late Pleistocene deposits in the Gulf Coastal Plain. Curren (1977a) references two UAM specimens he assigns to *P. mirifica* (UAM PV 85.13.54 and UAM PV 85.13.56), both collected from site F-26 in Dallas County. UAM PV 85.13.54, a large right astragalus (Fig. 4), is of particular interest as the maximum length and width of this element, 63 mm and 42 mm respectively, falls within the range of the astragali of the Late Pleistocene camelids *Palaeolama* and *Hemiauchenia* as listed by Meachen (2003, 2005). A 2001 re-examination of this specimen by George Phillips, then of North Carolina State University, resulted in a more tentative designation of this specimen to cf. *Palaeolama mirifica*. Through direct comparison of UAM PV 85.13.54 to *Palaeolama* and *Hemiauchenia* specimens at UF, Phillips concluded UAM PV 85.13.54 more closely resembled the astragali of *Palaeolama* as opposed to *Hemiauchenia* (G. Phillips, 2011, pers. comm.). Because camelid astragali are not elements described as having defined characters that allow for absolute specific determination, the re-designation of UAM PV 85.13.54 to the more conservative cf. *Palaeolama mirifica* is appropriate.

Although tentative, the designation of UAM PV 85.13.54 to cf. *P. mirifica* is significant as no other reports or records of this taxon from the Late Pleistocene of Alabama could be substantiated. Curren (1977a), for example, refers the aforementioned UAM PV 85.13.56, the

distal portion of a right tibia, as belonging to *P. mirifica*. While the size of this element suggests it is indeed camelid, the fragmentary state of this element and the lack of comparative material have limited the identification of this element by these authors to Camelidae only. Frazier (1985) later noted the discovery of *P. mirifica* material along the Tombigbee River of Alabama and Mississippi. Thought to be lost but recently rediscovered at the MMNS (Phillips, 2011, pers. comm.), this material was not examined as part of this study. In a search through museum collections, a proximal portion of a right scapula assigned to the family Camelidae (RMM 6730) was found in the collection at McWSC. Discovered at site ASu-2 in Sumter County, this element was too incomplete and weathered for identification beyond the family level. Finally, McCarroll and Dobie (1994) report a partial lower molar (AUMP 3175) they identified as "Artiodactyla indeterminate" from site ADa-1 in Dallas County. The authors conclude the size of this tooth to be too large to be *Odocoileus*, suggesting it may be camelid (McCarroll and Dobie, 1994). Unfortunately the fragmentary nature of this specimen has limited further identification (McCarroll and Dobie, 1994).

Although camelids are poorly represented in Late Pleistocene fossil record of Alabama, their presence is not unexpected. Reports of Late Pleistocene camels have been confirmed from the surrounding states of Florida (Kurtén and Anderson, 1980), Georgia (Hulbert and Pratt, 1998), Tennessee (Breitburg and Corgan, 1998), and Mississippi (Kaye, 1974; Phillips and Kaye, 2002). Furthermore, in the Black Prairie of Mississippi, Kaye (1974) reports the discovery of a metapodial from a creek in Clay and Lowndes Counties that he tentatively assigned to cf. *Tanupolama*, a junior synonym for both the camelids *Palaeolama* and *Hemiauchenia* (Kurtén and Anderson, 1980). In addition, Phillips and Kaye (2002) list both *P. mirifica* and *Hemiauchenia macrocephala* among their list of confirmed Late Pleistocene fauna within the Black Prairie of Mississippi. Along with UAM PV 85.13.54, these reports strongly suggest *P. mirifica*, and possibly a second camelid, *H. macrocephala*, did indeed have ranges in Alabama during Late Pleistocene times.

Map 4: Counties with confirmed cf. *Palaeolama mirifica* remains.

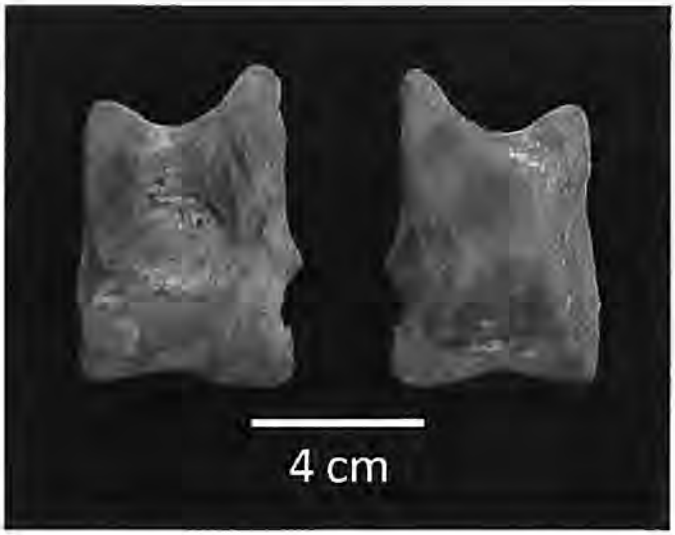


Figure 4. UAM PV 85.13.54, right astragalus of cf. *Palaeolama mirifica*. Left: Dorsal view. Right: Ventral view.

Cervidae Goldfuss, 1820
***Cervus canadensis* Erxleben, 1777 – Elk or Wapiti**

While no members of the genus *Cervus* have a recent distribution within the state (Whitaker, 1992; Mirarchi, 2004), paleontological and archaeological evidence confirms the presence of this genus within Alabama from the late Wisconsinan (Anonymous, 1856; GSA, 1976; Curren, 1977a; Frazier, 1985; Martin and Sneed, 1989) to possibly the Mississippian cultural time period (Curren, 1977b; Lev-Tov, 2002). The first Late Pleistocene report of *Cervus* in the state was noted by the ANSP in a published report of recent acquisitions by the institution (Anonymous, 1856). This report noted a *Cervus* humerus from a cave in north Alabama donated by Alabama state geologist Michael Tuomey (Anonymous, 1856). In a 1976 newsletter published by the GSA, a *Cervus canadensis* discovery was reported from along the Tombigbee River with an associated radiocarbon date of 8,250 to 14,650 B.P. (GSA, 1976). Curren et al. (1976) and Curren (1977a) report an additional *C. canadensis* discovery from site F-1 in Pickens County. While these accounts likely make reference to the same specimen, Curren (1977a) elaborates on the find by reporting the element as a metapodial found *in situ* beneath an overlying deposit of shells that yielded a radiocarbon date of 4,425 B.P. +/- 95

years. Due to its proximity to the overlying shell material, Curren suggested an older age of 8,000 to 12,000 B.P. for this underlying element (Curren, 1977a). In addition to these accounts, Curren (1977b) also reports elk from Russell Cave in Jackson County. While never actually examining the specimen he reports, Curren (1977b) cites a transcribed roundtable conversation between prominent southeastern archaeologists recorded during the 22nd Annual Southeastern Archaeological Conference in 1965. During this conversation, archaeologist Carl Miller is recorded as stating elk had been discovered at Russell Cave (Miller, 1965). Contrary to this report, no *C. canadensis* elements are listed in the final faunal report from Russell Cave (see Weigel et al., 1974), likely making this a case of misidentification or miscommunication. In addition to these reports, Frazier (1985) reports *C. canadensis* among the taxa recovered from Late Pleistocene deposits along the Tombigbee River in Alabama and Mississippi.

In 1989, Martin and Sneed reported the discovery of a left M1 (BC 286) they assign to *Cervus elaphus* from AJ Cave in DeKalb County. This *C. elaphus* specimen described by Martin and Sneed (1989) brings to the forefront a point of taxonomic confusion among members of this genus. Although the names *C. canadensis* and *C. elaphus* are both employed by researchers today (Mead, 2011, pers. comm.), both names refer to the same taxon. Based on recent mitochondrial studies, however, Ludt et al. (2004) suggest *C. canadensis* should be used for all members of this genus in North America and *C. elaphus* should be used for those from Europe, Africa, and the Middle East.

While the aforementioned reports substantiate the presence of *C. canadensis* in Alabama during the Late Pleistocene, the archaeological record suggests a presence of this species in the state well into the Holocene. Curren (1977b) reports two important *C. canadensis* finds in the archaeological record; UAM PV 85.13.225, an antler fragment from site 1Lull in Lauderdale County, and UAM PV 226, a m3 from site 1Gr2 in Greene County. UAM PV 85.13.225 is of particular interest as the antler fragment shows signs of human modification (Curren, 1977b). Lev-Tov (2002) later reports the discovery of two *C. canadensis* phalanges, a 1st and 2nd, from the Bluff Creek site in Lauderdale County. Both of these elements also exhibit signs of human modification (Lev-Tov, 2002). While Lev-Tov (2002) suggests the Bluff Creek site was occupied during Woodland and Mississippian cultural times, evidence from site 1Gr2 and site 1Lull suggest these sites were occupied from 4,000 B.C. to 1000 B.C. and 1000 B.C. to 500 B.C., respectively (Curren, 1977b). These finds provide evidence of not only direct interaction between humans and *C. canadensis* in Alabama (Curren, 1977b; Lev-Tov, 2002), but suggests this species had a range in the state as late as 2,500 years ago (Curren, 1977b).

Map 5: Counties with confirmed *Cervus* remains.

***Odocoileus virginianus* (Zimmermann, 1780) — White-tailed deer**

Odocoileus virginianus, the white-tailed deer, is the most common medium-to-large sized mammal found in Late Pleistocene and archaeological sites in Alabama. In Alabama today, *O. virginianus* is considered common and has a state-wide distribution (Mirarchi, 2004). *O. virginianus* remains recovered in the state suggests this species had a similar range dating back to the Late Pleistocene as remains of this taxon have been confirmed from both the Highland Rim and Gulf Coastal Plain (Table 1).

Map 6: Counties with confirmed *Odocoileus virginianus* remains.

Table 1. Late Pleistocene and Archaeological sites in Alabama with confirmed *Odocoileus virginianus* specimens

Site	County	Reference(s)
ABu-13	Butler	This study
ACh-1	Choctaw	This study
F-9	Clarke	Curren, 1977a
LaGrange	Colbert	Dejarnette and Knight, 1976
		Curren, 1976a
Stanfield-Worley	Colbert	Parmalee, 1962
		Miller, 1965
		Dejarnette et al., 1962
ACb-2	Colbert	Churcher et al., 1989
		Parmalee, 1992
ACb-3	Colbert	Womochel and Barnett, 1980a
		Lively et al., 1992
ACb-4	Colbert	This study
Little Bear Creek	Colbert	Curren, 1974
F-24	Dallas	Curren, 1977a
F-25	Dallas	Curren, 1977a
F-26	Dallas	Curren, 1977a
F-31	Dallas	Curren, 1977a
F-35	Dallas	Curren, 1977a
F-36	Dallas	Curren, 1977a
F-37	Dallas	Curren, 1977a
F-38	Dallas	Curren, 1977a
F-7	Greene	Curren, 1977a
AHl-1	Hale	This study
F-29	Hale	Curren, 1977a
F-30	Hale	Curren, 1977a
Moundville	Hale	Knight, 2010
"Near Newberne"	Hale	New York Times, 1887
Russell Cave	Jackson	Weigel et al., 1974
Dust Cave	Lauderdale	Grover, 1994
Not specified	Marengo	Curren, 1977a
Brooks Shelter	Marshall	Clayton, 1965
F-19	Montgomery	Curren, 1977a
F-20	Montgomery	Curren, 1977a
F-21	Montgomery	Curren, 1977a
F-28	Perry	Curren, 1977a
F-1	Pickens	Curren, 1977a
F-2	Pickens	Curren, 1977a
F-3	Sumter	Curren, 1977a
F-4	Sumter	Curren, 1977a
F-23	Wilcox	Curren, 1977a
Tombigbee River	Multiple	GSA, 1976
		Frazier, 1985

***Rangifer tarandus* (Linnaeus, 1758) — Caribou, Reindeer**

At present, only one confirmed record of *Rangifer tarandus*, the caribou, has been discovered from any Late Pleistocene or Holocene deposit in Alabama. This specimen, RMM 6657, a left distal metacarpal III+IV, was collected by the RMM during cave excavations at site ACb-2 in Colbert County. This element was formally described by Churcher et al. (1989) who were later cited by Parmalee (1992), Parmalee and Graham (2002), Schubert (2005), and Ruez (2008b). While the recent distribution of *R. tarandus* in North America is restricted to Alaska, Canada, British Columbia, Washington, and northern Idaho (Whitaker, 1992), Late Pleistocene records indicate this species had a range much further south during the Wisconsinan glacial (Kurtén and Anderson, 1980; Churcher et al., 1989; FAUNMAP, 1994). RMM 6657 represents the southern-most occurrence of *R. tarandus* in North America (Churcher et al., 1989).

Map 7: Counties with confirmed *Rangifer tarandus* remains.

Tayassuidae Palmer, 1897
***Mylohyus nasutus* (Leidy, 1860) - Long-nosed peccary**

Records of the extinct *Mylohyus nasutus*, the long-nosed peccary, have been limited to the northern region of the state and thus far have been confined strictly to cave dis-

coveries. The first account of *Mylohyus* from the state was made by Weigel et al. (1974) who reported the recovery of a right M2 and M3 from the lowest level at Russell Cave in Jackson County. Discovered in Late Paleo Indian deposits (Griffin, 1974), this specimen, assigned to *Mylohyus*. cf. *M. nasutus* (Weigel et al., 1974), was later cited by Curren et al. (1976) and Curren (1977a). Womochel (1982) and later Schubert (2005) report specimens assigned to *Mylohyus* sp. from both Winston Cave in Colbert County and Fern Cave in Jackson County, respectively. In a review of North American *Mylohyus* discoveries, Kurtén and Anderson (1980) synonymized all the species within this genus to *M. nasutus*, the only representative in their view that lived in central and eastern North America during the Irvingtonian and Rancholabrean.

Three reports can be found listing a second genus of peccary within Late Pleistocene deposits in Alabama, *Platygonus*, the flat-headed peccary (Womochel and Barnett, 1980b; Bell, 1985a; Bell, 1985b). Unfortunately, all three of these accounts are erroneous. The first was by Womochel and Barnett (1980b), who, in an abstract for the Southeastern Section of the Geological Society of America Annual Conference, report the discovery of *Platygonus* from site ACb-3 in Colbert County. Contrary to this report however, in their final manuscript presented at the conference, Womochel and Barnett (1980a) revised their identification of this specimen to *Mylohyus* cf. *fossilis* (which is here reassigned to *M. nasutus* after Kurtén and Anderson, 1980). Bell later reports the prescence of *Platygonus compressus* from the same site, ACb-3 (Bell, 1985b) and a second from site ACb-2 in Colbert County (Bell 1985a). Reported to be in the McWSC collection, all peccary specimens in this collection were later reassigned by Bell and other researchers to *M. nasutus*. It is likely these three cases of mistaken identity stem from descriptions of *Platygonus* by Kurtén and Anderson (1980) published just prior to their discoveries. Kurtén and Anderson (1980) describe *Platygonus* as very common within its range and found in higher abundance than *M. nasutus* (with the exception of certain sites in Florida). In some cave sites in the Appalachian region, *Platygonus* remains make up over 90 percent of the large mammal fauna (Kurtén and Anderson, 1980). While this description may have led to early "field" identifications of these specimens, in each case, further examination of the material resulted in the correct identification. The *M. nasutus* material housed in the McWSC collection from sites ACb-2 and ACb-3 have since been cited by Churcher et al. (1989), Lively et al. (1992), Parmalee (1992), Parmalee and Graham (2002), Schubert (2005), and Ruez (2008b).

To date, no peccary elements identifiable to the generic level have been confirmed from outside of caves in the northern counties of Alabama. The lone exception may be specimen RMM 7048. This specimen, a permineralized proximal portion of a metapodial, was discovered at site ADa-1 in Dallas County, a site that has produced a number of Late Pleistocene forms (see Curren, 1977a; McCarroll and Dobie, 1994). While this element is too incomplete for identification to the generic level, enough of the proximal portion is present for it to be assigned to the family Tayassuidae. Kurtén and Anderson (1980) describe *Mylohyus* and *Platygonus* as the only two Pleistocene representatives of the peccary family found in North America. Thus, if a further identification were possible, this element would certainly be assigned to one of these two genera. Although *P. compressus* is currently absent from the Alabama fossil record, this taxon has been confirmed from the surrounding states of Florida (Wright, 1995), Georgia (Ray, 1967), Tennessee (Guilday et al., 1978), and from the Black Prairie of Mississippi (Kaye, 1974; Frazier, 1985). These accounts place Alabama within the natural biogeographic range of this species during the Late Pleistocene and suggest further investigation into the associated Black Prairie of Alabama may yield the first records of this taxon within state lines.

Table 2. Late Pleistocene Artiodactyla status, distribution, and stratigraphic range.

Late Pleistocene Taxon		Status in Alabama		Pleistocene/Early Holocene Distribution				Stratigraphic Range										
								Blancan				Irvingtonian			Rancholabrean			
Order/Family	Genus and Species	EX	EP	H	C	G	V	1	2	3	4	E	M	L	I	S	W	R
Artiodactyla																		
Bovidae	*Bison* sp					●												
	Bison antiquus ⊗					●												
	?Bison bison		●			●												
Camelidae	cf. *Palaeolama mirifica* ⊗					●												
Cervidae	*Cervus* sp		●	●														
	Cervus canadensis		●			●												
	Odocoileus virginianus		●	●	●	●												
	Rangifer tarandus		●	●														
Tayassuidae	*Mylohyus nasutus* ⊗			●	●													

*Denotes first Pleistocene account in Alabama; ⊗ Extinct; **EX:** Extant in Alabama; **EP:** Extirpated from Alabama; **H:** Highland Rim; **C:** Cumberland Plateau; **G:** Gulf Coastal Plain; **V:** Valley and Ridge; **1 - 4:** Blancan stages; **E:** Early; **M:** Middle; **L:** Late; **I:** Illinoian; **S:** Sangmonian; **W:** Wisconsian; **R:** Recent. Stratigraphic ranges after Kurten and Anderson (1980).

Map 8: Counties with confirmed Tayassuidae remains.

Carnivora Bowdich, 1821
Canidae Fischer, 1817
***Canis* sp. Linnaeus, 1758 – Dogs, Foxes, Jackals**

Members of the Canidae are well represented in the Late Pleistocene and Holocene records of Alabama. Specimens assigned to *Canis* sp. have been reported from Russell Cave in Jackson County (Weigel et al., 1974), site ACb-3 in Colbert County (Lively et al., 1992), Dust Cave in Lauderdale County (Grover, 1994; Morey, 1994), along the Tombigbee River (Frazier, 1985), site F-24 in Dallas County (Curren, 1977a), and Moundville (Knight, 2010) and site F-30 in Hale County (Curren, 1977a). In addition, several unreported specimens assigned to *Canis* sp. can be found in the McWSC collection from site ACb-2 in Colbert County.

***Canis dirus* Leidy, 1858 - Dire wolf**
Fig. 5

The extinct dire wolf was one of the first Pleistocene species reported from the state. In 1856, a specimen assigned to *Canis primaevus* was listed among the Late Pleistocene taxa donated by Alabama state geologist Michael Tuomey to the ANSP (Anonymous, 1856). Said to be discovered in "a cave in the north of Alabama" (Anonymous, 1856), this specimen was likely identified by Joseph Leidy himself who, just a year earlier, named the first *C. primaevus* specimen after a left upper maxillary bone discovered in Evansville, Indiana (Leidy, 1855b). Leidy later realized the name *C. primaevus* had previously been used for the wild dog of Nepal and thus in 1858 he reassigned the Indiana specimen as the holotype of *Canis dirus*, the dire wolf (Spamer et al., 1996). As a result, the 1856 reference to *C. primaevus* from north Alabama (Anonymous, 1856) is here reassigned to *C. dirus*. Since this early discovery, *C. dirus* remains have been reported from Late Pleistocene deposits along the Tombigbee River in Alabama (Frazier, 1985) and from site ACb-2 in Colbert County (Bell, 1985a). Contrary to the report by Bell (1985a), however, a search through the McWSC collection (the repository for all the material collected by Bell) resulted in no *C. dirus* elements from site ACb-2. Thus this report is likely a case of misidentification.

Since the Frazier (1985) and ANSP specimens were not examined as part of this study, the presence of *C. dirus* in Alabama has been confirmed with two specimens, RMM 6616 and RMM 6035 (Fig. 5) from site ACb-3 in Colbert County. RMM 6616, a proximal portion of a left ulna, is here confirmed as belonging to *C. dirus* based on measurements of the anteroposterior length of the olecranon (33.46 mm) as well as the length from the coronoid process to the anconaeus process of the semilunar notch (26.02 mm). These two measurements nearly match those of a *C. dirus* specimen described by Graham (1976a) from Friesenhahn Cave in Bexar County, Texas that produced measurements of 33.5 and 28.03 mm, respectively. Two additional elements assigned to *C. dirus* were found in the McWSC collection from the same locality, a left P3 and a left upper canine. Both belonging to RMM 6035, the P3 falls within the crown length and width range of *C. dirus* as observed by Kurtén (1984) and the canine falls within the anteroposterior length range for *C. dirus* canines as listed by both Kurtén (1984) and Nowak (1979) (Table 3).

Table 3. Tooth measurements of RMM 6035.

	RMM 6035	Kurtén (1994)	Nowak (1979)
P3 crown width	6.9 mm	6.9 to 9.7 mm	NA
P3 crown length	17.36 mm	16.4 to 21.2 mm	NA
C1 crown length	17.76 mm	13.7 to 18.3 mm	13.5 to 18 mm

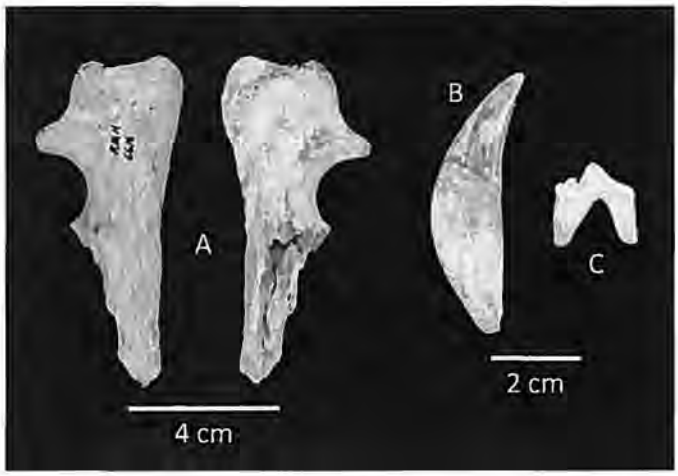
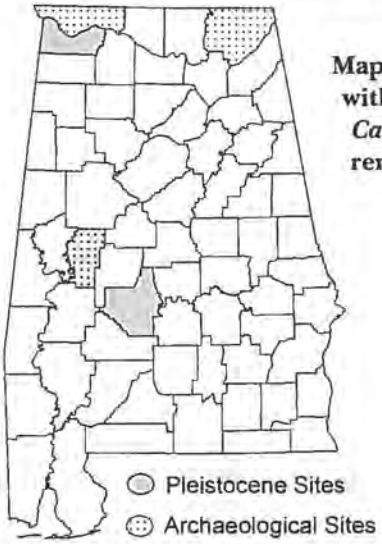


Figure 5. Late Pleistocene *Canis dirus* elements from Alabama. A. RMM 6616, proximal portion of left ulna. B. RMM 6035, upper left canine, lingual view. C. RMM 6035, upper left P3, buccal view.



Map 9: Counties with confirmed *Canis* sp. remains.

Map 10: Counties with confirmed *Canis dirus* remains.

Canis latrans Say, 1823 – Coyote
First Pleistocene Occurence
Fig. 6

In Alabama today, the coyote, *Canis latrans,* is considered common with a statewide distribution (Mirarchi, 2004). Remains of *C. latrans* have been reported from one archaeological site in the state, Dust Cave in Lauderdale County (Grover, 1994). Curren (1977a) reports the discovery of a partial proximal femur (UAM PV 85.13.102) from site F-30 in Hale County which was identified as belonging to "*Canis familiaris/ latrans.*" This specimen is here assigned to the more conservative *Canis* sp. as precise specific determination could not be made from this partial element alone. Not only does UAM PV 85.13.102 fall within the size range of both *C. familiaris* and *C. latrans* femora, but this specimen was not found *in situ* bringing into question whether or not the specimen is Late Pleistocene or Holocene in origin.

No confirmed accounts of *C. latrans* have been reported from any Late Pleistocene deposits in the state. However, in a search through museum collections, multiple unreported *C. latrans* specimens in the McWSC collection were identified from sites ACb-2 and ACb-3 in Colbert County. One of these specimens, RMM 4582, is particularly diagnostic (Fig. 6). Recovered from site ACb-2, this partial left mandible has the p1 and m3 alveoli present as well as teeth p2 through m2. Along with the presence of two mental foramina on the lateral surface of this mandible, a characteristic shared with *Canis rufus* but not with *Canis lupus* (which has three, Elbroch, 2006), RMM 4582 is here assigned to *C. latrans* based on size. Four mandibular measurements (see Table 4) place RMM 4582 within the range of *C. latrans* as opposed to the larger *C. rufus* and *C. dirus* as observed by Nowak (1979) allowing for specific determination. The confirmation of RMM 4582 as belonging to *C. latrans* is significant as it represents the first account of this taxon from any Late Pleistocene deposit in Alabama.

Map 11: Counties with confirmed *Canis latrans* remains.

Table 4. Mandibular measurements of RMM 4582 compared to other large canids.

	1	2	3	4
RMM 4582	75.3 mm	17.44 mm	11.66 mm	21.63 mm
Canis latrans*	69.1 to 88.5 mm	12.7 to 21.1 mm	10.7 to 14.1 mm	18.6 to 25.2 mm
Canis rufus*	88.2 to 99.5 mm	18.1 to 25.2 mm	12.3 to 15.8 mm	22.1 to 28.1 mm
Canis dirus*	102.0 to 105.0 mm	25.5 to 39.0 mm	17.7 to 30.8 mm	31.8 to 38.5 mm

*Canid measurements from Nowak (1979) and are as follows: **1.** the distance from anterior edge of the alveolus of p1 to the posterior edge of the alveolus of m3; **2.** the minimum depth from the dorsal surface of the mandible between p3 and p4 to the ventral surface of mandible; **3.** the crown length of p4.; and 4. the crown length of m2.

Canis cf. *C. rufus* Audubon and Bachman, 1851— Red wolf — *First Pleistocene Occurrence* Fig. 6

While presently extirpated from the state (Mirarchi, 2004), *Canis rufus*, the red wolf, is believed to have once had a range throughout the southeastern U.S. (Paradiso and Nowak, 1972; Mirarchi, 2004). Specimens assigned to *C. rufus* and *C.* cf. *C. rufus* have been discovered from Fern Cave in Jackson County (Ray, 1969, Hale, 1970; Paradiso and Nowak, 1973; Schubert, 2005; Semken et al., 2010a; 2010c) and sites ACb-2 and ACb-3 in Colbert County. The Fern Cave specimen is of particular interest as this specimen represents the most complete *C. rufus* yet recovered in the state. Discovered in 1969 by members of the Huntsville Grotto of the National Speleological Society (Ray, 1969; Hale, 1970; Paradiso and Nowak, 1973), this specimen was found in an upstream passage of the cave along with the remains of two other carnivores, *Panthera onca* and *Arctodus simus* (Ray, 1969; Hale, 1970; Paradiso and Nowak, 1973; Curren, 1977a; Richards et al., 1996; Schubert, 2005; Semken et al., 2010a; 2010c; Shubert et al., 2010). Comprised of both cranial and postcranial elements (Hale, 1970; Paradiso and Nowak, 1973), a formal description of this specimen was provided by Paradiso and Nowak (1973) who concluded the Fern Cave canid undoubtedly belongs to *C. rufus* based on measurements and direct comparisons with numerous recent canid specimens. Although the identification of this specimen is not in question, whether this specimen is Pleistocene or Holocene in age remains unclear. Even though the specimen was discovered in the same passageway of the extinct Late Pleistocene bear, *A. simus*, Ray (1969) and Paradiso and Nowak (1973) suggest the specimen lived in recent times noting the remains were not mineralized and were well preserved (as opposed to the poor state of preservation of the *A. simus* specimen), and had non-skeletal material on some of the bones. Hale (1970), in his report on the remains, suggests the specimen may have died as little as 20 years ago.

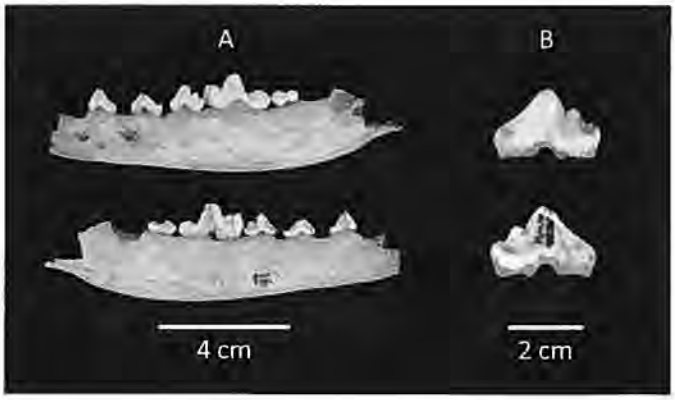
With the age of the Fern Cave *C. rufus* in question, the presence of this taxon in Alabama during the Late Pleistocene is tentatively confirmed with RMM 7639 (Fig. 6) from the McWSC collection. Recovered from site ACb-2 in Colbert County, this specimen was identified by the late carnivore authority Elaine Anderson who assigned RMM 7639 to *C.* cf. *C. rufus* based on size. Overall, *C. rufus* is described as being larger and more robust than *Canis latrans*, but smaller than *Canis lupus*, the gray wolf (Lawrence and Bossert, 1967; Kurtén and Anderson, 1980). While overall size can be used to differentiate between these three canids, the extremes in their size ranges overlap making specific determination difficult when presented only with isolated elements (Lawrence and Bossert, 1967). Measurements taken of the anteroposterior crown length of RMM

Table 5. Lower p4 crown length of RMM 7639 compared to other modern canids

	Crown length of p4
RMM 7639	15.36 mm
Canis rufus*	12.3 to 15.8 mm
Canis latrans*	10.7 to 14.1 mm
Canis lupus*	12.7 to 18.2 mm

*Canid measurements from Nowak (1979).

Figure 6. First Late Pleistocene records of *Canis latrans* and *Canis* cf. *C. rufus* from Alabama. A. RMM 4582, *C. latrans*, partial right mandible. B. RMM 7639, *C.* cf. *C. rufus*, right p4. Upper. Buccal views; Lower. Lingual views.



Map 12: Counties with confirmed *Canis* cf. *C. rufus* remains.

7639 place this element within the size range of both *C. rufus* and *C. lupus* (Table 5). With the exception of confirmed Late Pleistocene records in Georgia (Kurtén and Anderson, 1980), the paucity of Pleistocene *C. lupus* records in the southeastern U.S. (Mech, 1974; Nowak, 1979; FAUNMAP, 1994) suggests this taxon may not have had a Late Pleistocene distribution in Alabama. However, because the lack of *C. lupus* reports in the region should not alone serve as the determining factor in assigning RMM 7636 to *C. rufus*, the designation of this specimen to *C.* cf. *C. rufus* is appropriate.

Urocyon cinereoargenteus (Schreber, 1775) - Gray fox
First Pleistocene Occurrence
Fig. 7

Common statewide today (Mirarchi, 2004), remains of *Urocyon cinereoargenteus*, the gray fox, have been reported in Alabama from the archaeological sites of Stanfield-Worley (Parmalee, 1962; 1963) and Little Bear Creek (Curren, 1974) in Colbert County, Russell Cave (Weigel et al., 1974) and Bellefonte (Curren et al., 1977; Futato, 1977b) in Jackson County, and Dust Cave in Lauderdale County (Grover, 1994). While lower deposits yielding *U. cinereoargenteus* remains from Stanfield-Worley, Dust Cave, and Russell Cave date back as far as Paleo Indian times (Futato, 1977a; Weigel et al., 1974; Parmalee, 1962; 1963; Grover, 1994), the presence of this taxon in the Late Pleistocene of Alabama is confirmed with unreported specimens in the McWSC collection recovered from sites ACb-2 and ACb-3 in Colbert County.

One specimen in particular, RMM 4160 (Fig. 7) from site ACb-2, is particularly diagnostic. Although fragmented and rodent gnawed, RMM 4160, a partial right mandible, is here assigned to the genus *Urocyon* based on the presence of a distinctive step located just below the angular process on the posterior-ventral border of the mandible. This morphological characteristic is unique to the genera *Urocyon*, *Otocyon*, and *Nyctereutes* (Fritzell and Haroldson, 1982; Elbroch, 2006) with *Urocyon* being the only of the three genera native to North America (MacDonald, 1999). Kurtén and Anderson (1980) recognize three distinct species of *Urocyon* that lived in North America during the Pleistocene, *U. cinereoargenteus*, *Urocyon progressus*, and *Urocyon littoralis*. RMM 4160 is here assigned to *U. cinereoargenteus* as the geographic range of *U. littoralis* is limited to the Channel Islands of southern California and the stratigraphic range of *U. progressus* is limited to the Blancan (Kurtén and Anderson, 1980).

Map 13: Counties with confirmed *Urocyon cinereoargenteus* remains.

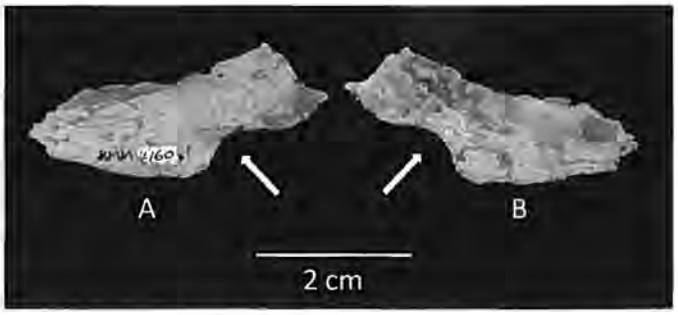


Figure 7. First Late Pleistocene record of *Urocyon cinereoargenteus* from Alabama. RMM 4160, partial left mandible. A. Buccal view. B. Lingual view. The arrows indicate the distinctive "step or notch," a character diagnostic of *Urocyon* mandibles.

Map 14: Counties with confirmed *Vulpes vulpes* remains.

***Vulpes vulpes* (Linnaeus, 1758) - Red fox**

The red fox, *Vulpes vulpes*, has been identified from the Late Pleistocene sites ACb-2 in Colbert County, ADa-1 in Dallas County (McCarroll and Dobie, 1994), and the Late Paleo Indian component of Dust Cave in Lauderdale County (Grover, 1994). Common statewide in Alabama today (Mirarchi, 2004), the presence of this taxon in the Late Pleistocene of Alabama was first confirmed by McCarroll and Dobie (1994) who assigned AUMP 2955, a partial right mandible, to *V. vulpes* based on general morphology and size. In a search through museum collections, three additional red fox specimens, RMM 4583, RMM 3732, and UAM PV 2008.2.6, were found. All three of these specimens were assigned prior to this study to *Vulpes fulvus* which was once considered to be a North American subspecies of *V. vulpes* (MacDonald, 1999). Churcher (1959), after a study of the cranial variation of North American and Eurasian red foxes, concluded all belong to a single species with the name *V. vulpes* having priority. As a result, these three specimens have here been reassigned as belonging to *V. vulpes*.

Felidae Fischer de Waldheim, 1817
***Lynx rufus* (Schreber, 1777) – Bobcat**

The first record of the bobcat, *Lynx rufus*, from an archaeological site in the state was reported by Parmalee (1963) who noted bobcat elements from the Stanfield-Worley in Colbert County. Later, *L. rufus* remains were reported from Russell Cave in Jackson County (Weigel et al., 1974), and Little Bear Creek (Curren, 1974) and site ACb-3 (Lively et al., 1992) in Colbert County. While Stanfield-Worley and Russell Cave each contain Paleo Indian deposits (Futato, 1977b; Weigel et al., 1974; Parmalee, 1962; 1963), the report of *L. rufus* remains from site ACb-3 (Lively et al., 1992) is significant as it confirms the presence of this taxon in the Late Pleistocene of Alabama. In addition to these accounts, unreported *L. rufus* specimens from site ACb-2 in Colbert County can be found in the McWSC collection. Of the Late Pleistocene felids recovered from sites of ACb-2 and ACb-3, *L. rufus* is the most common, outnumbering the other felids by a ratio of almost 5 to 1.

Map 15: Counties with confirmed *Lynx rufus* remains.

***Panthera onca* (Linnaeus, 1758) – Jaguar**
First Pleistocene Occurrence
***Panthera onca augusta* Leidy, 1872 – Pleistocene North American jaguar**
Fig. 8

The jaguar, *Panthera onca*, has been reported from one Late Pleistocene locality in Alabama, site ACb-2 in Colbert County (Churcher et al., 1989; Bell 1985a; Ruez, 2008b). Referred by these authors to *Felis onca*, Kurtén and Anderson (1980) and ITIS (2010) consider *F. onca* a junior synonym of *P. onca*. Thus, these three reports are here all reassigned to *P. onca*. While not cited by catalog number, the three reports of *P. onca* from site ACb-2 by Bell (1985), Churcher et al. (1989), and Ruez (2008b) all refer to specimen RMM 3935 (Fig. 8) from the McWSC collection. RMM 3935, a left P4, is here confirmed as belonging to *P. onca* as the anteroposterior length of the crown (28.97 mm) falls within the range of recent *P. onca* specimens (23 to 32.3 mm, mean= 27.1 mm, Seymour, 1989). Additional elements tentatively assigned to this taxon can be found in the McWSC collection from a second Late Pleistocene

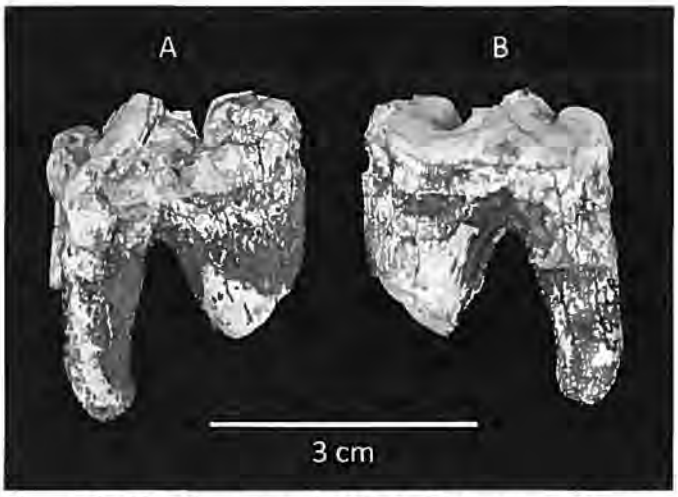


Figure 8. The first record of Late Pleistocene *Panthera onca* from Alabama. RMM 3935, left P4. A. Lingual view. B. Buccal view.

Map 16: Counties with confirmed *Panthera onca* remains.

Map 17: Counties with confirmed *Panthera onca augusta* remains.

locality in the state, site ACb-3 in Colbert County. In recent times *P. onca* has been almost completely extirpated from North America due to hunting pressure and habitat destruction (Seymore, 1989). In the Late Pleistocene, however, this taxon is known from over 30 Rancholabrean localities across the U.S. (Kurtén and Anderson, 1980).

A subspecies of the recent jaguar, the extinct *Panthera onca augusta*, has been reported in the state from one site, Fern Cave in Jackson County (Hale, 1970; Semken et al., 2010a; 2010c). This specimen, discovered in the same passageway as the aforementioned *C. rufus* (Ray, 1969; Hale, 1970; Paradiso and Nowak, 1973; Curren, 1977a; Semken et al., 2010a; 2010c), was assigned to the larger *P. onca augusta* (Ray, 1969; Hale, 1970; Semken et al., 2010a; 2010c). Represented by a single right upper canine, this specimen (USNM 26104) is said to be indistinguishable from referred *P. o. augusta* specimens (Ray, 1969). A subspecies that is suggested to have gone extinct at the end of the Pleistocene (Kurtén and Anderson, 1980), USNM 26104 represents the first and only known occurrence of *P. o. augusta* from the Late Pleistocene of Alabama.

?*Puma concolor* (Linnaeus, 1771) - Cougar, Mountain lion, Puma

Although currently extirpated from the state, *Puma concolor*, known as the cougar, mountain lion, or puma, was once believed to have a statewide range in Alabama (Mirarchi, 2004). Formerly thought to belong to the genus *Felis*, this species is now placed within the genus *Puma* (Wilson and Reeder, 1993). Reports of *P. concolor* remains in Alabama have come from the archaeological sites of Durant Bend in Dallas County (Thurmond, 1976; Nance, 1976), Russell Cave in Jackson County (Weigel et al., 1974), and Moundville in Hale County (Knight, 2010).

Elements assigned to *P. concolor* were reported from three different layers at Russell Cave (Weigel et al., 1974). The lowest layer, level E, yielded a radiocarbon date of 5490 +/- 200 B.P. at its base (Griffin, 1974). This specimen from level E represents the oldest known record of this taxon in the state, confirming its presence as far back as Late Archaic times in Alabama. While no records of this taxon have yet been identified from any Late Pleistocene deposits in the state, *P. concolor* remains have been reported from Late Pleistocene deposits in Mississippi (Phillips and Kaye, 2002) and Florida (Kurtén and Anderson, 1980). This would suggest *P. concolor* had a natural biogeographic range in Alabama during the Late Pleistocene, but with the lack of confirmed specimens, the presence of this taxon is suggested here as tentative.

Map 18: Counties with confirmed *Puma concolor* remains.

***Smilodon fatalis* (Leidy, 1868) – Saber-toothed cat**
Fig. 9

Only one record of the extinct saber-toothed cat, *Smilodon fatalis*, has been confirmed from any Late Pleistocene site in Alabama. RMM 5385, a partial canine fragment, was recovered from site ACb-3 in Colbert County. First reported by Bell (1985b), this specimen was later referenced by Lively et al. (1992), Parmalee and Graham (2002), and Schubert (2005). Although reported by each of these authors, none cited this specimen by its catalog number, RMM 5385 (Fig. 9). While Bell (1985b), Lively et al. (1992), and Schubert (2005) all refer to this specimen by generic name only, Parmalee and Graham (2002) refer this specimen to *S. fatalis* which is followed here.

Map 19: Counties with confirmed *Smilodon fatalis* remains

Figure 9. First record of *Smilodon fatalis* from Alabama. RMM 5385, upper canine.

Mephitidae Bonaparte, 1845
***Mephitis mephitis* (Schreber, 1776) - Striped skunk**
First Pleistocene Occurrence
Fig. 10

Extant within the state today (Mirarchi, 2004), *Mephitis mephitis*, the striped skunk, has been reported from early Holocene deposits at Stanfield-Worley (Parmalee, 1962) and LaGrange (Curren, 1976a) in Colbert County, Russell Cave in Jackson County (Weigel et al., 1974), Dust Cave in Lauderdale County (Grover, 1994), as well as the middle to late Holocene sites of Bellefonte in Jackson County (Curren et al., 1977; Futato, 1977b) and Eureka Landing in Monroe County (Gresham et al., 1987). Though the presence of *M. mephitis* at Late Paleo Indian sites such as Stanfield-Worley, Russell Cave, and Dust Cave lends strong evidence towards a Late Pleistocene occurrence of this species in Alabama, the discovery of over 20 *M. mephitis* specimens from sites ACb-2 and ACb-3 in Colbert County sheds any doubt. Of these specimens, RMM 6322, is particularly diagnostic and is here used to confirm the presence of this species in the Late Pleistocene. A partial left mandible with canine, p2, p3, p4, and m1 present, RMM 6322 is a match in general morphology to *M. mephitis* mandibles described and illustrated by Olsen (1964), Gilbert (1990), and Elbroch (2006) (Fig. 10). Furthermore, RMM 6322 has a shallow step located below the angular process on the ventral surface. This feature is nearly straight on the mandibles of skunks within the genus *Spilogale* (Elbroch, 2006), the only other genera of skunk native to Alabama (Mirarchi, 2004). Finally, man-

dibular measurements taken of RMM 6322 nearly match those of a recent *M. mephitis* specimen in the McWSC collection, MCWSC 20652 (Table 6), confirming RMM 6322 as belonging to *M. mephitis*. RMM 6322 represents the first confirmed Late Pleistocene report of this species in Alabama.

Table 6. Comparison of mandibular measurements of RMM 6322 to a modern *Mephitis mephitis* specimen, MSC 20652.

Measurement	RMM 6322	MSC 20652
Length of mandibular toothrow	27.94 mm	26.45 mm
Length of m1	9.91 mm	9.12 mm
Width of m1	4.42 mm	4.06 mm
Height of mandible behind m1	7.43 mm	7.19 mm
Height of mandible in front of p3	8.98 mm	8.48 mm

Figure 10. First Late Pleistocene record of *Mephitis mephitis* from Alabama. RMM 6322, partial right mandible. A. Buccal view. B. Lingual view. Arrows indicate the location of a shallow step, used to differentiate the mandibles of *Mephitis* and *Spilogale*.

Map 20: Counties with confirmed *Mephitis mephitis* remains.

Map 21: Counties with confirmed *Spilogale putorius* remains.

Spilogale putorius (Linneaus, 1758) — Eastern spotted skunk

The eastern spotted skunk, *Spilogale putorius*, was first reported in the archaeological record of Alabama by Parmalee (1963) who lists this species among the many recovered from Stanfield-Worley in Colbert County. The first Late Pleistocene record of this taxon in Alabama was reported by Churcher et al. (1989) who lists this taxon among the fauna from site ACb-2 in Colbert County. To date, these constitute the only published reports of *S. putorius* remains from any archaeological or Late Pleistocene site in the state. Of unpublished specimens, however, over 100 elements assigned to *S. putorius* can be found in the McWSC collection from sites ACb-2 and ACb-3 in Colbert County. While presently extant with a statewide distribution (Mirarchi, 2004), to date no *S. putorius* remains have been discovered from any Late Pleistocene deposits outside of Colbert County.

Mustelidae Fischer, 1817
Lontra canadensis (Schreber, 1777) - North American river otter – *First Pleistocene Occurrence*
Fig. 11

To date, four genera and six species within Mustelidae have been reported from Late Pleistocene sites in Alabama. Specimens identifiable to Mustelidae only have been reported from along the Tombigbee River in Alabama (GSA, 1976), and site F-1 in Pickens County (Curren et al., 1976). *Lontra canadensis*, the North American river otter, has been reported from the archaeological sites of Bellefonte in Jackson County (Curren et al., 1977; Futato, 1977b), Russell Cave in Jackson County (Weigel et al., 1974), and within the Late

Paleo Indian to Archaic component of Dust Cave in Lauderdale County (Grover, 1994). While often referred in the literature to the genus *Lutra*, Van Zyll de Jong (1972) and ITIS (2010) refer all American otters to the genus *Lontra* based on differences in the morphology of the baculum and postorbital processes of New and Old World otters. While still debated (see Sokolov, 1973; Kurtén and Anderson, 1980), the use of the genus *Lontra* is suggested here.

Confirmation of *L. canadensis* within a Late Pleistocene deposits in Alabama comes from RMM 5328 discovered at site ACb-2 in Colbert County. RMM 5328 (Fig. 11), a complete left ulna, matches the general morphology the ulnae of *L. canadensis* as illustrated by Olsen (1964) and Gilbert (1990). The relative size of RMM 5328 (Table 7) falls within the range of male *L. canadensis* as listed by Fisher (1942), lending further confirmation that RMM 5328 belongs to this taxon. Also in the McWSC collection, over 20 additional *L. canadensis* elements from site ACb-2 can be found. In recent times, *L. canadensis* is thought to have a state-wide distribution in Alabama (Mirarchi, 2004).

Map 22: Counties with confirmed *Lontra canadensis* remains.

Figure 11. First Late Pleistocene record of *Lontra canadensis* from Alabama. RMM 5328, left ulna.

Table 7. Ulna measurements of RMM 5328 compared to modern *Lontra canadensis* specimens.

Measurement	RMM 5328	Male range*	Female range*
Total length	7.75 mm	7.58 to 8.00 mm	7.29 to 7.53 mm
Shaft length	5.52 mm	5.51 to 5.70 mm	5.21 to 5.34 mm
Width of notch	0.94 mm	0.85 to 0.98 mm	0.80 to 0.84 mm
Width of proximal edge of notch	0.84 mm	0.80 to 0.89 mm	0.73 to 0.84 mm
Depth at proximal edge of notch	1.46 mm	1.38 to 1.47 mm	1.26 to 1.34 mm
Width at distal edge of notch	1.01 mm	0.97 to 1.07 mm	0.94 to 1.07 mm
Depth at distal edge of notch	1.44 mm	1.39 to 1.49 mm	1.27 to 1.40 mm
Mid-width	0.46 mm	0.46 to 0.51 mm	0.42 to 0.53 mm
Mid-depth	0.82 mm	0.80 to 0.88 mm	0.74 to 0.83 mm
Distal width	0.54 mm	0.55 to 0.88 mm	0.47 to 0.62 mm
Distal depth	1.04 mm	0.92 to 1.04 mm	0.87 to 0.95 mm

*Measurements from Fisher (1942).

Map 23: Counties with confirmed *Martes americana* remains.

Martes americana (Turton, 1806) — American marten

Martes americana, the American marten, has been reported in Alabama from one Late Pleistocene locality, site ACb-2 in Colbert County (Churcher et al., 1989; Ruez, 2008b). To date, over 20 elements assigned to *M. americana* have been discovered from this locality and are housed in the McWSC collection. The presence of *M. americana* in Alabama is of interest as the recent range of this boreal species is limited to extreme northern reaches of eastern North America and in historic times, this species likely had a range no further south than New England (Clark et al., 1987). According to FAUNMAP (1994), the presence of *M. americana* at site ACb-2 represents the southern-most range of this species yet reported from any Late Pleistocene locality. The presence of this species at site ACb-2 suggests a well established boreal coniferous forest once existed in northern Alabama during the Wisconsinan (Churcher et al., 1989). To date, no *M. americana* remains have been identified from any archaeological sites in the state suggesting *M. americana* no longer had a distribution in Alabama by the early Holocene. It is likely animals with known boreal affinities such as *M. americana* followed the retreat of the boreal forests to more preferable northern latitudes by the end of the Wisconsinan (Martin, 1958; Blair, 1958; Holt, 1971; Churcher et al., 1989).

Martes pennanti (Erxleben, 1777) — Fisher
Fig. 12

Martes pennanti, the fisher, is a mustelid that has a recent range in northern North America (Powell, 1981), but once had a Late Pleistocene distribution as far south as Alabama and Georgia (FAUNMAP, 1994). Remains of *M. pennanti* have been confirmed from two localities in Alabama, site ACb-2 in Colbert County (Churcher et al., 1989; Parmalee and Graham, 2002; Ruez, 2008b) and Law's site in Marshall County (Barkalow, 1961). While listed from site ACb-2 but not described (see Churcher et al., 1989; Parmalee and Graham, 2002; Ruez, 2008b), the Late Pleistocene occurrence of *M. pennanti* is confirmed by a nearly complete skull in the McWSC collection (RMM 3917, Fig. 12). One of over 80 *M. pennanti* elements collected from site ACb-2, the morphology and size of RMM 3917 matches those of recent male *M. pennanti* specimens as described by Elbroch (2006) (Table 8). While RMM 3917 confirms a Late Pleistocene occurrence of this taxon in Alabama, the report of *M. pennanti* from Law's site in Marshall County confirms a very recent range of this taxon in the state. At this site, a maxillary bone fragment assigned to *M. pennanti* was discovered in a historic burial dated to A.D. 1700 (Barkalow, 1961) making this specimen the most recent account of *M. pennanti* in Alabama yet known. While *M. pennanti* once had a Late Pleistocene distribution in North America as far south as Bartow County, Georgia (Kurtén and Anderson, 1980; FAUNMAP, 1994), this taxon has been extirpated from much of its former range as a result of habitat destruction and fur trapping beginning in the 1800s (Powell, 1981).

Table 8. Cranial measurements of RMM 3917 compared to modern *Martes pennanti* specimens.

Measurement	RMM 3917	Female*	Male*
Greatest length	123.65 mm	98.70 to 105.30 mm	112.80 to 135.02 mm
Condylobasal length	116.26 mm	95 to 120.09 mm	98.76 to 120.15 mm
Basilar length	103.56 mm	87.2 to 104.11 mm	101.50 to 107.40 mm
Palatilar length	58.44 mm	48.00 to 52.20 mm	56.50 to 60 mm
Zygomatic breadth	76.98 mm**	51.12 to 67.14 mm	60.60 to 83.64 mm
Interorbital breadth	27.15 mm	19.80 to 27.00 mm	23.60 to 27.34 mm
Braincase breadth	47.19 mm	41.14 to 45.00 mm	44.16 to 47.50 mm
Mastoidal breadth	51.55 mm	43.13 to 47.00 mm	49.87 to 57.22 mm

* Measurements from Elbroch (2006); ** Measurement estimated.

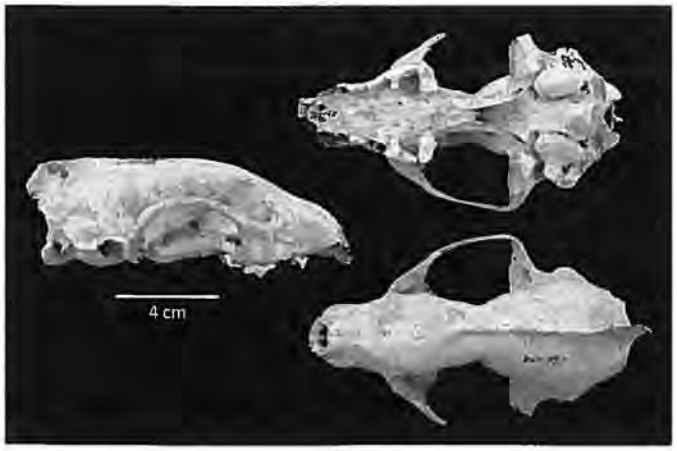


Figure 12. Late Pleistocene *Martes pennanti* skull. RMM 3917, lateral, ventral, and dorsal views.

Map 24: Counties with confirmed *Martes pennanti* remains.

***Mustela frenata* Lichtenstein, 1831 - Long-tailed weasel**
First Pleistocene Occurrence
Fig. 13

The long-tailed weasel, *Mustela frenata*, has been known from Late Pleistocene sites in the surrounding states of Florida, Georgia, and Tennessee (FAUNMAP, 1994). Until this study, however, this species has not been reported from any late Pleistocene or archaeological site in Alabama. Based on comparisons with recent specimens, the late Elaine Anderson assigned 14 partial mandibles in the McWSC collection to *M. frenata*. All collected from site ACb-2 in Colbert County, 13 of the 14 partial mandibles have the m1 present. The size of these molars all fall within the ranges of male (5 to 7 mm) and female (4 to 7 mm) *M. frenata* as listed by Sheffield and Thomas (1997). The Late Pleistocene presence of *M. frenata* is further confirmed with another McWSC specimen, RMM 4843 (Fig. 13), a partial left maxilla from site ACb-2. While incomplete, RMM 4843 has all the premolars and molars present as well as the alveolus of the canine. The anteroposterior length of maxillary toothrow of RMM 4843 (13.02 mm) falls within the ranges of both recent male and female *M. frenata*, but also overlaps with the range of male *Mustela nivalis* (Elbroch, 2006). Although the extremes in sizes of *M. frenata* and *M. nivalis* overlap, the length of the maxillary toothrow of RMM 4843 more closely matches the average length of female *M. frenata* (13.96 mm) specimens as opposed to the average male *M. frenata* (16.36 mm) or the average male or female *M. nivalis* (10.15 mm and 9.31 mm respectively, Elbroch, 2006) (Table 9). Furthermore, additional measurements of the lateral and medial length of the P4 and transverse width and anteroposterior length of the M1 fall within the ranges of *M. frenata* (Sheffield and Thomas, 1997, Table 10). Although *M. frenata* has a recent distribution in Alabama (Mirarchi, 2004), the remains described here represent the first Late Pleistocene occurrence of *M. frenata* in the state.

Map 25: Counties with confirmed *Mustela frenata* remains.

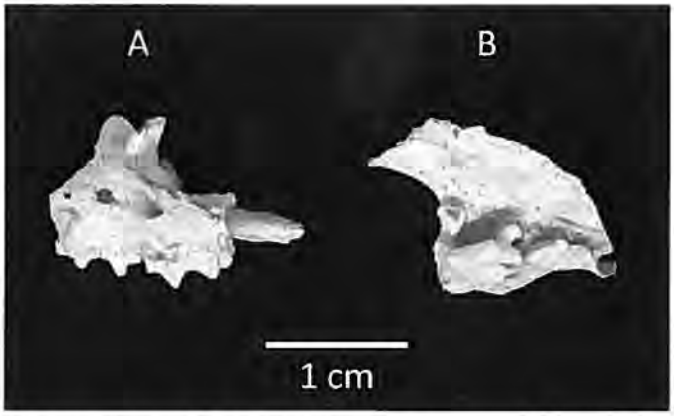


Figure 13. First Late Pleistocene record of *Mustela frenata* from Alabama. RMM 4843, right maxillary fragment. A. Lateral view. B. Palatal view.

Table 9. Length of maxillary toothrow of RMM 4843 compared to modern *Mustela* species.

Species	Length of maxillary toothrow (range)*	Length of maxillary toothrow (average)*
RMM 4834	NA	13.02 mm
Mustela erminea – female	8.36 to 12.70 mm	9.93 mm
Mustela erminea – male	9.00 to 15.00 mm	11.83 mm
Mustela frenata – female	10.90 to 16.90 mm	13.96 mm
Mustela frenata - male	12.71 to 18.90 mm	16.36 mm
Mustela nivalis – female	8.50 to 9.80 mm	9.31 mm
Mustela nivalis – male	9.60 to 15.00 mm	10.15 mm

* Measurements from Elbroch (2006)

Table 10. Tooth measurements of RMM 4843 compared to the ranges of modern *Mustela frenata* specimens.

Measurement	RMM 4843	Male*	Female*
Lateral length of P4	5.27 mm	5 to 7 mm	4 to 6 mm
Medial length of P4	5.70 mm	5 to 7 mm	4 to 6 mm
Breadth of M1	4.50 mm	4 to 5 mm	3 to 5 mm
Length of M1	2.41 mm	2 to 3 mm	1 to 3 mm

* Measurements from Sheffield and Thomas (1997).

Figure 14. First Late Pleistocene record of *Mustela nivalis* from Alabama. RMM 5878, left mandible. Top: Lingual view. Bottom: Buccal view.

Map 26: Counties with confirmed *Mustela nivalis* remains.

***Mustela nivalis* Bangs, 1896 - Least weasel**
First Pleistocene Occurrence
Fig. 14

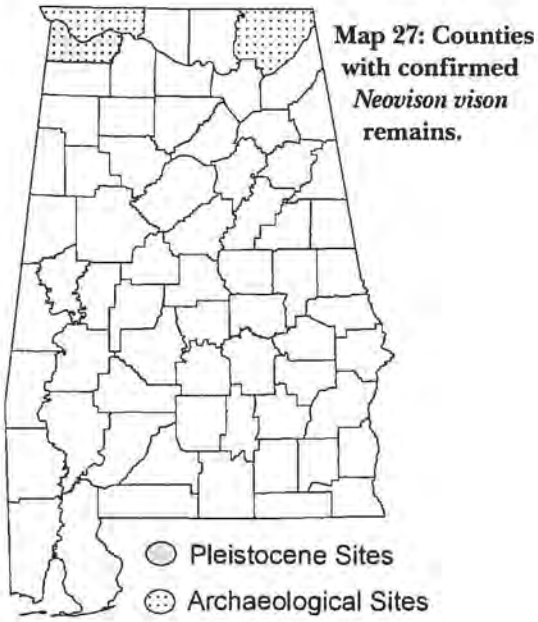
Four elements assigned to *Mustela nivalis*, the least weasel, have been recovered from sites ACb-2 and ACb-3 in Colbert County (RMM 5238, RMM 7624, McWSC 24564, and RMM 5878). These elements represent the first records of *M. nivalis* from the Late Pleistocene and/or Holocene from the state. These four specimens were assigned by previous researchers to *Mustela rixosa*, Bang's weasel, a name whose taxonomic status is under considerable debate. Whitaker (1992), for example, considers *N. nivalis* and *M. rixosa* conspecific with the former taking priority. Kurtén and Anderson (1980), on the other hand, consider *M. nivalis* and *M. rixosa* distinct species. At the same time however, they refer *M. rixosa* to the common name "least weasel," the recognized common name for *M. nivalis* (ITIS, 2010). Others such as ITIS (2010), MacDonald (1999), and Sheffield and King (1994) recognize *M. rixosa* as a subspecies of *M. nivalis*. Due to this taxonomic uncertainty of *M. rixosa*, the use of *M. nivalis* is suggested here.

One of these four specimens, RMM 5878 (Fig. 14), a complete right mandible, is here confirmed as belonging to *M. nivalis* based on general morphology. RMM 5878 is particularly small measuring 16.61 mm in greatest mandibular length. This measurement falls within the observed ranges of both *M. nivalis* (13.67 to 16.78 mm) and *Mustela erminea*, the ermine (15.22 to 22.36 mm) as listed by Elbroch (2006). While RMM 5878 possesses morphological characteristics common to both *M. nivalis* and *M. erminea* (i.e. curved mandible, triangular coronoid process, barrel-shaped condyle, and reduced angular process), the tip of the coronoid process is curved to the posterior, a characteristic known to *M. nivalis* but not *M. erminea*.

Neovison vison (Schreber, 1777) - American mink
First Pleistocene Occurrence
Fig. 15

As with *Mustela frenata* and *Mustela nivalis*, the American mink, *Neovison vison*, is yet another mustelid that has not previously been reported from any Late Pleistocene site in Alabama. Presently extant in the state, the American mink was previously placed within the genus *Mustela*.

Figure 15. First Late Pleistocene record of *Neovison vison* from Alabama. RMM 4990.2, Right mandible. Top: Lingual view. Bottom: Buccal view.



Map 27: Counties with confirmed *Neovison vison* remains.

Recently the American mink was reassigned to the genus *Neovison* based on cytogenetic and biochemical differences with the other species within the genus *Mustela* (Wozencraft, 2005). In all accounts of American mink in Alabama cited below, the former genus *Mustela* was utilized. These accounts are here all reassigned to *Neovison*.

In the Alabama archaeological record, remains of *N. vison* have been reported from Dust Cave in Lauderdale County (Grover, 1994), La Grange in Colbert County (Dejarnette and Knight, 1976), and Bellefonte in Jackson County (Curren et al., 1977; Futato, 1977b). Remains of *N. vison* have been confirmed from only one Late Pleistocene locality in the state, site ACb-2 in Colbert County. Housed in the McWSC collection, over 50 elements assigned to *N. vison* have been recovered from this site. All identified by Elaine Anderson, one element in particular, RMM 4990.2 (Fig. 15), a complete right mandible, is here used to confirm the presence of this taxon. RMM 4990.2 is confirmed as belonging to *N. vison* based on general morphology and comparisons with recent and archaeological representatives of this taxon.

The greatest mandibular length of RMM 4990.2 (42.29 mm) overlaps with the size range three North American mustelids, *N. vison* (male: 30.58 to 45.96 mm, female: 33.47 to 47.30 mm), *Martes americana* (male: 41.22 to 50.89 mm, female: 42.08 to 57.42 mm), and the male *Mustela nigripes* (39.01 to 44.25 mm) as listed by Elbroch (2006). When compared to recent representatives, the morphology of RMM 4990.2 more closely resembles that of *N. vison* as the dorsal-ventral depth of the mandible is not as deep as that of *N. nigripes* and the posterior edge of the coronoid process on RMM 4990.2 is less curved than that of *M. americana*. Furthermore, the length of the mandibular toothrow (25.57 mm), mandible height at m1 (7.42 mm), m1 length (9.36 mm), and m1 width (4.06

mm) of RMM 4990.2 fall within the observed ranges of *N. vision* and its known subspecies as observed by Mead et al. (2000). Based on this data, RMM 4990.2 is here confirmed as belonging to *N. vison* and represents the first account of this taxon from any Late Pleistocene site in Alabama.

Kurtén and Anderson (1980) suggest the presence of *N. vison* at a site is a good indicator of a nearby, permanent water source as much of diet of the American mink is aquatic. This is certainly the case with site ACb-2 as it is located along the banks of the Tennessee River, a major waterway in the state.

Procyonidae Gray, 1825
***Procyon lotor* (Linnaeus, 1758) - Raccoon**

In recent times, the raccoon, *Procyon lotor*, is considered common with a statewide distribution (Mirarchi, 2004). Remains of *P. lotor* have been discovered at sites across the state suggesting this taxon had a similar range in Alabama during the Late Pleistocene. The raccoon was first reported from a Late Pleistocene deposit in the state by the GSA (1976) which noted *P. lotor* remains discovered in a blue-gray clay zone along the Tombigbee River. Radiocarbon dates produced an age of 8,290 to 14,650 B.P. for this zone (GSA, 1976). Curren et al. (1976) and Curren (1977a) report *P. lotor* remains from site F-1 in Pickens County that were estimated to date between 8,000 and 12,000 B.P. based on carbon-14 dates taken from an overlying deposit of shells (Curren, 1977a). Frazier (1985) later listed *P. lotor* among the taxa discovered from Late Pleistocene deposits along the Tombigbee River in Mississippi and Alabama. In addition to these accounts, the McWSC collection houses over 50 unreported elements assigned to *P. lotor* that were recovered from sites ACb-2 and ACb-3 in Colbert County.

Remains of *P. lotor* have also been confirmed from Paleo Indian deposits at the Quad site in Morgan County (Cambron and Hulse, 1960), Stanfield-Worley in Colbert County (Parmalee, 1962; 1963), Russell Cave in Jackson County (Weigel et al., 1974), LaGrange in Colbert County (Curren, 1976a), and Dust Cave in Lauderdale County (Grover, 1994). *P. lotor* remains have also been reported from later archaeological deposits at the Little Bear Creek site in Colbert County (Curren, 1974), Eureka Landing in Morgan County (Gresham et al., 1987), D'Olive Creek in Baldwin County (Curren, 1976b), Seven Springs in Cherokee County (Dejarnette et al., 1973), Bellefonte in Jackson County (Curren et al., 1977; Futato, 1977b), and Moundville in Hale County (Knight, 2010).

Ursidae Fischer de Waldheim, 1817
***Arctodus simus* (Cope, 1897) - Giant Short-faced bear**

To date, only one report of *Arctodus simus*, the extinct giant short-faced bear, has been confirmed from any Late Pleistocene deposit in Alabama. Discovered by members of the National Speleological Society in 1969 in Fern Cave in Jackson County (Hale, 1970; Curren, 1977a; Richards et al., 1996), the remains were sent to the USNM where they were identified and studied by the curator of the Division of Vertebrate Paleontology, Dr. Clayton E. Ray (Hale, 1970; Semken et al., 2010a; 2010c). In 1969 Ray wrote an unpublished manuscript describing not only the Fern Cave specimen (USNM 26097), but other *Arctodus* specimens housed at the USNM (Ray, 1969). In this manuscript, Ray confirms USNM 26097 as belonging to *A. simus* based on direct comparisons of the humerus and radius to an *A. simus* specimen recovered from Potter Creek Cave, CA. In addition, Ray (1969) notes that measurements of eight of

Map 28: Counties with confirmed *Procyon lotor* remains.

Map 29: Counties with confirmed *Arctodus simus* remains.

the 14 teeth recovered fell within the size range of *A. simus* allowing the specimen to be "referred with confidence to *A. simus*."

Unlike many of the other Late Pleistocene specimens discovered in Alabama, the Fern Cave *A. simus* has appeared multiple times in the literature. Beginning with Hale's initial report in 1970, this specimen has been mentioned by Paradiso and Nowak (1973), Curren (1977a), Kurtén and Anderson (1980), Richards et al. (1996), Schubert (2005), Semken et al. (2010a; 2010c), and Shubert et al. (2010). Over the years, however, the multiple reports citing this specimen have produced conflicting accounts as to what elements belonging to the Fern Cave *A. simus* were recovered and how many individuals are actually present. Hale (1970) first reports the recovery of a right humerus (belonging to a young adult), canines, and molars that represented two individuals. Curren (1977a) later references this specimen twice in the same manuscript, first citing Hale (1970) and noting the discovery as a canine, molar (both singular), and right humerus. Later, Curren (1977a) lists a right humerus, canines, and molars (both plural). Curren (1977a) also notes the presence of two *A. simus* specimens with the humerus belonging to a young individual. Richards et al. (1996) notes the elements as belonging to a single individual and being made up of 14 isolated teeth, a left humerus, a distal diaphysis, and partial right radius.

Table 11 is a complete list of elements for the Fern Cave *A. simus* based on data from USNM personnel, elements listed in the Ray (1969) manuscript, and photographs of the Fern Cave specimen taken by Blaine Schubert of ETSU. This list should serve to supersede those published by Hale (1970), Curren (1977a) and Richards et al. (1996) for USNM 26097. The presence of at least two individuals, as noted by Ray (1969), Hale (1970), and Curren (1977a), is confirmed by the presence of two left M2 and five canines (two of which are from the lower left side). This finding corrects the minimum number of individuals of one as noted by Richards et al. (1996). The presence of a subadult individual is also confirmed as the left humerus is lacking the distal epiphysis.

Table 11. Confirmed list of elements for the Fern Cave *Arctodus simus* (USNM 26097).

Left humerus, distal half of diaphysis, lacks distal epiphysis, subadult
Partial right radius
3 unidentified long bone fragments
Left M1
Right M1
Left M2
Left M2
Right m1
Left m2
Right m2
Left canine
2 premolars
Left lower canine
Left lower canine
Right upper canine
Right canine
Associated unidentified fragments

Ursus sp. Linneaus, 1758
Ursus americanus Pallas, 1780 - American black bear

Remains of the American black bear, *Ursus americanus*, have been reported from various Alabama Pleistocene and archaeological sites including Russell Cave (Weigel et al., 1974) and Bellefonte in Jackson County (Curren et al., 1977; Futato, 1977b), Durant Bend in Dallas County (Thurmond, 1976; Nance, 1976), sites ACb-2 (Parmalee, 1992; Churcher et al., 1989) and ACb-3 (Womochel and Barnett, 1980a) in Colbert County, and Eureka Landing in Monroe County (Gresham et al., 1987). In addition, Holman et al. (1990) make reference to "bears" from site ACb-2 and specimens assigned to *Ursus* sp. have been reported from Concord Shelter and the Rock House site in Marshall County (Clayton, 1965), site ACb-3 (Womochel and Barnett, 1980b), and Moundville in Hale County (Knight, 2010). Extirpated from much of its former range in the state, *U. americanus* is presently known in Alabama only from an area just north of Mobile where a breeding population still resides (Mirarchi, 2004).

Map 30: Counties with confirmed *Ursus* remains.

Table 12. Late Pleistocene Carnivora status, distribution, and stratigraphic range.

Late Pleistocene Taxon		Status in Alabama		Pleistocene/Early Holocene Distribution				Stratigraphic Range										
								Blancan				Irvingtonian			Rancholabrean			
Order/Family	Genus and Species	EX	EP	H	C	G	V	1	2	3	4	E	M	L	I	S	W	R
Carnivora																		
Canidae	*Canis* sp	●		●	●	●												
	Canis dirus ⊗			●														
	Canis latrans	●		●														
	Canis cf. *C. rufus**	●	●															
	*Urocyon cinereoargenteus**	●	●	●	●													
	Vulpes vulpes	●		●		●												
Felidae	*Lynx rufus*	●		●	●													
	*Panthera onca**	●		●														
	Panthera onca augusta ⊗			●														
	?Puma concolor		●		●													
	Smilodon fatalis ⊗			●														
Mephitidae	*Mephitis mephitis*	●		●	●													
	Spilogale putorius	●		●														
Mustelidae	*Lontra canadensis**	●		●	●													
	Martes americana		●	●														
	Martes pennati		●	●														
	*Mustela frenata**	●		●														
	*Mustela nivalis**		●	●														
	*Neovison vison**	●		●														
Procyonidae	*Procyon lotor*	●		●	●	●												
Ursidae	*Arctodus simus* ⊗				●													
	Ursus sp.	●		●														
	Ursus americanus	●		●	●													

*Denotes first Pleistocene account in Alabama; ⊗ Extinct; **EX:** Extant in Alabama; **EP:** Extirpated from Alabama; **H:** Highland Rim; **C:** Cumberland Plateau; **G:** Gulf Coastal Plain; **V:** Valley and Ridge; **1 - 4:** Blancan stages; **E:** Early; **M:** Middle; **L:** Late; **I:** Illinoian; **S:** Sangmonian; **W:** Wisconsian; **R:** Recent. Stratigraphic ranges after Kurten and Anderson (1980).

Chiroptera Blumenbach, 1779
Vespertilionidae Gray, 1821
Eptesicus fuscus (Beauvoidm, 1796) - Big brown bat
Myotis lucifugus (LeConte, 1831) - Little brown bat
Nycticeius humeralis (Rafinesque, 1818) – Evening bat
?Pipistrellus sp. Kaup, 1829 - Pipistrelle

Members of the bat order Chiroptera have been confirmed from only three Late Pleistocene sites in Alabama, sites ACb-2, ACb-3, and ACb-4, all in Colbert County. Bell (1985b) lists "bats" among the taxa recovered from site ACb-3 and Lively et al. (1992) makes reference to "2+" members of Chiroptera from the same site. After preliminary investigations at site ACb-2, Womochel and Barnett report the first Pleistocene accounts of: *Eptesicus fuscus* (Womochel and Barnett, 1980a), *Myotis lucifugus* (Womochel and Barnett, 1980a), *Nycticeius humeralis* (Womochel and Barnett, 1980a), and *Pipistrellus* sp. (Womochel and Barnett, 1980a; 1980b). Womochel and Barnett (1980a) suggest that at least three species of *Myotis* were recovered from site ACb-2, of which only one, *M. lucifugus*, could be positively identified. All extant in the state (Mirarchi, 2004), Womochel and Barnett (1980a) also mention thousands of cranial and post cranial elements they assign to the genus *Myotis* from site ACb-2, the most abundant taxon collected at this site. This is also the case with *Myotis* elements from sites ACb-3 and ACb-4 housed in the McWSC collection. Of the thousands of bat elements recovered

Table 13. Late Pleistocene Chiroptera status, distribution, and stratigraphic range.

Late Pleistocene Taxon		Status in Alabama		Pleistocene/Early Holocene Distribution				Temporal Range										
								Blancan				Irvingtonian			Rancholabrean			
Order/Family	Genus and Species	EX	EP	H	C	G	V	1	2	3	4	E	M	L	I	S	W	R
Chiroptera																		
Vespertilionidae	*Eptesicus fuscus*	●		●														
	Myotis lucifugus	●		●														
	Nycticeius humeralis	●		●														
	?Pipistrellus sp.	●		●														

*Denotes first Pleistocene account in Alabama; ⊗ Extinct; **EX:** Extant in Alabama; **EP:** Extirpated from Alabama; **H:** Highland Rim; **C:** Cumberland Plateau; **G:** Gulf Coastal Plain; **V:** Valley and Ridge; **1 - 4:** Blancan stages; **E:** Early; **M:** Middle; **L:** Late; **I:** Illinoian; **S:** Sangmonian; **W:** Wisconsian; **R:** Recent. Stratigraphic ranges after Kurten and Anderson (1980).

Map 31: Counties with confirmed Chiroptera remains.

from these sites, a large majority has been assigned to the genus *Myotis*. In contrast, Womochel and Barnett (1980a; 1980b) could only identify a single *Pipistrellus* sp. based on a partial dentary. Since no additional *Pipistrellus* elements could be identified in the McWSC collection, the presence of this genus in the Late Pleistocene of Alabama is here suggested as tentative only. Of the specimens described by Womochel and Barnett (1980a; 1980b), all are uncataloged but accessible for study in the AUMP collection.

Didelphimorphia Gill, 1872
Didelphidae Gray, 1821
***Didelphis virginiana* Kerr, 1792 - Virginia opossum**
First Pleistocene Occurrence
Fig. 16

In the Alabama archaeological record, two members of the genus *Didelphis* have been reported; *Didelphis virginiana*, the Virginia opossum, and *Didelphis marsupialis*, the common opossum. Considered common in the state today (Mirarchi, 2004), *D. virginiana* has been reported from the archaeological sites of Dust Cave in Lauderdale County (Grover, 1994) and Moundville in Hale County (Knight, 2010). *D. marsupialis*, on the other hand, has been reported from Stanfield-Worley (Parmalee, 1962; 1963; Dejarnette et al., 1962), the Little Bear Creek site (Curren, 1974), and LaGrange in Colbert County (Dejarnette and Knight, 1976), Russell Cave (Weigel et al., 1974) and Bellefonte in Jackson County (Curren et al., 1977; Futato, 1977b), D'Olive Creek in Baldwin County (Curren, 1976b), Durant Bend in Dallas County (Thurmond, 1976; Nance, 1976), Abercrombie in Russell County (Rock, 1980), Tukabatchee in Elmore County (Knight, 1985), and Eureka Landing in Monroe County (Gresham et al., 1987).

Although these archaeological reports suggest the presence of both *D. virginiana* and *D. marsupialis* in Alabama during the Holocene, this is in fact not the case. Confusion exists in the literature as *D. marsupialis* has historically been used as the name for the North American species of opossum (see Olsen, 1964; Gilbert, 1990 for examples). Gardner (1973) attributes this confusion in part to the wide range of interspecific variation exhibited within *Didelphis*, leading to the taxonomic assignment of various species and subspecies within the genus. According to Gardner (1973), the use of *D. marsupialis* for North American opossums stems from the works of Hershkovitz (1951) and Hall and Kelson (1952; 1959) who recognized only two species of extant opossums, *D. marsupialis* and *Didelphis albiventris*, with only *D. marsupialis* having a range in North America. Although Hershkovitz (1951) recognized *Didelphis marsupialis virginiana* for North American opossums, Gardner (1973) argued *D. virginiana* was without a doubt a distinct species. The latter view is now widely accepted with *D. virginiana* suggested for all opossums found in North America in both the Holocene and Pleistocene (Gardner, 1973; Kurtén and Anderson, 1980; Krause, 2001). As a result, the species *D. virginiana* is suggested here for all aforementioned reports of *D. marsupialis* in Alabama.

Figure 16. First Late Pleistocene record of Didelphis virginiana from Alabama. A. RMM 6735, Late Pleistocene *D. virginiana* right maxilla fragment, ventral view. B. RCC 3, skull from a recent *D. virginiana* specimen, occlusal view.

Pleistocene remains of *D. virginiana* are considered rare in the southeastern U.S. (Kurtén and Anderson, 1980; FAUNMAP, 1994; Schubert, 2005) and no *D. virginiana* remains have previously been reported from any Late Pleistocene deposit in Alabama. In the McWSC collection, however, *D. virginiana* elements have been recovered from the Late Pleistocene sites ACb-2, ACb-3, and ACb-5 in Colbert County, site ABu-13 in Butler County, and site ADa-1 in Dallas County. The lone specimen from site ADa-1, RMM 6735, is particularly diagnostic of this taxon and is here used to confirm the presence of *D. virginiana* in Alabama during

Map 32: Counties with confirmed *Didelphis virginiana* remains.

the Late Pleistocene. RMM 6735 is represented by an associated right humerus and right maxilla fragment with M3 and M4 present. The general morphology of this humerus matches that of *D. virginiana* figured by Olsen (1964) and Gilbert (1990) and the total length of this element (70.79 mm) matches that of recent *D. virginianus* specimens (71 mm, Gilbert, 1990). The morphology of the right maxilla fragment matches that of recent comparative *D. virginiana* specimens (Fig. 16) as well as those figured by Olsen (1964), Gilbert (1990), and Elbroch (2006). The molars present on RMM 6735 are triangular, reduced, and flattened, all diagnostic characteristics of *D. virginiana* (Elbroch, 2006).

Lagomorpha Brandt, 1855
Leporidae Fischer, 1817
***Sylvilagus* sp. Gray, 1867 - Cottontails**
***Sylvilagus floridanus* (Allen, 1890) - Eastern cottontail**
First Pleistocene Occurrence
***?Sylvilagus aquaticus* (Bachman, 1837) - Swamp rabbit**
Fig. 17

Members of Leporidae, the hares and rabbits, are well represented in Late Pleistocene deposits in Alabama. Specimens assigned to the genus *Sylvilagus*, the cottontails, have been reported from several Late Pleistocene localities in the state including site F-1 in Pickens County (Curren et al., 1976; Curren, 1977a), along the Tombigbee River (GSA, 1976; Frazier, 1985), and site ACb-3 (Womochel and Barnett, 1980a; Lively et al., 1992) in Colbert County. Curren (1977a) reports six additional *Sylvilagus* sp. specimens (UAM PV 127-132), however he fails to provide locality data for them. In a search through the UAM records, these numbers have been assigned to specimens other than rabbits, and thus, these accounts by Curren (1977a) stand as unconfirmed. In the McWSC collection, unreported specimens assigned to *Sylvilagus* sp. can be found from site ACb-2 in Colbert County. In the archaeological record, *Sylvilagus* sp. has been reported from Stanfield-Worley (Parmalee, 1962; Dejarnette et al., 1962), Little Bear Creek (Curren, 1974) and LaGrange (Dejarnette and Knight, 1976) in Colbert County, Bellefonte in Jackson County (Curren et al., 1977; Futato, 1977b), Abercrombie in Russell County (Rock, 1980), Eureka Landing in Monroe County (Gresham et al., 1987), and Moundville in Hale County (Knight, 2010).

Specimens assigned to *Sylvilagus floridanus*, the eastern cottontail, have been reported from the Alabama archaeological sites of Russell Cave in Jackson County (Weigel et al., 1974) and Dust Cave in Lauderdale County (Grover, 1994). Although *S. floridanus* remains have not been reported from any Late Pleistocene locality in the state, remains of this taxon have been identified in the McWSC collection. RMM 7506 (Fig. 17) from site ACb-3, a complete right femur, matches in general morphology the *S. floridanus* figured by Gilbert (1990). In addition, the overall size of this femur falls within the range of *S. floridanus* (Fostowicz-Frelik, 2007, Table 14) confirming the specific level designation of taxon. RMM 7506 represents the first confirmed record of *S. floridanus* from any Late Pleistocene deposit in Alabama.

Sylvilagus aquaticus, the swamp rabbit, has been reported from the Late Paleo Indian components of Stanfield-Worley in Colbert County (Parmalee, 1962; Dejarnette et al., 1962) and Dust Cave in Lauderdale County (Grover, 1994). Notably, while confirmed from these Early Holocene deposits, no Late Pleistocene accounts of this species have been reported from Alabama or any other southeastern state (FAUNMAP, 1994). Chapman and Feldhamer (1981) note that specific level identification of *S. aquaticus* is dependent on having unusually good material. This might suggest *S. aquaticus* had a range in Alabama during the Late Pleistocene, but discovered remains have yet to be identified to the specific level. In support of this hypothesis, hundreds of elements assigned to Lagomorpha or Leporidae from sites ACb-2, ACb-3, and ACb-5 in Colbert County can be found in the McWSC collection. Bell (1985b) makes particular reference to several of these specimens as he mentions the discovery of "rabbits" from site ACb-2. Although further investigation of this material may confirm elements belonging to *S. aquaticus*, until such a specimen is presented, the Late Pleistocene presence of this taxon is suggested here as tentative.

Map 33: Counties with confirmed *Sylvilagus* sp. remains.

Figure 17. First Late Pleistocene record of *Sylvilagus floridanus* from Alabama. RMM 7506, right femur. A. Posterior view. B. Anterior view.

Map 34: Counties with confirmed *Sylvilagus floridanus* remains.

Map 35: Counties with confirmed *Sylvilagus aquaticus* remains.

Table 14. Femora measurements of Late Pleistocene RMM 7506 and recent *Sylvilagus floridanus specimens.*

Measurement	RMM 7506	*S. floridanus**
Greatest length	80.83 mm	81.8 mm
Proximal width	17.84 mm	18.3+/-2.2 mm
Distal width	13.34 mm	13.4+/-1.4 mm
Width of intercondyloid fossa	3.21 mm	3.8+/-.7 mm
Width of patellar groove	4.08 mm	4.5+/-.5 mm
Width of neck of femur	4.60 mm	5.0 mm
Width of head	6.00 mm	6.3 mm
Height of head of femur	5.75 mm	5.8 mm
Width of mid-shaft	6.83 mm	7.0+/-.7 mm
Thickness of mid-shaft	6.20 mm	6.5+/-.2 mm
Length of medial condyle	8.13 mm	8.5 mm
Length of lateral condyle	8.77 mm	9.3 mm

* Measurements from Fostowicz-Frelik (2007).

Table 15. Late Pleistocene Didelphimorpha and Lagomorpha status, distribution, and stratigraphic range.

Late Pleistocene Taxon		Status in Alabama		Pleistocene/Early Holocene Distribution				Stratigraphic Range										
								Blancan				Irvingtonian			Rancholabrean			
Order/Family	Genus and Species	EX	EP	H	C	G	V	1	2	3	4	E	M	L	I	S	W	R
Didelphimorphia																		
Didelphidae	*Didelphis virginiana**	●		●	●					—	—	—	—	—	—	—	—	—
Lagomorpha																		
Leporidae	*Sylvilagus* sp.	●		●		●						—	—	—	—	—	—	—
	*Sylvilagus floridanus**	●		●	●							—	—	—	—	—	—	—
	?*Sylvilagus* cf. *aquaticus*	●		●													—	—
	cf. *Lepus* sp.		●	●								—	—	—	—	—	—	—

*Denotes first Pleistocene account in Alabama; ⊗ Extinct; **EX:** Extant in Alabama; **EP:** Extirpated from Alabama; **H:** Highland Rim; **C:** Cumberland Plateau; **G:** Gulf Coastal Plain; **V:** Valley and Ridge; **1 - 4:** Blancan stages; **E:** Early; **M:** Middle; **L:** Late; **I:** Illinoian; **S:** Sangmonian; **W:** Wisconsian; **R:** Recent. Stratigraphic ranges after Kurten and Anderson (1980).

cf. *Lepus* sp. Linneaus, 1758 – Hare or Jack rabbit
Fig. 18

McCarroll and Dobie (1994) report the first Late Pleistocene record of the genus *Lepus*, the hare, in Alabama as they assign specimen AUMP 2948 to cf. *Lepus* sp. This specimen, made up of isolated dental material, was recovered from site ADa-1 in Dallas County (McCarroll and Dobie, 1994). In their description of AUMP 2948, McCarroll and Dobie (1994) discuss the difficulty in distinguishing between the teeth of *Lepus* and *Sylvilagus* and use the tentative designation of cf. *Lepus* sp. as the material falls within the size range of the larger *Lepus*. In the McWSC collection, a lone right tibia, RMM 3710 (Fig. 18), is here also tentatively assigned to cf. *Lepus* sp. Discovered from site ACb-2 in Colbert County, RMM 3710 is missing both proximal and distal ends. The designation of RMM 3710 to cf. *Lepus* sp. is based on the size of this incomplete tibia (greatest length = 97.40 mm) which exceeds the total length of the tibiae in *S. floridanus* (92.7 mm, Fostowicz-Frelik, 2007) and that of a Late Pleistocene *Sylvilagus* sp. (RMM 6229; Fig. 18). Although no members of the genus *Lepus* currently reside in Alabama (see Mirarchi, 2004), the identification of this genus within Irvingtonian and late Wisconsinan deposits in Florida (Kurtén and Anderson, 1980) provides evidence that the distribution of *Lepus* did indeed extend into the southeastern U.S. during Late Pleistocene times.

Figure 18. Comparison of the tibiae of Late Pleistocene cf. *Lepus* sp. and *Sylvilagus* sp. A. RMM 3710, cf. *Lepus* sp. right tibia. B. RMM 6229, *Sylvilagus* sp., right tibia.

Map 36: Counties with confirmed cf. *Lepus* sp. remains.

Equidae Gray, 1821
Equus sp. Linneaus, 1758 - Horses

Specimens assigned to *Equus* sp. have been reported from 31 Late Pleistocene localities in Alabama from both the Highland Rim and Gulf Coastal Plain sections (Table 16). The first account of a Late Pleistocene horse from Alabama was made by Hay (1923) who reports an equid incisor from a creek at Newbern in Hale County. Curren (1977a) later references this same tooth, but uses his own site designation, F-29. Hay (1923) also reports the 1883 discovery of a horse tooth in Bogue Chitto Creek (site ADa-1) in Dallas County. Discovered by L. C. Johnson of the GSA, Hay (1923) assigns this USNM specimen to *Equus leidyi*. This tooth, a right M1 or M2, was later cited by Curren (1977a), Thurmond and Jones (1981), and McCarroll and Dobie (1994), all of whom disagree with Hay's specific-level identification. These authors all refer this tooth to *Equus* sp. with Thurmond and Jones (1981) and McCarroll and Dobie (1994) citing the difficulty of species determination

of Pleistocene horses from isolated teeth (see Kurtén and Anderson, 1980). McCarroll and Dobie (1994) go as far as to describe Hay's use of *E. leidyi* as "insupportable," making the argument that *E. leidyi* is not a valid species. This is supported by Kurtén and Anderson (1980), who do not recognize *E. leidyi*, and Hulbert and Morgan, (1989) who suggest *E. leidyi* is a junior synonym of *Equus fraternus*.

A second species of Late Pleistocene horse in the state, *Equus complicatus*, was reported by the GSA (1976), Curren et al. (1976), and Curren (1977a). The GSA (1976) and Curren et al. (1976) both reference UAM PV 85.13.18, a right radius, discovered at site F-5 in Sumter County. First reported as *E. complicatus* (GSA, 1976; Curren et al., 1976), this identification was later revised by Curren (1977a) to *Equus* sp. Two additional specimens, UAM PV 85.13.16 and GSA 1091 are figured and referred to cf. *E. complicatus* by Curren (1977a). In the same manuscript, Curren (1977a) also figures two teeth UAM PV 85.13.118 and USNM 8329, he assigns to a third species of horse, cf. *E. fraternus*. All four of these specimens are here suggested to be *Equus* sp. as all are isolated teeth and inadequate for specific level determination of Pleistocene horses (see Kurtén and Anderson, 1980; Thurmond and Jones, 1981).

In addition to these published accounts, the McWSC and UAM collections yielded Late Pleistocene *Equus* remains from site ADa-13 in Dallas County, site AGr-40 in Greene County, sites AHl-1 and AHl-5 in Hale County, sites APe-1 and APe-10 in Perry County, sites APn-1 and APn-2 in Pickens County, and ASu-11 in Sumter County. The YMP collection also houses a single *Equus* sp. tooth (YPM VP 45527) from an unspecified locality in Perry County.

Kurtén and Anderson (1980) recognize 15 Late Pleistocene species of *Equus* that once resided in North America. Of these, at least six have been confirmed from the surrounding states of Florida, Georgia, Mississippi, and Tennessee (Kurtén and Anderson, 1980; FAUNMAP, 1994). While at the present time the state of the *Equus* remains from Late Pleistocene deposits in Alabama have limited the ability to make any specific level identifications, further investigation may show that multiple species of horse once had a range within the state.

Table 16. Alabama Late Pleistocene localities with confirmed Equus sp. remains.

Site	County	Reference(s)
F-27	Unspecified	Curren, 1977a
ACb-2	Colbert	Bell, 1985a
		Holman, 1989
ACb-3	Colbert	Womochel and Barnett, 1980a
		Womochel and Barnett, 1980b
ACb-4		Womochel, 1982
ADa-1	Dallas	McCarroll and Dobie, 1994
F-24	Dallas	Curren, 1977a
F-25	Dallas	Curren, 1977a
F-26	Dallas	Curren, 1977a
F-31	Dallas	Curren, 1977a
F-35	Dallas	Curren, 1977a
F-36	Dallas	Curren, 1977a
F-37	Dallas	Curren, 1977a
F-38	Dallas	Curren, 1977a
ADa-13	Dallas	This study
F-6	Greene	Curren, 1977a
F-7	Greene	Curren, 1977a
F-22	Greene	Curren, 1977a
AGr-40	Greene	This study
F-13	Hale	Curren, 1977a
F-29	Hale	Hay, 1923
		Curren, 1977a
F-30	Hale	Curren, 1977a
AHl-1	Hale	This study
AHl-5	Hale	This study
Fern Cave	Jackson	Schubert, 2005
F-12	Lauderdale	Curren, 1977a
F-19	Montgomery	Curren, 1977a
F-20	Montgomery	Curren, 1977a
F-21	Montgomery	Curren, 1977a
F-28	Perry	Curren, 1977a
APe-1	Perry	This study
APe-10	Perry	This study
F-1	Pickens	Curren, 1977a
F-2	Pickens	Curren et al., 1976
		Curren, 1977a
APn-1	Pickens	This study
APn-2	Pickens	This study
Not specified	Pickens	This study
F-3	Sumter	Curren et al., 1976
		Curren, 1977a
F-4	Sumter	Curren et al., 1976
		Curren, 1977a
F-5	Sumter	Curren, 1977a
ASu-11	Sumter	This study
F-23	Wilcox	Curren, 1977a
Tombigbee River	Multiple	Curren et al., 1976
		Frazier, 1985

Map 37: Counties with confirmed *Equus* sp. remains.

Tapiridae Gray, 1821
***Tapirus veroensis* Sellards, 1918 – Tapir**
***Tapirus* sp. Brünnich, 1771 – Tapirs**

Kurtén and Anderson (1980) recognize two species of tapir, *Tapirus copei* and *Tapirus veroensis,* that once resided in the southeastern U.S. during the Pleistocene. Although *T. copei* has yet to be identified from Alabama, specimens assigned to *T. veroensis* have been confirmed from along the Tombigbee River (Curren et al., 1976; Frazier, 1985), site ADa-1 in Dallas County (McCarroll and Dobie, 1994), and site ACb-2 in Colbert County (Graham, 2003; Schubert, 2005; Ruez, 2008b). Specimens assigned to *Tapirus* sp. have been confirmed from along the Tombigbee River (GSA, 1976), and sites ACb-2 (Bell, 1985a; Parmalee, 1992; Parmalee and Graham, 2002; Schubert, 2005) and ACb-3 in Colbert County (Bell, 1985b, Lively et al., 1992, Parmalee and Graham, 2002; Schubert, 2005). Curren (1977a) reports specimens assigned to *Tapirus* sp. from sites F-24-26, F-31, and F-35-38 in Dallas County, sites F-6,7 and F-22 in Greene County, sites F-14, and F-29,30 in Hale County, sites F-19-21 in Montgomery County, site F-28 in Perry County, site F-1 in Pickens County, site F-23 in Wilcox County, and site F-27 (unspecified county). In the UAM collections, unreported Tapiridae specimens have been collected from site F-37 in Dallas County and site APe-10 in Perry County.

Map 38: Counties with confirmed *Tapirus* remains.

Proboscidea Illiger, 1811
Elephantidae Gray, 1821
***Mammuthus* sp. Brookes, 1828 - Mammoths**

One of the world's first records of Pleistocene mammoth was discovered in Alabama (Thurmond and Jones, 1981) and was first described in the literature by Warren (1855). This unnumbered specimen, an upper right molar, was discovered "near the Gulf of Mexico" and originally assigned by Warren to *Elephas primigenius* (Warren, 1855). A cast of this tooth was later examined and figured by Falconer (1868) who reassigned the tooth to *Elephas columbi.* Hay (1923) later refers this same tooth to *Elephas imperator*

Table 17. Late Pleistocene Perissodactyla status, distribution, and stratigraphic range.

Late Pleistocene Taxon		Status in Alabama		Pleistocene/Early Holocene Distribution				Stratigraphic Range										
								Blancan				Irvingtonian			Rancholabrean			
Order/Family	Genus and Species	EX	EP	H	C	G	V	1	2	3	4	E	M	L	I	S	W	R
Perissodactyla																		
Equidae	*Equus* sp. ⊗		●		●	●												
Tapiridae	*Tapirus* sp.⊗			●		●												
	Tapirus veroensis⊗			●		●												

*Denotes first Pleistocene account in Alabama; ⊗ Extinct; **EX:** Extant in Alabama; **EP:** Extirpated from Alabama; **H:** Highland Rim; **C:** Cumberland Plateau; **G:** Gulf Coastal Plain; **V:** Valley and Ridge; **1 - 4:** Blancan stages; E: Early; **M:** Middle; L: Late; **I:** Illinoian; **S:** Sangmonian; **W:** Wisconsian; **R:** Recent. Stratigraphic ranges after Kurten and Anderson (1980).

claiming Falconer was not well acquainted with this latter species and therefore had referred it, with "some doubt," to *E. columbi*. This same tooth was cited by the GSA (1976) as simply "mammoth" and Thurmond and Jones (1981), using a more conservative approach, assigned the specimen to *E. columbi* citing the difficulty in distinguishing between isolated teeth of *E. columbi* and *E. imperator*. Kurtén and Anderson (1980) lend clarification to the taxonomy of mammoths and note three lineages within Elephantidae, *Loxodonta*, *Elephas*, and *Mammuthus*. Of these, only *Mammuthus* is currently accepted for North American mammoths (Kurtén and Anderson, 1980) and therefore this genus should supersede all aforementioned uses of the name *Elephas* for mammoth discoveries in Alabama. Kurtén and Anderson (1980) also suggest that until extensive comparative studies are carried out on this genus, all isolated mammoth teeth and limb elements from North America should be assigned to *Mammuthus* sp. Following this practice, the aforementioned tooth is here suggested as *Mammuthus* sp.

A second historical reference of a Pleistocene mammoth discovery in Alabama was also reported by Hay (1923). This specimen, USNM V 6677, a lower left molar, was discovered in Bogue Chitto Creek in Dallas County (Hay, 1923; Thurmond and Jones, 1981; McCarroll and Dobie, 1994). Hay (1923) assigns this tooth to *Elephas imperator*, the Imperial mammoth, and notes, along with the presence of other Pleistocene fauna, that this specimen suggests the presence of Aftonian age deposits (Pre-Illinoian) along the creek. Curren (1977a) refers this same tooth to *Mammuthus* sp. while Thurmond and Jones (1981) refer it to *M. columbi*. Making reference to the same specimen, McCarroll and Dobie (1994) believe the tooth to be either *M. columbi* or *M. jeffersonii*. Consequently, according to USNM records, this specimen has been referred to *M. columbi* with Hay listed as the individual who made the identification. This suggests Hay himself may have reassigned the tooth from *E. imperator* to *M. columbi* after his 1923 publication. Nevertheless, *E. imperator* is now considered by many to be a synonym of *M. columbi* (Kurtén and Anderson, 1980; McCarroll and Dobie, 1994) serving to further invalidate Hay's original assessment. As with the isolated mammoth tooth first described by Warren (1855), USNM V 6677 is here assigned to the more conservative *Mammuthus* sp. after Kurtén and Anderson (1980).

Curren (1977a) reports the discovery of an additional *Mammuthus* sp. specimen within the AMNH collection from site F-44 (an unspecified locality in Alabama). Curren (1977a) also reports two specimens, UAM PV 85.13.152 from site F-36 in Dallas County and UAM PV 85.13.209 from site F-1 in Pickens County. Noted as a long bone fragment and transverse process, respectively, these specimens are listed by Curren (1977a) as belonging to "*Mammuthus* or *Mammut*." In addition, Frazier (1985) reports the discovery of a specimen from along the Tombigbee River they list as belonging to "*Mammuthus floridanus* or *columbi*."

Map 39: Counties with confirmed *Mammuthus* remains.

Kurtén and Anderson (1980), however, recognize *M. floridanus* as a junior synonym of *M. jeffersonii*, suggesting the identification of the specimen reported by Frazier (1985) to be either *M. jeffersonii* or *M. columbi*. While it is clear mammoths did indeed reside in Alabama during the Late Pleistocene, the designation of any of these isolated elements to the specific level should only be seen as tentative at best. With *M. columbi* and *M. jeffersonii* both confirmed in neighboring southern states (Kurtén and Anderson, 1980; FAUNMAP, 1994), in all probability one or both of these species once resided within Alabama during Late Pleistocene times.

Mammutidae Hay, 1922
Mammut americanum (Kerr, 1791) - American mastodon
Fig. 19

Mastodons were among the first Pleistocene mammals reported from Alabama. First reported by state geologist Michael Tuomey in 1858, the remains of a mastodon are described as being discovered within caves in the vicinity of Tuscumbia in Colbert County (Tuomey, 1858). In 1887, the New-Orleans Times-Democrat reported a discovery by Dr. J. Huggins of a mastodon femur, maxilla fragment, tusk fragment, tooth, vertebra, rib fragment, and foot bone in Prairie Creek near the village of Newberne in Hale County (New York Times, 1887). Considering this big news at the time, this story was later picked up by the New York Times. The Atlanta Constitution reported a similar find in 1904 with the discovery of two mastodon teeth in a creek near Hurtsboro in Russell County (The Atlanta Constitution, 1904). Historical reports such as these all make references to the American mastodon, *Mammut americanum*, the only species of mastodon to roam North America during the Pleistocene (Kurtén and Anderson,

1980). Since these early reports, *M. americanum* remains have been discovered from nearly 50 Late Pleistocene localities in both the Gulf Coastal Plain and Highland Rim physiographic sections in the state (Table 18).

Of the many mastodon discoveries in Alabama, perhaps the most notable was the discovery of a nearly complete cranium and associated elements by three Georgia fishermen along the Tombigbee River in 1963 (GSA, 1976; Curren et al., 1976; Curren, 1977a; Thurmond and Jones, 1981). Donated to the UAM, Dr. Doug Jones of the University of Alabama was able to get a radiocarbon date of 14650 +/- 500 B.P. from wood associated with the cranium (GSA, 1976; Curren et al., 1976; Curren, 1977a). A second notable mastodon discovery was made in 1933 in Jefferson County when W. P. A. workers recovered portions of a skeleton while constructing a small bridge (Curren, 1977a). According to reports, a limb bone some three feet long and a molar were found in "very sticky gray clay" (Curren, 1977a). In 2004 a single mastodon molar was donated to the McWSC collection by Mr. Mike Krawcheck of Birmingham. Mr. Krawcheck inherited the tooth from his father who purchased it from a road crew who reportedly excavated it in the "1930s or 1940s" near Pinson in Jefferson County (M. Krawcheck, 2005, pers. comm.). It is likely this specimen (D-72, Fig. 19) and the 1933 mastodon discovery are one and the same. This specimen is significant as it represents the only Pleistocene fossil yet discovered from the Valley and Ridge section of the state (Fig. 1).

Table 18. Late Pleistocene Proboscidea status, distribution, and stratigraphic range.

Late Pleistocene Taxon		Status in Alabama		Pleistocene/Early Holocene Distribution				Stratigraphic Range										
								Blancan				Irvingtonian			Rancholabrean			
Order/Family	Genus and Species	EX	EP	H	C	G	V	1	2	3	4	E	M	L	I	S	W	R
Proboscidea																		
Elephantidae	*Mammuthus* sp.⊗					●												
Mammutidae	*Mammut americanum*⊗			●		●	●											

*Denotes first Pleistocene account in Alabama; ⊗Extinct; **EX:** Extant in Alabama; **EP:** Extirpated from Alabama; **H:** Highland Rim; **C:** Cumberland Plateau; **G:** Gulf Coastal Plain; **V:** Valley and Ridge; **1 - 4:** Blancan stages; E: Early; **M:** Middle; **L:** Late; **I:** Illinoian; **S:** Sangmonian; **W:** Wisconsian; **R:** Recent. Stratigraphic ranges after Kurten and Anderson (1980).

Table 19. Alabama Late Pleistocene sites with confirmed Mammut americanum specimens.

Site	County	Reference(s)
ACh-3	Choctaw	This report
F-8	Clarke	Curren, 1977a
F-9	Clarke	Curren, 1977a
ACb-3	Colbert	This report
Caves near Tuscumbia	Colbert	Tuomey, 1858
F-40	Colbert	Curren, 1977a
ADa-1	Dallas	Hay, 1923
		Thurmond and Jones, 1981
		McCarroll and Dobie, 1994
ADa-3	Dallas	This report
AGr-26	Dallas	This report
F-24	Dallas	Curren, 1977a
F-25	Dallas	Curren, 1977a
F-26	Dallas	Curren, 1977a
F-31	Dallas	Curren, 1977a
F-35	Dallas	Curren, 1977a
F-36	Dallas	Curren, 1977a
F-37	Dallas	Curren, 1977a
F-38	Dallas	Curren, 1977a

Table 19. *continued*

Site	County	Reference(s)
F-45	Dallas	Curren,1977a
F-22	Greene	Curren, 1977a
F-6	Greene	Curren, 1977a
F-7	Greene	Curren, 1977a
AHl-5	Hale	This report
F-13	Hale	Curren, 1977a
F-29	Hale	Curren, 1977a
F-30	Hale	Curren, 1977a
Prairie Creek	Hale	The New York Times, 1887
F-34	Jefferson	Curren, 1977a
F-14	Limestone	Curren, 1977a
F-15	Madison	Curren, 1977a
Unspecified	Marengo	Thurmond and Jones, 1981
F-19	Montgomery	Curren, 1977a
F-20	Montgomery	Curren, 1977a
F-21	Montgomery	Curren, 1977a
APe-3	Perry	This report
F-28	Perry	Curren, 1977a
F-1	Pickens	Curren, 1977a
		Curren et al., 1976
F-2	Pickens	Curren, 1977a
		Curren et al., 1976
Creek near Hurtsboro	Russell	The Atlanta Constitution. 1904
Unspecified	Sumter	Thurmond and Jones, 1981
F-4	Sumter	Curren, 1977a
		Curren et al., 1976
F-41	Sumter	Curren, 1977a
F-5	Sumter	Curren, 1977a
		Curren et al., 1976
F-27	Unspecified	Curren, 1977a
F-33	Unspecified	Curren, 1977a
F-42	Unspecified	Curren, 1977a
Unspecified	Wilcox	Thurmond and Jones, 1981
F-23	Wilcox	Curren, 1977a
F-43	Wilcox	Curren, 1977a
Black Prairie	Various	Phillips and Kaye, 2002
Coastal Plain	Various	GSA, 1976
Tombigbee River	Various	Frazier, 1985
		Curren et al., 1976
		GSA, 1976
		Thurmond and Jones, 1981

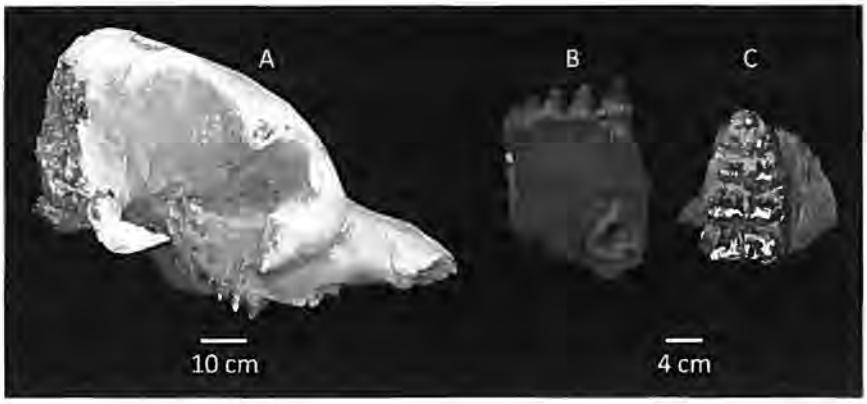


Figure 19. Notable mastodon specimens from Alabama. A. UAM PV 85.13.19, complete skull, right lateral view. B. D-72, left maxillary fragment with last upper molar, buccal view. C. .

Map 41: Counties with confirmed *Castor canadensis* remains.

Map 40: Counties with confirmed *Mammut americanum* remains.

Rodentia Bowdich, 1821
Castoridae Hemprich, 1820
***Castor canadensis* Kuhl, 1820 — American beaver**

Of the Late Pleistocene sites in the state, the American beaver, *Castor canadensis,* has been reported from site F-1 in Pickens County (Curren, 1977a), site ADa-1 in Dallas County (McCarroll and Dobie, 1994), and from along the Tombigbee River (Frazier, 1985). In the UAM and McWSC collections, unreported *C. canadensis* specimens have been recovered from site ABu-13 in Butler County, sites ACb-2 and ACb-3 in Colbert County, ACh-3 in Choctaw County, AHl-5 in Hale County, and LU-131 in Sumter County. In the Alabama archaeological record, this taxon has been confirmed from the Little Bear Creek site in Colbert County (Curren, 1974), Dust Cave in Lauderdale County (Grover, 1994), Moundville in Hale County (Knight, 2010), Eureka Landing in Monroe County (Gresham et al., 1987), Abercrombie in Russell County (Rock, 1980), Durant Bend in Dallas County (Thurmond, 1976; Nance, 1976), and Bellefonte in Jackson County (Curren et al., 1977; Futato, 1977b). According to Mirarchi (2004), the American beaver was once nearly extirpated from Alabama but is now considered common and found statewide. Fossil remains recovered from both the Highland Rim and Gulf Coastal Plain of Alabama suggests *C. canadensis* had a similar distribution during the Late Pleistocene.

***Castoroides* sp. Foster, 1838 — Giant beaver**

The extinct giant beaver, *Castoroides* sp., has been discovered from four Late Pleistocene sites in Alabama: sites ACb-2 (Bell, 1985a; Parmalee and Graham, 2002; Schubert, 2005) and ACb-3 in Colbert County (Parmalee and Graham, 2002; Schubert, 2005); site F-1 in Pickens County (Curren, 1977a); and site ADa-1 in Dallas County (McCarroll and Dobie, 1994; Parmalee and Graham, 2002). Bell (1985a), McCarroll and Dobie (1994), and Curren (1977a) refer the *Castoroides* remains from sites ACb-2, ADa-1, and F-1, respectively, to *Castoroides ohioensis.* Parmalee and Graham (2002) later re-examined the material collected by McCarroll and Dobie (1994) and Bell (1985a) and reassigned these specimens to *Castoroides* sp. In their review of new southeastern giant beaver discoveries, Parmalee and Graham (2002) discuss how the taxonomy of southeastern *Castoroides* is at present unclear. These authors discuss the slight variations in cranial and dental characters between northern and southern *Castoroides* and suggest these variations may be a result of sexual dimorphism, geographic variation, or ontogeny (Parmalee and Graham, 2002). The authors were also uncertain whether one or two species or subspecies of *Castoroides* once lived in the southeastern U.S. during the Late Pleistocene. To date, all giant beaver elements recovered from Alabama have been isolated tooth fragments. As suggested by Par-

Map 42: Counties with confirmed *Castoroides* sp. remains.

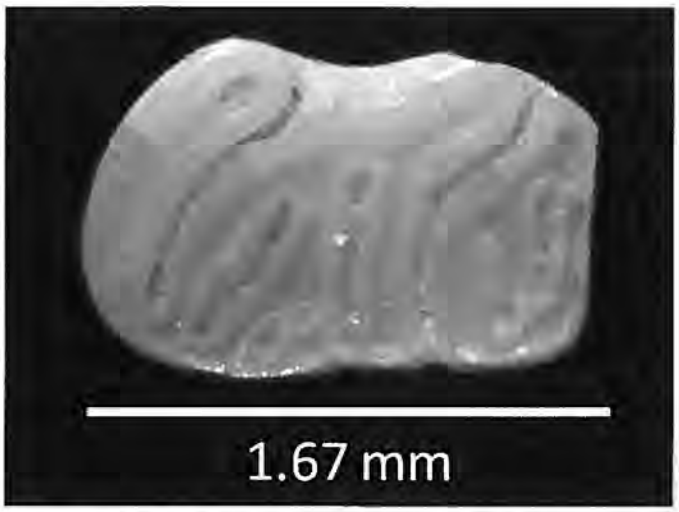


Figure 20. First Late Pleistocene record of *Napaeozapus insignis* from Alabama. RMM 5223, left m2, occlusal view.

malee and Graham (2002), these elements would serve as insufficient for specific determination. As a result, until further comparative studies of northern and southern associated cranial and dental material is conducted on this genus, all isolated remains of giant beaver in Alabama are here suggested to be *Castoroides* sp.

Dipodidae Fischer, 1817
Napaeozapus insignis* (Miller, 1891) — Woodland jumping mouse — *First Pleistocene Occurrence
Fig. 20

The extant woodland jumping mouse, *Napaeozapus insignis*, has a range throughout the northeastern U.S. and southeastern Canada with a southern range to the Alleghenies in northeast Georgia and the Smokey Mountains in Tennessee (Whitaker and Wrigley, 1972; and Whitaker, 1992). An isolated Late Pleistocene specimen, RMM 5223 from site ACb-2 in Colbert County, has here been assigned to this taxon (Fig. 20). This left m2 exhibits a flat crowned occlusal surface that resembles recent *N. insignis* specimens as illustrated by Krutzsch (1954), Whitaker and Wrigley (1972), and Wrigley (1972). The occlusal surface of this specimen is more complex than that of the extant *Zapus* or Pleistocene *Eozapus* (a *N. insignis* character noted by Krutzsch (1954), Whitaker and Wrigley (1972), Wrigley (1972) and Ruez and Bell (2004)). The numerous isolated islands and six re-entrant folds observed on RMM 5223 are characteristics of *N. insignis* molars (Wrigley, 1972) and all are completely closed on the lingual side by a thin cingulum. This is a character that is used to differentiate between *Napaeozapus* and *Zapus* molars (Ruez and Bell, 2004). Because RMM 5223 exhibits these diagnostic features, this specimen is here assigned to *N. insignis* which is the only species currently described within this genus (Kurtén and Anderson, 1980; ITIS, 2010).

The *N. insignis* specimen (RMM 5223) discovered from site ACb-2 in Colbert County represents the first occurrence of this taxon in either the Pleistocene or Holocene of Alabama. RMM 5223 also represents the southern-most occurrence of *N. insignis* yet known in North America during the Late Pleistocene (see Whitaker and Wrigley, 1972; Kurtén and Anderson, 1980; FAUNMAP, 1994).

Map 43: Counties with confirmed *Napaeozapus insignis* remains.

Zapus sp. Coues, 1875 – Jumping mouse
First Pleistocene Occurrence
Fig. 21

Among the members of the genus *Zapus*, only *Zapus hudsonius*, the meadow jumping mouse, is known from Late Pleistocene deposits in the southern U.S. (Kurtén and Anderson, 1980; FAUNMAP, 1994). In the McWSC collection, a single Late Pleistocene specimen (RMM 5757) from site ACb-2 in Colbert County has been referred to *Zapus* (Fig. 21). This specimen, a partial left mandible, has a well-preserved m2 present allowing for generic-level identification. This m2 has a flat occlusal surface and well-developed enamel lophs as found among the North American zapodids *Zapus*, *Napeozapus*, and *Javazapus* (Ruez and Bell, 2004). Of the topographic features present on the occlusal surface of RMM 5757, the m2 possesses all 15 diagnostic features of members of the genus *Zapus* as described by Klingener (1963) and Martin (1989; 1994). On the occlusal surface of RMM 5757, four buccal re-entrant folds are present and are unequal in length (the first and third of which are longer than the second and fourth). In addition, the anterior and posterior cingula are moderately large. These are all diagnostic characteristics of the m2 of *Zapus* (Krutzsch, 1954). Furthermore, the occlusal surface of this m2 is less complex than that of *Napeozapus* but more so than the Pleistocene *Eozapus* as noted by Krutzsch (1954), Whitaker and Wrigley (1972), Wrigley (1972) and Ruez and Bell (2004). RMM 5757 further differs from *Napeozapus* as it lacks the cingulum that closes all of the lingual reentrant folds, a prominent feature present on the m2 of *Napeozapus* (Ruez and Bell, 2004). The m2 on RMM 5757 differs from *Javazapus* as the entoconid is connected to the posterior cingulum at the lingual border of the tooth, a character difference observed by Ruez and Bell (2004). Based on these topographic occlusal characters, RMM 5757 is here assigned to the genus *Zapus*.

While RMM 5757 is undoubtedly *Zapus*, specific determination of this specimen cannot be made at this time. Krutzsch (1954) lists several characteristics useful in differentiating between the various species and subspecies of *Zapus* such as the length of maxillary toothrow, various cranial measurements, ear ossicles, and the baculum. Unfortunately, with only a partial mandible preserved, none of these characteristics can be applied to RMM 5757. Furthermore, Krutzsch (1954) notes *Zapus* molars show little morphological variation and overall are not helpful in separating species or subspecies. The relatively large size of RMM 5757 is also puzzling (the anteroposterior length of the mandibular toothrow is 3.78 mm). This length exceeds the maximum observed range of recent *Z. hudsonius* specimens (3.22-5.52 mm, Elbroch, 2006), the only species of *Zapus* known from the southeastern U.S. during the Late Pleistocene (Kurtén and Anderson, 1980; FAUNMAP, 1994). This length does, however, correspond with the late Sangamonian subspecies *Zapus hudsonius adamsi* (3.8 mm) as described by Hibbard (1955) and Klingener (1963). Furthermore, Klingener (1963) observed size differences between Illinoian and Sangamonian *Z. hudsonius* populations, attributing this difference to "climate-induced shifting of a geographical cline." Although Klingener (1963) notes there are no apparent size clines among recent populations, it is possible the size variation between RMM 5757 and recent *Z. hudsonius* populations are a result of geographical and/or temporal variation. With RMM 5757 being an isolated, incomplete element, and an element not known to yield characteristics needed for specific determination among zapoids, RMM 5757 is here referred to *Zapus* sp. Nevertheless, RMM 5757 proves significant as represents the only confirmed occurrence of *Zapus* from any Late Pleistocene or archaeological site in Alabama.

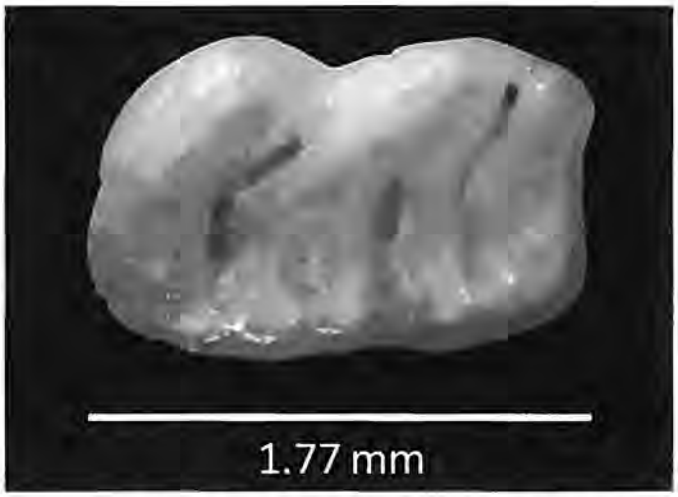


Figure 21. First Late Pleistocene record of *Zapus* sp. from Alabama. RMM 5757, left m2, occlusal view.

Map 44: Counties with confirmed *Zapus* sp. remains.

Erethizontidae Bonaparte, 1845
***Erethizon dorsatum* (Linnaeus, 1758) - Porcupine**
Fig. 22

The porcupine, *Erethizon dorsatum*, has been reported from two Late Pleistocene localities in Alabama: along the Tombigbee River (Frazier, 1985) and site ACb-2 in Colbert County (Churcher et al., 1989; Ruez, 2008b). Because the *E. dorsatum* specimen reported by Frazier (1985) was not examined as part of this study, the specimens reported by Churcher et al. (1989) and later Ruez (2008b) are here used to confirm the occurrence of this taxon from a Late Pleistocene site in the state.

While not referenced by catalog number, the specimens reported by Churcher et al. (1989) and Ruez (2008b) refer to RMM 3682 (Fig. 22), two upper left molars, and RMM 4429 (Fig.22), a lower left molar. These specimens are here confirmed as belonging to *E. dorsatum* as the occlusal views of these three molars are morphological matches to those of recent comparative *E. dorsatum* specimens. In addition, all three molars exhibit characters unique to the upper and lower molars of *E. dorsatum* as described by Hillson (2005) such as being rooted and having a square occlusal outline. The upper molars also have three buccal infolds and one lingual infold while the lower molar has three lingual and one buccal infold. These infolds on the upper and lower molars form a "v"-shaped lamellae, a diagnostic characteristic in *E. dorsatum* (Hillson, 2005).

While *E. dorsatum* has a recent range largely across North America, this species is presently absent from the southeastern U.S. (Woods, 1973). The fossil records suggests *E. dorsatum* once had a distribution across the southeastern U.S. as remains have been confirmed from Late Pleistocene sites in Tennessee and as far south as Florida (Kurtén and Anderson, 1980; FAUNMAP, 1994). In the archaeological record of the state, *E. dorsatum* specimens have been confirmed from Stanfield-Worley (Parmalee, 1962; 1963), and the Little Bear Creek site (Barkalow, 1961) in Colbert County, and Russell Cave in Jackson County (Weigel et al., 1974). The *E. dorsatum* remains from Little Bear Creek are significant as they indicate this taxon had a range in Alabama as late as the Archaic Period (Barkalow, 1961).

Map 45: *Counties with confirmed Erethizon dorsatum* remains.

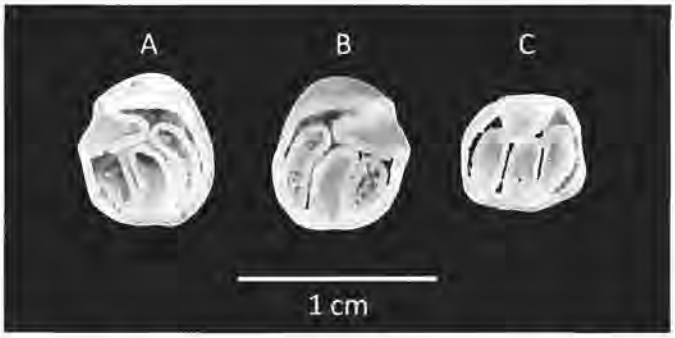


Figure 22. First Late Pleistocene records of *Erethizon dorsatum* from Alabama. A: RMM 3682, upper left molar. B: RMM 3682, upper right molar. C: RMM 4429, lower left molar. All occlusal views.

Muridae Illiger, 1815
***Clethrionomys gapperi* (Vigors, 1830) —**
Southern Red-backed Vole
Fig. 23

The southern red-backed vole, *Clethrionomys gapperi*, has been discovered from two Late Pleistocene sites in Alabama, sites ACb-2 and ACb-3 in Colbert County. The first Late Pleistocene account of this species was published by Churcher et al. (1989) who was later cited by Ruez (2008b). Both authors list *C. gapperi* among the taxa recovered from site ACb-2. While not described or cited by catalog number, the *C. gapperi* specimens reported by Churcher et al. (1989) and Ruez (2008b) are housed at McWSC where 19 specimens assigned to this taxon can be found. All from sites ACb-2 and ACb-3, one of these specimens, RMM 7553 (Fig. 23), is here used to confirmed the Late Pleistocene presence of *C. gapperi*.

A partial right mandible with m1, RMM 7553 is here assigned to *C. gapperi* based on the length of the mandibular toothrow and the topography of the occlusal surface of the m1. The length of the mandibular toothrow is 5.46 mm which is less than that of all known North American Muridae with the exception of *C. gapperi* and *Orzomys palustris*, the marsh rice rat (see Elbroch, 2006). Exceeding the range of female (4.22 to 4.94 mm) and male (4.90 to 5.20 mm) *O. palustris* specimens, the length of the mandibular toothrow of RMM 7553 falls within the recent range of both female and male *C. gapperi* specimens (4.48 to 5.50

mm and 4.93 to 5.98 mm, respectively, Elbroch, 2006).

In addition to the length of the mandibular toothrow, the incisor root of RMM 7553 is located between the alveolus of the m3 and the condyle of the ramus. This is a character of *C. gapperi* observed by Hooper and Hart (1962). The occlusal pattern of the m1 on the mandible reveals seven sections with three buccal and four lingual re-entrant folds. The lingual folds are slightly longer than the buccal folds, and the anterior pair of sections is open with the dentine confluent between them and the cingulum. According to Hooper and Hart (1962), these characters are all diagnostic of the m1 of *C. gapperi*, and thus confirming RMM 7553 as belonging to this taxon.

According to Kurtén and Anderson (1980), Merritt (1981), and FAUNMAP (1994), this confirmed *C. gapperi* specimen from Colbert County (RMM 7553) represents the southernmost occurrence of this taxon from the eastern half of the country. Furthermore, recent members of this taxon do not have a range in Alabama (see Merritt. 1981; Mirarchi, 2004) nor have any records of *C. gapperi* surfaced from any archaeological sites in the state. This would strongly suggest *C. gapperi* did not have a range in Alabama long after the Wisconsinan glaciation. Whatever the case may be, the *C. gapperi* specimens from Colbert County represent the first accounts, Pleistocene or Holocene, of this taxon within the state.

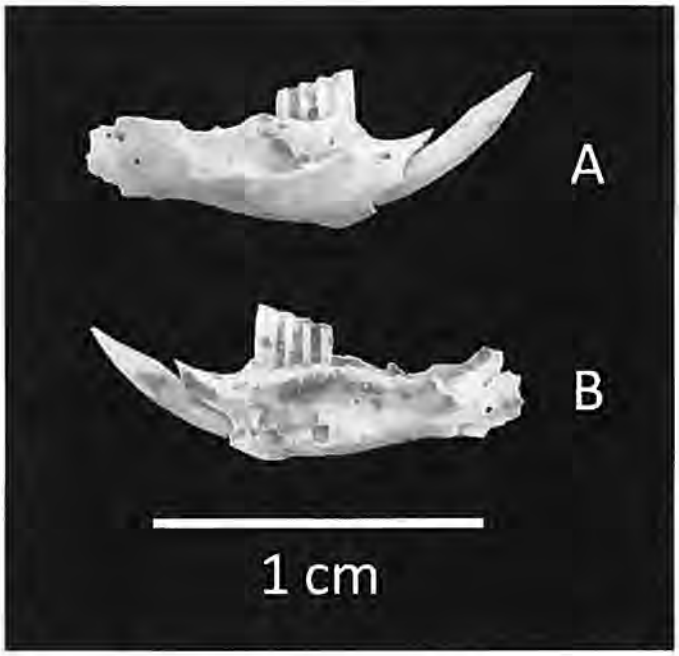


Figure 23. First Late Pleistocene record of *Clethrionomys gapperi* from Alabama. RMM 7553, right mandible. A. Buccal view. B. Lingual view.

Map 46: Counties with confirmed *Clethrionomys gapperi* remains.

***Microtus* sp. Schrank, 1798 - Meadow mice, Meadow voles**
***Microtus pennsylvanicus* (Ord, 1815) - Meadow Vole**

The first report of Late Pleistocene members of the genus *Microtus*, the meadow mice and meadow voles, in Alabama was by Womochel and Barnett (1980a) who listed specimens assigned to *Microtus* sp. from site ACb-2 in Colbert County. Lively et al. (1992) later report specimens they assign to *Microtus* sp. from the nearby site ACb-3 in Colbert County. Unreported specimens assigned to *Microtus* sp. can be found in the McWSC collection from a third site in Colbert County, site ACb-4.

Of *Microtus* specimens identifiable to the specific level, only one, *Microtus pennsylvanicus*, the meadow vole, has previously been reported in the literature from any Late Pleistocene deposit in the state. This taxon was first reported by Curren (1977a) who noted the discovery of *M. pennsylvanicus* remains from site F-1 in Pickens County. Consequently, in an earlier report, Curren et al. (1976) mentions the recovery of "microtine-like" incisors and molars from the same site. In a search through UAM records, the repository for the material collected by Curren, only one record of a microtine could be located from site F-1 (an unnumbered specimen) suggesting these two accounts refer to the same specimen. Martin and Prince (1990) later studied 11 *M. pennsylvanicus* molars from the McWSC collection collected from three distinct zones within site ACb-2. In an analysis of these specimens, Martin and Prince (1990) note slight variations in the molars over a 15,000 year period they suggest significantly correlate with "climatic modification" during the Late Pleistocene.

The confirmation of *M. pennsylvanicus* from the Late Pleistocene of Alabama comes to no surprise. Late Pleistocene accounts of this species have been recovered from

the southeastern states of Tennessee, Florida, Louisiana, and Arkansas (Kurtén and Anderson, 1980; Reich, 1981; FAUNMAP, 1994), and their known fossil distribution makes this taxon the most widely distributed microtine from the Late Pleistocene in North America (Kurtén and Anderson, 1980). Interestingly, *M. pennsylvanicus* does not have a recent distribution in Alabama (see Mirarchi, 2004; Reich, 1981) nor have remains of this taxon been identified from any archaeological site in the state. This would suggest a change in range for *M. pennsylvanicus* to more northern latitudes after the Wisconsinan glacial.

Mirarchi (2004) recognizes two recent species of *Microtus* in Alabama, *Microtus ochrogaster*, the prairie vole, and *Microtus pinetorum*, the pine vole. In the McWSC collection, hundreds of isolated molars and cranial fragments assigned to *Microtus* sp. have been recovered from sites ACb-2, ACb-3, and ACb-4. It is likely additional members of this genus would be identified through further study of this material.

Map 47: Counties with confirmed *Microtus* remains.

***Neotoma* sp. Say and Ord, 1825 – Packrats, Woodrats**
***Neotoma floridana* (Ord, 1818) - Eastern woodrat**

Fossil remains assigned to the genus *Neotoma*, the packrats and woodrats, have been identified from both Late Pleistocene and archaeological sites in the state. Specimens assigned to *Neotoma* sp. have been reported from the Late Pleistocene site ACb-3 in Colbert County (Lively et al., 1992) and the Late Paleo Indian component of Dust Cave in Lauderdale County (Grover, 1994). In the collections at the UAM and McWSC, additional unreported *Neotoma* sp. specimens have been recovered from site F-1 in Pickens County and site ACb-3 in Colbert County, respectively.

The eastern woodrat, *Neotoma floridana*, has a recent distribution in Alabama (Mirarchi, 2004) and has been reported from Paleo Indian deposits from Russell Cave in Jackson County (Weigel et al., 1974), Dust Cave in Lauderdale County (Grover, 1994), and Stanfield-Worley in Colbert County (Parmalee, 1962). This species has also been reported from one Late Pleistocene locality; site ACb-3 in Colbert County (Womochel and Barnett, 1980a). The identification of this taxon is based on a single incomplete M2 (Womochel and Barnett, 1980a) currently housed at the AUMP. In the McWSC Collection, over 100 elements including mandibles, molars, and cranial fragments have been assigned to this species. This collection of elements from site ACb-2 leaves little doubt as to the presence of *N. floridana* in Alabama during the Late Pleistocene.

Map 48: Counties with confirmed *Neotoma* remains.

***Ondatra zibethicus* (Linnaeus, 1766) – Muskrat**

The muskrat, *Ondatra zibethicus*, is considered common in Alabama today and can be found in nearly every county with the exception of those bordering the Florida panhandle (Mirarchi, 2004). This species had a similar paleogeographic distribution in the Late Pleistocene as *O. zibethicus* remains have been confirmed from both the Highland Rim and Gulf Coastal Plain sections. The first Late Pleistocene account of *O. zibethicus* in the state was noted by the GSA (1976) who identified remains from Pleistocene-age deposits along the Tombigbee River. Reported from the same locality by Frazier (1985), *O. zibethicus* specimens have also been confirmed from site F-1 in Pickens County (Curren et al., 1976; Curren, 1977a), and site ADa-1 in Dallas County (McCarroll and Dobie, 1994). In the McWSC collection unreported *O. zibethicus* specimens have been recovered from two additional Late Pleis-

tocene sites, ACb-2 and ACb-3 in Colbert County. From archaeological sites in the state, *O. zibethicus* specimens have been confirmed from Russell Cave (Weigel et al., 1974) and Bellefonte in Jackson County (Curren et al., 1977; Futato, 1977b), Dust Cave in Lauderdale County (Grover, 1994), and Abercrombie in Russell County (Rock, 1980).

Map 49: Counties with confirmed *Ondatra zibethicus* remains.

Peromyscus sp. Gloger, 1841 — Deer mice, White-footed mice

To date, only six elements assigned to the genus *Peromyscus*, the deer mice and white-footed mice, have been reported from any Late Pleistocene site in Alabama. These elements were all described by Womochel and Barnett (1980a) who report a partial dentary with no teeth, three M1, and two M2 that are assigned to *Peromyscus* sp. All from site ACb-3 in Colbert County and housed at the AUMP, these unnumbered specimens represent the first accounts of Late Pleistocene *Peromyscus* from the state. In the McWSC collection, dozens of unreported Late Pleistocene specimens assigned to *Peromyscus* sp. can be found. Among these are numerous complete and partial mandibles, teeth, and fragmentary cranial elements, all of which recovered from sites ACb-2 and ACb-3 in Colbert County. In the archaeological record, additional specimens assigned to *Peromyscus* sp. have been reported from Bellefonte in Jackson County (Curren et al., 1977; Futato, 1977b) and Moundville in Hale County (Knight, 2010).

Mirarchi (2004) recognizes three species and two subspecies of *Peromyscus* in the state today: *Peromyscus gossypinus*, *Peromyscus leucopus*, *Peromyscus polionotus*, *Peromyscus peromyscus ammobates*, and *Peromyscus peromyscus trissylepsis*. Of these, *P. gossypinus* is the only species considered com-

Map 50: Counties with confirmed *Peromyscus* sp. remains.

mon with a statewide distribution (Mirarchi, 2004). The other members of this genus are poorly known with *P. p. ammobates* and *P. p. trissylepsis* (dune mice) considered endangered and only found in coastal dune areas in Baldwin County (Mirarchi, 2004).

Reithrodontomys humulis (Audubon and Bachman, 1841) Eastern harvest mouse

Two reports can be found noting the Late Pleistocene occurrence of the harvest mouse, *Reithrodontomys*, in the state. Both published by Womochel and Barnett (1980a; 1980b), the same specimen is reported twice. The specimen in question, an unnumbered AUMP specimen, is a single right edentulous dentary recovered from site ACb-3 in Colbert County (Womochel and Barnett, 1980a; 1980b). The authors assign this specimen to *Reithrodontomys* cf. *humulis*, the eastern harvest mouse, and explain their tentative specific identification is based on the range of *Reithrodontomys megalotis* not extending east of Arkansas and that of *Reithrodontomys flavescens* only into southwestern Mississippi (Womochel and Barnett, 1980a).

In the McWSC collection, nine specimens from site ACb-2 in Colbert County can be found that have been referred to *R. humulis*. All upper incisors, the designation of these specimens to the genus *Reithrodontomys* is based on morphology. These incisors all exhibit a deep groove on the anterior surface, a character that separates *Reithrodontomys* from members of the genus *Mus*, the house mice, and *Peromyscus*, the deer mice and white-footed mice (Hooper, 1952; Whitaker and Hamilton, 1998). The width range of these incisors (.63 to .71 mm) is less than that of other mice and rats in the family Muridae (Elbroch, 2006) and the range of the anteroposterior depth of the incisors (1.16 to 1.31 mm) falls within the range of *Reithrodontomys*

Map 51: Counties with confirmed *Reithrodontomys humulis* remains.

as figured by Gardner and Carleton (2009). These incisors are here assigned to the specific level *Reithrodontomys humulis* based on the known distribution of other Pleistocene members of this genus. Kurtén and Anderson (1980) recognize eight species of Pleistocene *Reithrodontomys* but only *R. humulis* is known to have a range in the southeastern U.S. during the Late Pleistocene. Furthermore, Mirarchi (2004) recognizes *R. humulis* as the only member of this genus in Alabama today. To date, no members of this genus have been reported from any archaeological site in the state.

Sigmodon hispidus Say and Ord, 1825 – Hispid cotton rat
First Pleistocene Occurrence
Fig. 24

Sigmodon hispidus, the hispid cotton rat, is known to have a statewide distribution in Alabama today (Mirarchi, 2004). In the archaeological record, *S. hispidus* remains have been confirmed from Eureka Landing in Monroe County (Gresham et al., 1987), Abercrombie in Russell County (Rock, 1980), and Bellefonte in Jackson County (Curren et al., 1977; Futato, 1977b). In the Pleistocene record of the southeastern U.S., *S. hispidus* specimens have been confirmed from the surrounding states of Mississippi (Frazier, 1985), Tennessee, Florida, and Georgia (Kurtén and Anderson, 1980; FAUNMAP, 1994). Considered common in Rancholabrean deposits in Florida and Texas (Kurtén and Anderson, 1980), *S. hispidus* has yet to be reported from any Late Pleistocene deposit in Alabama. In this study, a lone Late Pleistocene specimen, RMM 5727 (Fig. 24), is here confirmed as belonging to *S. hispidus*.

RMM 5727, an isolated left m2, was discovered in Pleistocene terrace deposits along Limestone Creek in Hale County in 1982. The enamel folds on the occlusal surface of this hyspodont molar form a distinct "s" pattern (Fig. 24). This pattern is a diagnostic character on the 2nd and 3rd molars of *Sigmodon* (Chomko, 1990). Kurtén and Anderson (1980) recognize the following six *Sigmodon* species from the Pleistocene and early Holocene of North America: *S. hispidus, Sigmodon medius, Sigmodon hudspethensis, Sigmodon curtisi, Sigmodon bakeri,* and *Sigmodon ochrognathus*. Of these, *S. medius, S. hudspethensis,* and *S. curtisi* are known only from Blancan and Irvingtonian deposits in North America (Kurtén and Anderson, 1980) and *S. ochrognathus* is only known from Wisconsinan and early Holocene deposits in Texas and Arizona (Kurtén and Anderson, 1980; FAUNMAP, 1994). While *S. bakeri* and *S. hispidus* are both known from Pleistocene deposits in the southeastern U.S., *S. bakeri* is only known from late Irvingtonian to early Rancholabrean deposits (Kurtén and Anderson, 1980). Furthermore, *S. bakeri* is separated from other members of this genus by the lack of an anterior cingulum on the m2 and m3 (Kurtén and Anderson, 1980). With the anterior cingulum present on RMM 5727, this specimen is confirmed as belonging to *S. hispidus* and represents the first occurrence of this taxon from any Late Pleistocene deposit in the state.

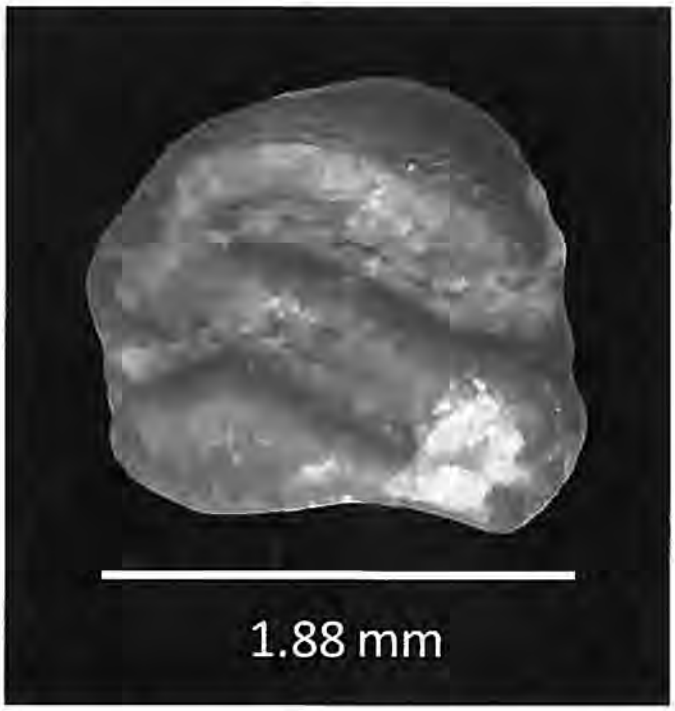


Figure 24. First Late Pleistocene record of *Sigmodon hispidus* from Alabama. RMM 5727, left lower m2, occlusal view.

Map 52: Counties with confirmed *Sigmodon hispidus* remains.

Map 53: Counties with confirmed *Synaptomys* remains.

Synaptomys cooperi Baird, 1858 - Southern Bog lemming
Synaptomys sp. Baird, 1858 – Bog lemmings

Synaptomys cooperi, the Southern bog lemming, is an extant species that has a recent range across the northeastern U.S. (Linzey, 1983). Not known in recent times from anywhere south of southeastern Tennessee (Linzey, 1983), *S. cooperi* specimens recovered from sites ACb-2 and ACb-3 in Colbert County indicate this taxon had a range further south during the Late Pleistocene than in recent times. Martin et al. (2003) report two *S. cooperi* specimens from site ACb-2, UF 162597, a right m2, and UF 162598, a right m3. Collected from mixed levels at the site, Martin et al. (2003) assign a date of 11,600-26,500 B.P. to the specimens based on radiocarbon dates published for the site ACb-2 by Martin and Prince (1990). Although these specimens represent the only published records of *S. cooperi* from any Late Pleistocene deposit in the state, in the McWSC collection, 12 unreported *S. cooperi* molars and 33 additional *Synaptomys* sp. elements (all from sites ACb-2 and ACb-3) can be found. This latter material includes molars, partial mandibles, and maxillae.

To date, no Late Pleistocene *S. cooperi* remains have been identified from outside of Colbert County and no reports of this taxon could be found from any archaeological site in the state. This would suggest *S. cooperi* populations in Alabama opted for more favorable northern climates after the Wisconsinan glaciation.

Sciuridae Hemprich, 1820
Ictidomys tridecemlineatus (Mitchill, 1821) — Thirteen-lined ground squirrel
Fig. 25

Chipmunks, marmots, and squirrels, are well represented in the Late Pleistocene and archaeological records of the state. Specimens assigned to Sciuridae have been reported from the Late Pleistocene site ACb-3 in Colbert County (Lively et al., 1994) and from the Eureka Landing archaeological site in Monroe County (Gresham et al., 1987).

Ictidomys tridecemlineatus, the thirteen-lined ground squirrel, has been confirmed from one Late Pleistocene site, ACb-2 in Colbert County (Churcher et al., 1989). Listed by Churcher et al. (1989) as *Spermophilus tridecemlineatus*, recent phylogenetic studies have placed the thirteen-lined ground squirrel in the genus *Ictidomys* (Helgen et al., 2009). Listed but not described, this account by Churcher et al. (1989) is based on seven cataloged McWSC specimens, all of which are teeth. One of these teeth, RMM 7102.2 (Fig. 25), is here used to confirm the identifciation of this species.

An upper right cheek tooth, RMM 7102.2 is morphologically distinct from the upper teeth of tree squirrels and chipmunks in that the occlusal outline is triangular. The occlusal outline of the upper teeth of chipmunks and tree squirrels are more square (Hillson, 2005). As with other members of the genus *Ictidomys*, RMM 7102.2 has two tall transverse ridges with the distal most of these ridges being reduced (Hillson, 2005). Furthermore, the trigone forms a narrow "v -shape," a character of the upper cheek teeth of *Ictidomys* (Chomko, 1990). Moreover, the metacone on RMM 7102.2 is separated from the protocone by a distinct suculus, yet another characteristic diagnostic of *Ictidomys*

(Howell, 1938; Chomko, 1990). Kurtén and Anderson (1980) recognize 23 species of ground squirrel that once resided in North America during the Pleistocene. With confirmed records in Arkansas and Tennessee, *I. tridecemlineatus* is the only member of this genus known from the southeastern U.S. during the Late Pleistocene (Kurtén and Anderson, 1980; FAUNMAP, 1994). Thus, RMM 7102.2 is here assigned to *I. tridecemlineatus* and confirms the report by Churcher et al. (1994) of the thirteen-lined ground squirrel from a Late Pleistocene deposit in the state.

A curious account of a second species of ground squirrel, *Citellus columnianus*, the Columbian ground squirrel, was reported by Curren (1976a) who identified this taxon from the archaeological site LaGrange in Colbert County. According to Curren (1976a), an isolated mandible was recovered from Zone D of the site, and the age of this zone was estimated to be from 11,240 to 7,340 B.P. (Dejarnette and Knight, 1976). Although not examined as part of this report, the designation of this element to *C. columbianus* is likely incorrect as the known Pleistocene and early Holocene range of this species is limited to Idaho, Montana, Washington, and Alberta, Canada (Kurtén and Anderson, 1980). Although the Columbian ground squirrel has since been reassigned by Helgen et al. (2009) to the genus *Urocitellus*, this specimen likely belongs to the morphologically similar *I. tridecemlineatus*.

Map 54: Counties with confirmed *Ictidomys tridecemlineatus* remains.

Figure 25. First Late Pleistocene record of *Ictidomys tridecemlineatus* from Alabama. RMM 7102.2, left m2, occlusal view.

Marmota monax Linnaeus, 1758 – Woodchuck
First Pleistocene Occurrence
Fig. 26

In Alabama today, the woodchuck, *Marmota monax*, has a distribution over most of the northern two-thirds of the state (Mirarchi, 2004). In the Alabama archaeological record, *M. monax* remains have been identified from Russell Cave in Jackson County (Weigel et al., 1974), Dust Cave in Lauderdale County (Grover, 1994), and the Seven Springs site in Cherokee County (Dejarnette et al., 1973). To date there are no reports of this taxon from any Late Pleistocene deposit in the state, however, 23 unreported *M. monax* specimens from site ACb-2 in Colbert County can be found in the McWSC collection. Of these specimens, RMM 4439.1 (Fig. 26) is used here to confirm the presence of this taxon in the Late Pleistocene of the state.

RMM 4439.1, a complete right mandible, is a match in general morphology to recent comparative specimens as well as figured specimens in Gilbert (1990), Kweicinski (1998), and Elbroch (2006). The length of the mandibular toothrow of RMM 4439.1, 19.57 mm, falls within the upper limits of recent male and female *M. monax* specimens (17.16 to 22.23 mm and 18.08 to 20.44 mm, respec-

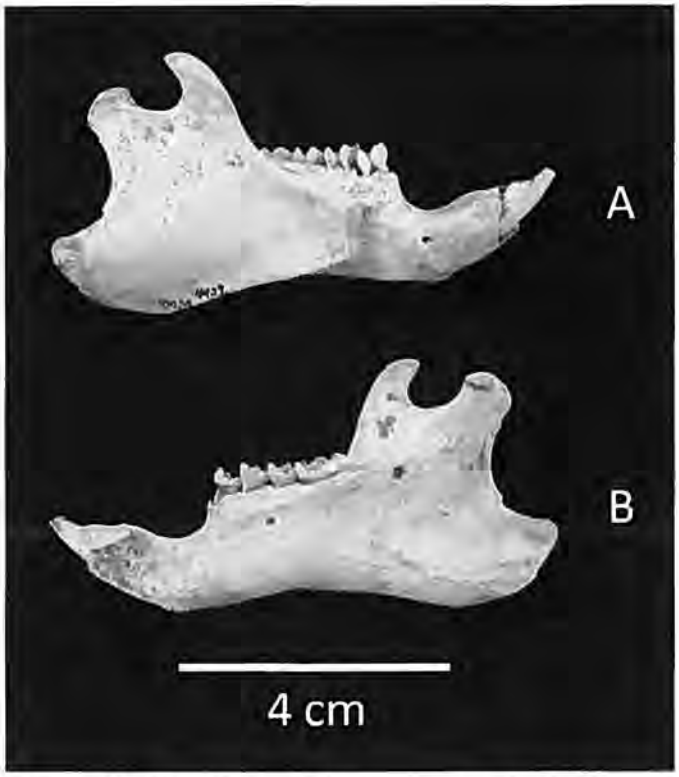


Figure 26. First Late Pleistocene record of *Marmota monax* from Alabama. RMM 4439.1, right mandible. A: Buccal view. B: Lingual view.

Map 55: Counties with confirmed *Marmota monax* remains.

tively, Elbroch, 2006). Although the toothrow length of RMM 4439.1 is a match for *M. monax*, the total mandibular length, 71.48 mm, slightly exceeds the observed range of recent specimens (52.14-70.50 mm, Elbroch, 2006). This may suggest RMM 4439.1 belongs to *Marmota monax monax*, the southern woodchuck (Howell, 1915; Kweicinski, 1998). Known to have a recent range in the Midwest and Northeast U.S., the southern range of this subspecies extends into the northern parts of Georgia and Alabama (Howell, 1915; Kweicinski, 1998). Considered the largest of the known subspecies, the overall cranial size of *M. m. monax* exceeds that of all known recent *Marmota* subspecies (see Howell, 1915). Although not confirmed to the sub specific level, RMM 4439.1 is here assigned to *M. monax* based on general morphology alone and thus represents the first confirmed account of this taxon from any Late Pleistocene deposit in the state.

Sciurus sp. Linnaeus, 1758 — Tree squirrels
Sciurus carolinensis Gmelin, 1788 — Eastern gray squirrel — *First Pleistocene Occurrence*
Sciurus niger Linnaeus, 1758 — Eastern fox squirrel — *First Pleistocene Occurrence*

Specimens assigned to *Sciurus* sp., the tree squirrel, have been identified from Late Pleistocene deposits along the Tombigbee River (GSA, 1976) and site F-1 in Pickens County (Curren et al., 1976; Curren, 1977a). In the archaeological record, *Sciurus* sp. remains have been identified from Eureka Landing (Gresham et al., 1987), Abercrombie in Russell County (Rock, 1980), Stanfield-Worley (Parmalee, 1962; Dejarnette et al., 1962) and LaGrange in Colbert County (Dejarnette and Knight, 1976), and Bellefonte in Jackson County (Curren et al., 1977; Futato, 1977b).

The eastern gray squirrel, *Sciurus carolinensis*, is considered common and has a recent distribution across the state (Mirarchi, 2004). In the Alabama archaeological record, *S. carolinensis* specimens have been confirmed from Bellefonte (Curren et al., 1977; Futato, 1977b) and Russell Cave in Jackson County (Weigel et al., 1974), Stanfield-Worley (Parmalee, 1962; Dejarnette et al., 1962) and Little Bear Creek in Colbert County (Curren, 1974), Moundville in Hale County (Knight, 2010), and Dust Cave in Lauderdale County (Grover, 1994). A second member of this genus, *Sciurus niger*, the eastern fox squirrel, has been reported from the archaeological sites of Russell Cave (Weigel et al., 1974), Stanfield-Worley (Parmalee, 1962; Dejarnette et al., 1962), D'Olive Creek in Baldwin County (Curren, 1976b), Bellefonte (Curren et al., 1977; Futato, 1977b), and Moundville (Knight, 2010). Like the eastern gray squirrel, *S. niger* is considered common and has a statewide distribution in Alabama today (Mirarchi, 2004).

Although reported from known Late Paleo Indian deposits in the state, no remains of *S. carolinensis* or *S. niger* have yet been identified from any Late Pleistocene site in Alabama. In the McWSC collection however, 22 unreported specimens from sites ACb-2 and ACb-3 in Colbert County have been recovered and referred to the genus *Sciurus*. In an examination of this material, 46 upper and

lower incisors could be identified among the remains. Using the transverse and anteroposterior incisor width ratios published by Emry and Thorington (1982), the Late Pleistocene presence of both *S. carolinensis* and *S. niger* have here been confirmed. Emry and Thorington (1982) describe this ratio as a character that can be used to differentiate the incisors of *S. carolinensis* and *S. niger* and can be used with both upper and lower incisors. Calculated from recent *Sciurus* specimens, Emry and Thorington (1982) provide the following ratios for upper and lower incisors: *S. niger* upper = 0.52, lower = .046; *S. carolinensis* upper = .046, lower = 0.36. Using these values and calculating the ratio for the 46 incisors in the McWSC collection, 24 *S. carolinensis* incisors and 13 *S. niger* incisors were identified. The nine remaining are considered as indeterminate *Sciurus* due to: 1) incompleteness of the incisor; and 2) the ratio ranging outside of that observed for *S. carolinensis* and *S. niger* (Emry and Thorington, 1982). Catalog numbers, measurements, and calculated ratios for these specimens are listed in Table 20. The 37 incisors identified here as *S. carolinensis* and *S. niger* represent the first records of these taxa from any Late Pleistocene deposits in Alabama.

Map 56: Counties with confirmed *Sciurus* sp. remains.

Table 20. Transverse and anteroposterior ratios of Late Pleistocene *Sciurus* incisors.

Number	Upper/ Lower	Transverse width	Anteroposterior width	Ratio	Specific Designation
RMM 3673.1	Upper	1.80 mm	3.90 mm	0.46	*S. carolinensis*
RMM 3673.6	Lower	1.31 mm	3.68 mm	0.35	*S. carolinensis*
RMM 3673.9	Upper	1.06 mm	2.26 mm	0.46	*S. carolinensis*
RMM 3673.12	Lower	1.34 mm	3.37 mm	0.39	*S. carolinensis*
RMM 3673.14	Lower	1.16 mm	3.12 mm	0.37	*S. carolinensis*
RMM 7093.1	Lower	1.33 mm	3.55 mm	0.37	*S. carolinensis*
RMM 7093.2	Lower	1.29 mm	3.72 mm	0.34	*S. carolinensis*
RMM 7093.3	Lower	1.36 mm	3.57 mm	0.38	*S. carolinensis*
RMM 7093.4	Upper	1.43 mm	2.96 mm	0.48	*S. carolinensis*
RMM 7093.5	Upper	1.50 mm	3.07 mm	0.48	*S. carolinensis*
RMM 7093.6	Lower	1.25 mm	3.24 mm	0.38	*S. carolinensis*
RMM 7093.8	Lower	1.30 mm	3.71 mm	0.35	*S. carolinensis*
RMM 7093.9	Upper	1.46 mm	3.37 mm	0.43	*S. carolinensis*
RMM 7093.11	Upper	1.59 mm	3.39 mm	0.46	*S. carolinensis*
RMM 7093.12	Upper	1.33 mm	3.11 mm	0.42	*S. carolinensis*
RMM 4981.1	Lower	1.31 mm	3.40 mm	0.38	*S. carolinensis*
RMM 4981.5	Lower	1.28 mm	3.55 mm	0.36	*S. carolinensis*
RMM 4981.6	Lower	1.39 mm	3.65 mm	0.38	*S. carolinensis*
RMM 4981.7	Lower	1.35 mm	3.68 mm	0.36	*S. carolinensis*
RMM 4981.10	Lower	1.43 mm	3.67 mm	0.38	*S. carolinensis*
RMM 7Å095.1	Lower	1.47 mm	3.88 mm	0.37	*S. carolinensis*
RMM 7095.3	Lower	1.32 mm	3.69 mm	0.36	*S. carolinensis*
RMM 5299.1	Upper	1.71 mm	3.63 mm	0.47	*S. carolinensis*
RMM 5380.3	Lower	1.19 mm	2.98 mm	0.39	*S. carolinensis*
RMM 3673.8	Lower	1.41 mm	3.07 mm	0.45	*S. niger*
RMM 4925	Upper	1.58 mm	3.07 mm	0.51	*S. niger*

Sciurus incisor ratios after Emry and Thorington (1982): *S. niger*; upper = 0.52, lower = .046; *S. carolinensis*; upper = .046, lower = 0.36.

Table 20. *continued*

Number	Upper/Lower	Transverse width	Anteroposterior width	Ratio	Specific Destignation
RMM 7093.7	Upper	1.36 mm	2.65 mm	0.51	*S. niger*
RMM 7093.10	Upper	1.84 mm	3.51 mm	0.52	*S. niger*
RMM 4981.9	Upper	1.49 mm	2.88 mm	0.51	*S. niger*
RMM 7095.4	Upper	1.60 mm	2.95 mm	0.54	*S. niger*
MSC 24683	Upper	1.18 mm	2.18 mm	0.54	*S. niger*
RMM 5299.2	Lower	1.29 mm	2.85 mm	0.45	*S. niger*
RMM 5299.3	Lower	0.95 mm	2.04 mm	0.46	*S. niger*
RMM 5380.1	Upper	1.48 mm	2.96 mm	0.50	*S. niger*
RMM 5380.2	Upper	1.50 mm	2.90 mm	0.51	*S. niger*
RMM 5380.4	Upper	1.44 mm	2.85 mm	0.50	*S. niger*
RMM 7092.1	Lower	1.25 mm	2.90 mm	0.43	*S. niger*
RMM 7095.2	Indeterminate	1.41 mm	2.90 mm	0.48	Indeterminate
RMM 4981.8	Indeterminate	1.17 mm	2.57 mm	0.45	Indeterminate
RMM 4981.2	Indeterminate	1.37 mm	3.42 mm	0.40	Indeterminate
RMM 4981.3	Indeterminate	1.42 mm	3.16 mm	0.44	Indeterminate
RMM 4981.4	Indeterminate	1.18 mm	2.65 mm	0.44	Indeterminate
RMM 3673.10	Indeterminate	1.53 mm	3.13 mm	0.48	Indeterminate
RMM 3673.7	Lower	1.46 mm	3.51 mm	0.41	Indeterminate
RMM 3673.11	Lower	1.43 mm	3.46 mm	0.41	Indeterminate
RMM 3673.13	Lower	1.36 mm	3.29 mm	0.41	Indeterminate

Map 57: Counties with confirmed *Sciurus carolinensis* remains.

Map 58: Counties with confirmed *Sciurus niger* remains.

***Tamias striatus* (Linnaeus, 1758) - Eastern chipmunk**
First Pleistocene Occurrence
Fig. 27

The recent eastern chipmunk, *Tamias striatus*, is considered common statewide in Alabama with the exception of the extreme southwestern and southeastern regions of the state (Mirarchi, 2004). *T. striatus* remains have been reported from the archaeological sites of Stanfield-Worley in Colbert County (Parmalee, 1962; Dejarnette et al., 1962), Russell Cave (Weigel et al., 1974) and Bellefonte in Jackson County (Curren et al., 1977; Futato, 1977b), and Abercrombie in Russell County (Rock, 1980). To date no *T. striatus* remains have been reported from any Late Pleistocene localities in the state, however, 15 unreported *T. striatus* specimens can be found in the McWSC collection from site ACb-2 in Colbert County. Of these, RMM 4779 is used here to confirm the Late Pleistocene presence of

T. striatus in the state as it is particularly diagnostic of this taxon.

RMM 4779 (Fig. 27), a left mandible fragment, has the incisor and p1 through m3 present. This mandible fragment is a match in general morphology to recent *T. striatus* specimens described and illustrated by Snyder (1982) and Elbroch (2006). In addition, the length of the mandibular toothrow (6.28 mm) falls within the observed range of recent male (6.08 to 6.94 mm) and female (6.04-7.10 mm) *T. striatus* specimens and exceeds the observed ranges of all other recent chipmunk species known from North America (see Elbroch, 2006).

Kurtén and Anderson (1980) recognize three species North American Pleistocene chipmunks, *T. striatus*, *Tamias aristus*, and *Eutamias minimus*. *T. aristus* is known only from the Sangmonian site Ladds in Georgia and the cranial dimensions of this species are on average 10 to 30 percent larger than that of *T. striatus* (Kurtén and Anderson, 1980). *E. minimus*, on the other hand, is known from several Appalachian faunas dating back to the Late Sangmonian and, as the name suggests, is the smallest of the known chipmunks (Kurtén and Anderson, 1980). With the length of the mandibular toothrow of RMM 4779 falling within the range of recent examples of *T. striatus*, this specimen is here formally assigned to this species.

Figure 27. First Late Pleistocene record of *Tamias striatus* from Alabama. RMM 4779, partial left mandible. A: Buccal view. B: Lingual view.

Map 59: Counties with confirmed *Tamias striatus* remains.

***Tamiasciurus hudsonicus* (Erxleben, 1777) - Red squirrel**
Fig. 28

The red squirrel, *Tamiasciurus hudsonicus*, is a species of tree squirrel that does not have a recent distribution in Alabama (Steele, 1998). Remains of *T. hudsonicus* have not been reported from any archaeological sites in the state although remains have been reported from one Late Pleistocene locality, site ACb-2 in Colbert County. This taxon was first reported by Churcher et al. (1989) who listed *T. hudsonicus* among the many Late Pleistocene forms recovered from site ACb-2. The report by Churcher et al. (1989) refers to *T. hudsonicus* specimens identified in the McWSC collection. Of the 16 cataloged *T. hudsonicus* specimens at McWSC, RMM 5308 is here used to confirm the presence of this taxon.

RMM 5308 (Fig. 28), a complete right femur, is here assigned to *T. hudsonicus* based on overall size and shape. Thorington et al. (2005) illustrate that overall size and relative position of the lesser trochanter can be used to distinguish the femora of tree squirrels, marmotine ground squirrels, xerine ground squirrels, and flying squirrels. Thorington et al. (2005) state the following femoral characters that are diagnostic of tree squirrels: 1) larger lesser trochanter than those of ground and flying squirrels; 2) the lesser trochanter extending medially as far or farther than the middle of the femoral head; and 3) the third trochanter placed slightly distal to the lesser trochanter. As seen in Fig. 28, the location of the lesser trochanter on RMM 5308, as described by Thorington et al. (2005), confirms this specimen as belonging to a type of tree squirrel. The greatest femoral length of RMM 5308 (41.82 mm) falls within the range of recent male (37 to 42.2 mm)

Map 60: Counties with confirmed *Tamiasciurus hudsonicus* remains.

and female (36 to 42.1 mm) *T. hudsonicus* specimens (Layne, 1954) and precisely fits into the standard deviation of *T. hudsonicus* femoral lengths (41.8 +\- .09 mm, Thorington and Santana, 2007). Kurtén and Anderson (1980) recognize one other species within this genus with a distribution in North America during the Pleistocene, *Tamiasciurus douglasii*. RMM 5308 is here assigned to *T. hudsonicus* as not only is it a match in overall size and shape, but *T. douglasii* is only known from the Pacific Northwest and Sierra Nevada (Kurtén and Anderson, 1980). This in turn confirms the account by Churcher et al. (1989) of a Late Pleistocene distribution of *T. hudsonicus* in the state.

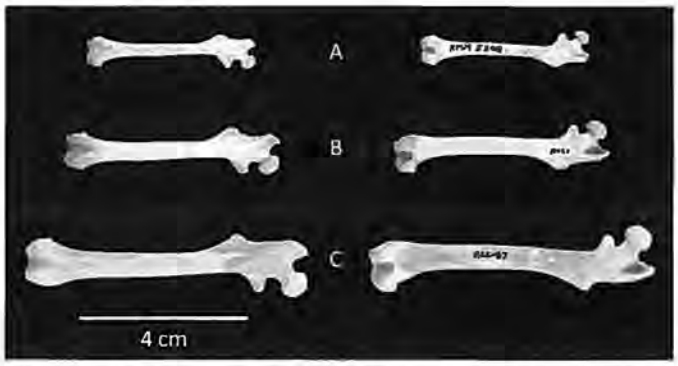


Figure 28. Femora of Late Pleistocene *Tamiasciurus hudsonicus* and recent sciurids. A: RMM 5308, Late Pleistocene *T. hudsonicus*, right femur. B. RCC 5, recent *Sciurus carolinensis*, right femur. C. RCC 67, recent *Sciurus niger*, right femur. Left: Anterior view. Right: Posterior view.

Table 21. Late Pleistocene Rodentia status, distribution, and stratigraphic range.

Late Pleistocene Taxon		Status in Alabama		Pleistocene/Early Holocene Distribution				Stratigraphic Range										
								Blancan				Irvingtonian			Rancholabrean			
Order/Family	Genus and Species	EX	EP	H	C	G	V	1	2	3	4	E	M	L	I	S	W	R
Rodentia																		
Castoridae	*Castor canadensis*	●		●		●												
	Castoroides sp. ⊗			●		●												
Dipodidae	*Napaeozapus insignis**		●	●														
	Zapus sp.*	●		●														
Erethizontidae	*Erethizon dorsatum*		●	●	●	●												
Muridae	*Clethrionomys gapperi*		●	●														
	Microtus sp.	●		●														
	Microtus pennsylvanicus		●	●														
	Neotoma sp.	●		●														
	Neotoma floridana	●		●	●													
	Ondatra zibethicus	●		●		●												
	Peromyscus sp.	●		●														
	Reithrodontomys humulis	●		●														
	*Sigmodon hispidus**	●				●												
	Synaptomys cooperi		●	●														
	Synaptomys sp.		●	●														
Sciuridae	*Ictidomys tridecemlineatus*	●		●														
	*Marmota monax**	●		●	●													
	Sciurus sp.	●		●		●												
	*Sciurus carolinensis**	●		●	●													
	*Sciurus niger**	●		●														
	*Tamias striatus**	●		●	●													
	Tamiasciurus hudsonicus		●	●														

*Denotes first Pleistocene account in Alabama; ⊗ Extinct; **EX:** Extant in Alabama; **EP:** Extirpated from Alabama; **H:** Highland Rim; **C:** Cumberland Plateau; **G:** Gulf Coastal Plain; **V:** Valley and Ridge; **1 - 4:** Blancan stages; **E:** Early; **M:** Middle; **L:** Late; **I:** Illinoian; **S:** Sangmonian; **W:** Wisconsian; **R:** Recent. Stratigraphic ranges after Kurten and Anderson (1980).

Soricomorpha Gregory, 1910
Soricidae Fischer, 1814
Blarina brevicauda* (Say, 1823) - Northern short-tailed shrew – *First Pleistocene Occurrence
***Blarina* cf. *carolinensis* (Bachman, 1837) – Southern short-tailed shrew**
Fig. 29

To date, Late Pleistocene and archaeological occurrences of members of the Soricidae, the shrews, are limited to two counties in Alabama, Colbert and Jackson. In the archaeological record, specimens assigned to Soricidae have been reported from Bellefonte in Jackson County (Curren et al., 1977; Futato, 1977b). In the McWSC collection, unreported specimens assigned to Soricidae have been recovered from the Late Pleistocene sites ACb-2 and ACb-3 in Colbert County.

Remains of Late Pleistocene *Blarina*, the American short-tailed shrews, have been recovered from two sites in Alabama, ACb-2 and ACb-3. Lively et al. (1992) noted the presence of *Blarina* sp. at site ACb-3 based on specimens identified in the McWSC collection and *Blarina* cf. *carolinensis*, the Southern short-tailed shrew, was reported from site ACb-2 by Womochel and Barnett (1980a). Womochel and Barnett (1980a) list four elements in the AUMP collection belonging to this taxon: an upper incisor, an isolated M1, a right maxilla with all teeth except M3, and an anterior portion of a right dentary. Womochel and Barnett (1980a) do not provide reasons why they assigned these elements to the more tentative *B.* cf. *carolinensis*, nevertheless, these four specimens represent the first records of this species from the Late Pleistocene of Alabama.

In a review of the *Blarina* material housed in the McWSC collection, hundreds of teeth, mandibles, and cranial elements were found from sites ACb-2 and ACb-3. Of this material, 30 complete mandibles previously assigned to *Blarina* sp. are present. These mandibles all exhibit numerous sharp and pigmented teeth with enlarged forward pointing mandibular incisors. These are both characteristics present on recent Soricidae mandibles (Elbroch, 2006). The overall shape and size one of these specimens, RMM 5387 (Fig. 29), allows for the identification of a second species of shrew, *Blarina brevicauda* the northern short-tailed shrew. Collected from site ACb-3, the mandibular length of RMM 5387 is 13.17 mm and the height is 7.62

Map 61: Counties with confirmed *Blarina* remains.

Table 22. Mandibular measurements of RMM 5387 compared to modern *Blarina brevicauda* specimens.

Measurement	RMM 5387	*B. brevicauda**
Height of coronoid process	6.46 mm	5.70 to 7.90 mm
Length of coronoid-condyloid processes	5.69 mm	5.00 to 6.90 mm
Length of c1 to m3	6.41 mm	5.80 to 7.30 mm
Height of m1	1.35 mm	0.80 to 1.90 mm
Height of unpigmented portion of m1	0.62 mm	0.40 to 0.07 mm
Depth of mandible below m1	2.27 mm	1.70 to 3.00 mm
Distance of i1 to p4	0.22 mm	0.10 to 0.30 mm
Width of c1	0.90 mm	0.80 to 1.10 mm
Width of p4	1.09 mm	0.90 to 1.60 mm
Width of m1	1.36 mm	1.20 to 1.70 mm
Width of m2	1.26 mm	1.00 to 1.60 mm
Length of m1	2.17 mm	1.70 to 2.50 mm
Length of m2	1.83 mm	1.60 to 2.00 mm

*Measurements from Carraway (1995)

mm. These measurements fall within the ranges of recent *B. brevicauda* (11.6 to 14.4 mm and 6.3 to 8.2 mm, George et al., 1986). In addition, the position of the mental foramen on the buccal side lies just below the hypoconid of the m1 in RMM 5387. This is a diagnostic character of *B. brevicauda* (Carraway, 1995). Furthermore, 13 additional mandibular measurements taken of RMM 5387 fall within the range of recent *B. brevicauda* specimens (Carraway, 1995, Table 22) confirming the first record of this taxon from any Late Pleistocene deposit in the state. To date, no *B. brevicauda* specimens have been identified from any archaeological site in Alabama but populations of both *B. brevicauda* and *B. carolinensis* are known to have a distribution in the state today (Mirarchi, 2004).

Figure 29. First Late Pleistocene record of *Blarina brevicauda* from Alabama. RMM 5387, right mandible. Top: Buccal view. Bottom: Lingual view.

Sorex sp. Linneaus, 1758 – Red-toothed shrews

Two recent species within the genus *Sorex*, the red-toothed shrews, are known in Alabama: *Sorex hoyi*, the American pygmy shrew, and *Sorex longirostris*, the southeastern shrew (Mirarchi, 2004). Womochel and Barnett (1980a, 1980b) published brief reports of a Late Pleistocene occurrence of red-toothed shrews in Alabama, noting the discovery of a single partial molar from site ACb-2 in Colbert County. These authors note this specimen was too fragmentary for specific identification; however they mention *S. longirostris* as the only member of this genus currently living in the vicinity of the site (Womochel and Barnett, 1980a). In the McWSC collection, an additional 17 unreported specimens from sites ACb-2 and ACb-3 in Colbert County have been assigned to *Sorex* sp. Comprised mostly of mandibular and cranial fragments, the relatively small size and fragmentary nature of these specimens make further identification difficult. Regardless, the unnumbered AUMP specimen described by Womochel and Barnett (1980a, 1980b) and the McWSC specimens reported here represent the first confirmed accounts of any member of the genus *Sorex* from any Late Pleistocene or archaeological site in Alabama.

Map 62: Counties with confirmed *Sorex* sp. remains.

Talpidae Fischer, 1814
Condylura cristata (Linnaeus, 1758) - Star-nosed mole
First Pleistocene Occurrence
Parascalops breweri (Bachman, 1842) - Brewer's hairy-tailed mole – *First Pleistocene Occurrence*
Scalopus aquaticus (Linnaeus, 1758) - Eastern mole
First Pleistocene Occurrence
Fig. 30

Kurtén and Anderson (1980) recognize four genera of Talapidae, the moles, which once had a range in North America during the Late Pleistocene: *Condylura, Parascalops, Scapanus,* and *Scalopus.* Of these taxa, only one species, *Scalopus aquaticus*, is known in Alabama today (Mirarchi, 2004). To date, no remains of Late Pleistocene moles have been reported from the state. In the McWSC collection, however, over 30 Talpidae humeri can be found from the Late Pleistocene sites ACb-2 and ACb-3 in Colbert County.

The humeri of moles are distinct from all other mammals as they are rectangular, massive in proportion to the other elements, and have unique humeroclavicular joints that allow them to articulate to the clavicle rather than the scapula (Feldhamer et al., 2003). Based on a study of these mole humeri, three species of moles could be identified in the McWSC collection: *Condylura cristata* (RMM 4647), *Parascalops breweri* (RMM 4961), and *Scalopus aquaticus* (RMM 5191) (Fig. 30). Generic and specific determination of these three specimens was based on morphological comparisons by Sanchez-Villagra et al. (2004) who list 28 unique characteristics on the humeri of extant members of the Talpidae family. Of these 28 characteristics, Sanchez-Villagra et al. (2004) observed three that could be used to differentiate the humeri of *C. cristata, P. breweri,* and *S. aquaticus*: 1) the direction of the humeral head; 2) the presence or absence of the scalopine ridge; 3) and the shape of the clavicular facet.

Applying these characters, RMM 4647, a complete right humerus, is here referred to *C. cristata* based on: 1) the humeral head is at an oblique angle to the long axis of the shaft (this axis is parallel or sub parallel in *S. aquaticus* and *P. breweri*); 2) the scalopine ridge is low and completely connected (in *P. breweri*, this ridge is only partially connected and, in *S. aquaticus*, the scalopine ridge connects to the head of the humerus); and 3) in lateral view, the clavicular facet is wedge shaped as opposed to rectangular shaped in *P. breweri* and *S. aquaticus*. RMM 4961, a complete left humerus, is here assigned to *P. breweri* based on: 1) the long axis of the humeral head is nearly parallel to the long axis of the humeral shaft; 2) the scalopine ridge being only half present; and 3) in lateral view, the clavicular facet is wedge shaped. RMM 4647 and RMM 4961 are here assigned to the specific level of *C. cristata* and *P. breweri*, respectively, as the two taxa are monospecific (Kurtén and Anderson, 1980).

RMM 5191, a complete left humerus, is here identified as belonging to *Scalopus aquaticus* (which is also monospecific, ITIS, 2010) as: 1) the long axis of the humeral head is nearly parallel to the long axis of the humeral shaft; 2) the scalopine ridge connects to the head of the humerus; and 3) in lateral view, the clavicular facet is wedge shaped. While the large size of this element is a characteristic of *Scalopus* humeri and differentiates it from those of *C. cristata* and *P. breweri* (Schubert, 2003), the aforementioned characteristics present on RMM 5191 are shared among two extant mole species, *Scalopus aquaticus* and *Scapanus latimanus* (Sanchez-Villagra et al., 2004). According to Sanchez-Villagra et al. (2004), *Scalopus aquaticus* and *Scapanus*

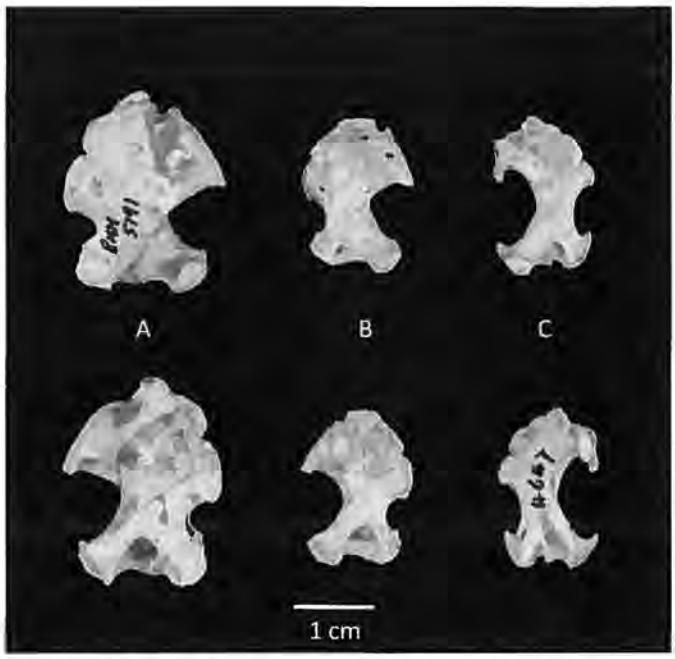


Figure 30. First Late Pleistocene records of Scalopus aquaticus, Parascalops breweri, and Condylura *cristata* from Alabama. A: RMM 5191, *S. aquaticus*, left humerus. B: RMM 4961, *P. breweri*, left humerus. C: RMM 4647, *C. cristata*, right humerus. Top: Anterior view. Bottom: Posterior view

Table 23. Late Pleistocene Sorciomorpha status, distribution, and stratigraphic range.

Late Pleistocene Taxon		Status in Alabama		Pleistocene/Early Holocene Distribution				Stratigraphic Range										
								Blancan				Irvingtonian			Rancholabrean			
Order/Family	Genus and Species	EX	EP	H	C	G	V	1	2	3	4	E	M	L	I	S	W	R
Soricomorpha																		
Soricidae	*Blarina* sp.	●		●														
	*Blarina brevicauda**	●		●														
	Blarina cf. *carolinensis*	●		●														
	Sorex sp.	●		●														
Talapidae	*Candylura cristata**		●	●														
	*Parascalops breweri**		●	●														
	Scalopus aquaticus	●		●	●													

*Denotes first Pleistocene account in Alabama; ⊗Extinct; **EX:** Extant in Alabama; **EP:** Extirpated from Alabama; **H:** Highland Rim; **C:** Cumberland Plateau; **G:** Gulf Coastal Plain; **V:** Valley and Ridge; **1 - 4:** Blancan stages; **E:** Early; **M:** Middle; **L:** Late; **I:** Illinoian; **S:** Sangmonian; **W:** Wisconsian; **R:** Recent. Stratigraphic ranges after Kurten and Anderson (1980).

Map 63: Counties with confirmed *Condylura cristata* and *Parascalops breweri* remains.

latimanus share 27 of the 28 humeral characteristics with the only differentiating character being the position of the humeral head (Sanchez-Villagra et al., 2004). In recent *S. aquaticus* specimens, the medial edge of the humeral head is in line with the lateral edge of the shaft, while in *S. latimanus*, the entire head is placed lateral to the lateral edge of the shaft (Sanchez-Villagra et al., 2004). With the medial edge of the humeral head in line with the lateral edge of the shaft, RMM 5191 is here confirmed as belonging to *S. aquaticus*. Furthermore, the Late Pleistocene remains of *S. latimanus* have not been confirmed from outside of California and Oregon while remains of *S. aquaticus* have been confirmed from numerous sites across the eastern half of the U.S. (Kurtén and Anderson, 1980; FAUNMAP, 1994).

Map 64: Counties with confirmed *Scalopus aquaticus* remains.

The identification of these three species in Alabama is significant as they represent the first Late Pleistocene reports of these taxa in the state. Of the three species, only *S. aquaticus* has a recent range in Alabama (Mirarchi, 2004) and is the only one of the three reported from any archaeological site in the state. Confirmed accounts of *S. aquaticus* have been reported from the archaeological sites of Bellefonte (Curren et al., 1977; Futato, 1977b) and Russell Cave (Weigel et al., 1974), both in Jackson County. *C. cristata* and *P. breweri*, on the other hand, currently do not have distributions in the Alabama (see Petersen and Yates, 1980; Hallet, 1978) and have yet to be reported from any archaeological site in the state. The absence of *C. cristata* and *P. breweri* in the archaeological record suggests a change to their respective distributions sometime in Late Pleistocene to early Holocene times.

Xenarthra Cope, 1889
Dasypodidae Gray, 1821
***Dasypus bellus* (Simpson, 1930) – Giant armadillo**

The extinct giant armadillo, *Dasypus bellus*, is well documented in Alabama and has been reported from several Late Pleistocene deposits in the state. The first reports of *D. bellus* from Alabama were made by Bell who reported this taxon from sites ACb-2 (Bell, 1985a) and ACb-3 (Bell, 1985b) in Colbert County. Housed in the McWSC collection, the *D. bellus* material first reported by Bell (1985a, 1985b) has since been referenced by Holman et al. (1990) (who reported "armadillos" from site ACb-2), Churcher et al. (1989), Lively et al. (1992), Parmalee and Graham (2002), and Schubert (2005). Additional *D. bellus* remains have been reported from Fern Cave in Jackson County (Schubert, 2005; Semken et al., 2010a, 2010b, 2010c), and site ADa-1 in Dallas County (McCarroll and Dobie, 1994). The *D. bellus* material from site ADa-1 represents the first account of this taxon from the Gulf Coastal Plain physiographic section of the state. Unreported *D. bellus* remains at the UAM have been discovered from one additional site in the Gulf Coastal Plain, site APe-10 in Perry County (UAM PV 93.2.154).

One curious specimen, McWSC 24573 from site ACb-3, was previously assigned to *Dasypus novemcinctus*, the extant long-nosed or nine-banded armadillo. When compared to recent specimens, the 12 scutes that make up McWSC 24573 fall within the size and width range of recent *D. novemcinctus*. Unfortunately the designation of this specimen to *D. novemcinctus* is likely incorrect. Kurtén and Anderson (1980) consider the presence of *D. novemcinctus* in the Pleistocene of North America tenuous as only a single scute assigned to this species is known from any Late Pleistocene deposit. Furthermore, McBee and Baker (1982) note that outside of the large size of *D. bellus*, this species is osteologically identical to *D. novemcinctus*. This has led Kurtén and Anderson (1980) to believe the iso-

Map 65: Counties with confirmed *Dasypus bellus* remains.

Map 66: Counties with confirmed *Holmesina septentrionalis* remains.

lated scute they describe may belong to small *D. bellus*. This may also be the case with McWSC 24573 which was collected from site ACb-3, a site that has produced multiple *D. bellus* specimens. This suggests McWSC 24573 may represent a juvenile or very small member of this species.

Holmesina septentrionalis (Leidy, 1889) — Northern pampathere

The extinct northern pampathere, *Holmesina septentrionalis*, has been confirmed from one Late Pleistocene locality in Alabama: site ADa-1 in Dallas County. Reported by McCarroll and Dobie (1994), a lone dermal scute, AUMP 3263, was assigned to *H. septentrionalis* based on overall size and morphology. Although represented by only a single isolated scute, the discovery of *H. septentrionalis* in Alabama comes as no surprise. In the southern U.S., *H. septentrionalis* have been confirmed from Florida, South Carolina, Texas (FAUNMAP, 1994), Louisiana (Domning, 1969), and the Black Prairie of Mississippi (Kaye, 1974; Phillips and Kaye, 2002).

Megalonychidae Ameghino, 1889
Megalonyx jeffersonii (Desmarest, 1822) - Jefferson's ground sloth

Megalonyx jeffersonii, Jefferson's ground sloth, was one of the first Pleistocene animals from Alabama described in the literature. Leidy (1855) figures an isolated molar from the collection of a close friend and well known early American naturalist, Jeffries Wyman. Said to be found in "Tuscumbia Co., Alabama" (Leidy, 1855, p. 6), this incorrect locality that was meant to say "in a cave near Tuscumbia" in Colbert County (Thurmond and Jones, 1981, p. 187). Around this same time, Alabama's first state geologist, Michael Tuomey, was shown a number of "bone caves" near the vicinity of Tuscumbia by two gentlemen, Mr. Pybas and Dr. Powel (Tuomey, 1858). In one of these caves, Tuomey (1858) reported the discovery of *Megalonyx* remains. Tuomey subsequently sent these remains to Leidy in Philadelphia who shortly after published a paper entitled *Remarks of the Structure of the Feet of Megalonyx* (Leidy, 1860). In this paper, Leidy describes how he had only the 2nd, 4th, and 5th metatarsal bones available to him while he was writing his 1855 manuscript. However the *M.*

Table 24. Alabama Late Pleistocene sites with confirmed *Megalonyx jeffersonii* specimens.

Site	County	Reference(s)
F-10	Clarke	Curren, 1977a
Caves near Tuscumbia	Colbert	Leidy, 1855
		Anonymous, 1856
		Tuomey, 1858
		Hay, 1916
		Hay, 1923

Table 24. *continued*

Site	County	Reference(s)
		Curren, 1977a
		Thurmond and Jones, 1981
		Bell 1985a, b
		McDonald, 2003
		Schubert, 2005
		Shaver et al., 2006
		Ruez, 2008a, b
ACb-3	Colbert	Bell, 1985b
		Bell and Lamb, 1987a, b
		Lively et al., 1992
		Parmalee and Graham, 2002
		McDonald, 2003
		Schubert, 2005
		Shaver et al., 2006
		Ruez, 2008a,
ACb-2	Colbert	Bell, 1985a
		McDonald, 2003
		Ruez, 2008a, b
ADa-1	Dallas	McCarroll and Dobie, 1994
F-24	Dallas	Curren, 1977a
F-24	Dallas	Curren, 1977a
F-25	Dallas	Curren, 1977a
F-26	Dallas	Curren, 1977a
F-31	Dallas	Curren, 1977a
F-35	Dallas	Curren, 1977a
F-47	Dallas	This study
F-6	Greene	Curren, 1977a
F-7	Greene	Curren, 1977a
F-22	Greene	Curren, 1977a
AGr-43	Greene	This study
F-13	Hale	Curren, 1977a
F-29	Hale	Curren, 1977a
F-30	Hale	Curren, 1977a
Fern Cave	Jackson	Shubert, 2005
		Semken, 2010a, b
F-19	Montgomery	Curren, 1977a
F-20	Montgomery	Curren, 1977a
F-21	Montgomery	Curren, 1977a
F-18	Montgomery	Curren, 1977a
F-28	Perry	Curren, 1977a
ASu-2	Sumter	This study
F-23	Wilcox	Curren, 1977a
F-27	Unspecified	Curren, 1977a

Map 67: Counties with confirmed *Megalonyx jeffersonii* remains.

jeffersonii remains sent to him by Tuomey included a complete set that he describes and figures (Leidy, 1860). It is likely these metatarsals from Alabama represent the first complete set known from *M. jeffersonii*.

In addition to the *Megalonyx* metatarsals described by Leidy (1860), Tuomey donated numerous other associated elements to the ANSP including cervical, caudal, dorsal and lumbar vertebrae, ribs, two tibae, a scapula, ulna, radius, femur, innominate, calcaneus, astragalus, cuboids, a cuneiform, metacarpals, and phalanges (Anonymous, 1856). Many of these elements were later figured by Curren (1977a) who noted this specimen was cataloged under three different ANSP numbers, 12478, 12485, and 12537. According to an unpublished manuscript by Bell and Lamb (1987b), these "well traveled" *M. jeffersonii* remains were given to Tuomey by Dr. Powel of Tuscumbia who had received them from four unidentified men who found them in a cave "somewhere near Tuscumbia" while presumably mining for saltpeter. While the precise locality of this ANSP specimen is not known, in 1985 RMM personnel discovered signs of old excavations during an investigation of site ACb-3 near Tuscumbia in Colbert County (Bell, 1985b; Bell and Lamb, 1987a). After collecting additional *M. jeffersonii* remains from these old excavations, the elements were compared to Tuomey's specimen at the ANSP and were seen as identical down to "the most minute details of preservation" (Bell and Lamb, 1987a, 1987b). Furthermore, during the 1985 excavations in site ACb-3, RMM workers discovered an inscription on the cave wall that read "Gene L. Burt 1851," convincing the investigators that site ACb-3 was indeed the precise locality for the Tuomey *M. jeffersonii* (Bell and Lamb, 1987a, 1987b).

The Tuomey *M. jeffersonii* was not only the first Pleistocene land-mammal reported from the state of Alabama (Bell and Lamb, 1987b), it has since become the most referenced Pleistocene fossil from the state. In addition to the aforementioned reports, this historically important specimen has been noted by Hay (1916, 1923), Thurmond and Jones (1981), FAUNMAP (1994), McDonald (2003), Schubert (2005), Shaver et al. (2006), and Ruez (2008a, 2008b). Since this early discovery, additional *M. jeffersonii* remains have been excavated from numerous sites across the state within both the Highland Rim and Gulf Coastal Plain physiographic sections (Table 24). Unreported *M. jeffersonii* specimens have been recovered from site AGr-43 in Greene County, F-47 in Dallas County, and ASu-2 in Sumter County. Notable discoveries include a cache of *M. jeffersonii* remains from site ACb-3 that may include as many as 14 individuals (Bell and Lamb, 1987a; 1987b; McDonald, 2003; Shaver et al., 2006). All housed at McWSC, these remains include multiple juvenile and sub-adult specimens, possibly male and female specimens, and a nearly complete adult (RMM 5353).

Mylodontidae Gill, 1872
***Paramylodon harlani* (Owen, 1840) – Harlan's ground sloth**
Fig. 31

The extinct Harlan's ground sloth, *Paramylodon harlani*, has been confirmed from three Late Pleistocene sites in Alabama – all in the Black Prairie. The first account of this taxon from Alabama was reported by Curren (1977a) who noted a specimen from site F-10 in Clarke County. Discovered and donated to the UAM in 1975, Curren returned to the site in 1976 and recovered additional elements belonging to this specimen found *in situ* within a blue-grey clay layer (Curren, 1977a). Wood samples from this layer produced a radiocarbon date of 40,000 B.P. (Curren, 1977a). This specimen (UAM PV 85.13.224; Fig. 31) represents the most complete *P. harlani* specimen yet discovered in the state and includes left and right humeri, the proximal portion of an ulna, ribs, vertebrae, and long bone fragments (Curren, 1977a). In addition to this find, three specimens assigned to *Glossotherium harlani* are reported by McCarroll and Dobie (1994). These specimens, AUMP 3179 and AUMP 3203, two 1st phalanges, and AUMP 3180, a mesocuneiform, were all discovered at site ADa-1 in Dallas County. These specimens are here reassigned to *Paramylodon harlani* after McDonald (1995).

In a search through museum collections, two unreported elements assigned to *P. harlani* were found in the UAM collection (UAM PV 94.2.10 and UAM PV 94.2.11). Consisting of a first unfused sacral vertebra and a scapula, respectively, these remains were recovered from a third locality in the state, site AGr-43 in Greene County. To date, no *P. harlani* specimens have been discovered within any cave localities in the state or from any site outside of the Black Prairie region in the Gulf Coastal Plain. McDonald

Table 25. Late Pleistocene Xenarthra status, distribution, and stratigraphic range.

Late Pleistocene Taxon		Status in Alabama		Pleistocene/Early Holocene Distribution				Stratigraphic Range										
								Blancan				Irvingtonian			Rancholabrean			
Order/Family	Genus and Species	EX	EP	H	C	G	V	1	2	3	4	E	M	L	I	S	W	R
Xenarthra																		
Dasypodidae	*Dasypus bellus* ⊗			●	●	●												
	Holmesina septentrionalis ⊗					●												
Megalonychidae	*Megalonyx jeffersonii* ⊗			●	●	●												
Mylodontidae	*Paramylodon harlani* ⊗					●												

*Denotes first Pleistocene account in Alabama; ⊗Extinct; **EX:** Extant in Alabama; **EP:** Extirpated from Alabama; **H:** Highland Rim; **C:** Cumberland Plateau; **G:** Gulf Coastal Plain; **V:** Valley and Ridge; **1 - 4:** Blancan stages; **E:** Early; **M:** Middle; **L:** Late; **I:** Illinoian; **S:** Sangmonian; **W:** Wisconsian; **R:** Recent. Stratigraphic ranges after Kurten and Anderson (1980).

Map 68: Counties with confirmed *Paramylodon harlani* remains.

(2003) notes the absence of *Paramylodon* from caves sites in North America may suggest a difference in habitat utilization from that of *Megalonyx* with *Paramylodon* considered a grazer and *Megalonx* a browser.

AGE OF PLEISTOCENE FAUNAL MATERIAL FROM ALABAMA

In order to discuss the ages of Pleistocene faunal material in Alabama, it becomes necessary to divide the state into physiographic sections (Gulf Coastal Plain, Highland Rim, Cumberland Plateau, and Valley and Ridge) as the Pleistocene faunal assemblages within these sections were formed through different mechanisms. No Pleistocene localities have been discovered in the Piedmont Upland so this section will not be reviewed here. To date no species have been discovered in Alabama that have a last occurrence prior to the Sangmonian (see Kurtén and Anderson, 1980). This would suggest the Pleistocene deposits in the state were deposited after the Illinoian and all Pleistocene taxa discovered in the state are Rancholabrean in land mammal age.

Figure 31. *Paramylodon harlani* humerus. UAM PV 85.13.224, left humerus, anterior view.

The Gulf Coastal Plain

As mentioned above, the Pleistocene fossil localities in the Gulf Coastal Plain section are mostly located within stream deposits with a majority of these localities clustered within the Black Prairie. To date, upwards of 95% of the Pleistocene fossils collected from sites in the Gulf Coastal Plain have been recovered from gravel or point bars (see Kaye, 1974; McCarroll and Dobie, 1994; Phillips, 2006). Only on rare occasions have Pleistocene specimens been found *in situ*, and in all cases *in situ* specimens were discovered in a blue-gray clayey silt layer that can be found at all known Gulf Coastal Plain Pleistocene localities (Curren et al., 1976; Curren 1977a). Thought to be the origin of all Pleistocene material recovered from the Gulf Coastal Plain (see Kaye, 1974; Curren et al., 1976; Curren 1977a; and Phillips, 2006), this distinct layer consists of clayey silt and very fine sub-angular quartz sand and often contains abundant organic materials such as pieces of wood (Curren et al., 1976), and occasionally concentrations of leaves (Berry, 1906; 1910).

Phillips (2006) compiles all known existing evidence on the age of the Black Prairie blue-gray clays and concludes that the faunal assemblages within the Black Prairie are no older than Wisconsinan in age. Phillips (2006) bases his conclusion on radiocarbon dates published by Kaye (1974) and Curren et al. (1976), fluorine analyses from Curren (1977a), vertebrate index fossils from Frazier (1985) and McCarroll and Dobie (1994), stratigraphic correlations by Kaye (1974) and Frazier (1985), and geomorphic evolution rates interpreted from Muto and Gunn (1985). Curren et al. (1976) noted the blue-gray deposits along the Tombigbee River varied in elevation and thickness, are non-uniform in slope, and are "lenticular and generally discontinuous except in relatively small areas." Muto and Gunn (1985) further investigated the geomorphology of these Tombigbee River blue-gray deposits and concluded that their origins were the result of two erosional events that occurred before the river was cut into its present location. Muto and Gunn (1985) suggest the first erosional event occurred more than 40,000 years ago (and possibly as far back as 100,000 years) and the second between 18,000 to 20,000 years ago. Kaye (1974) and Curren (1977a) formulate similar conclusions as both noted the presence of at least three blue-gray terraces, or as Kaye (1974) described them, different faunal assemblages occurring at different elevations. Based on radiocarbon dates, Curren (1977a) summarizes the ages and lithological features of these three terraces; Terrace 1: 40,000 B.P., massive sand and clay; Terrace 2: 14,000 B.P. to 8,000 B.P., massive sand and clay; and Terrace 3: circa 4,000 B.P., cut and fill clay lenses. Furthermore, Kaye (1974) provided the following radiocarbon dates for the Pleistocene three fossil assemblages he observed; F1 assemblages, 33,000 B.P. to 16,000 B.P.; F2 assemblages, date not available; F3 assemblages, 18,000 B.P. to 3,000 B.P.

Because a vast majority of the faunal material discovered in the Gulf Coastal Plain has not been found *in situ*, most of the material is assumed to be reworked at least once and in some cases, deposits may represent fauna of different ages (McCarroll and Dobie, 1994). This is certainly the case with Curren's (1977a) Terrace 3 deposits and Kaye's (1974) F3 assemblages as both provided date ranges that extend into the Holocene. In an attempt to help limit Holocene "contamination" from Pleistocene remains found in the region, Phillips (2006) provides a set of physical properties that can be used to differentiate Pleistocene and Holocene bone in mixed Black Prairie assemblages.

On rare occasions loose Pleistocene faunal material has been discovered in Cretaceous chalk gullies in the Black Prairie. Due to the rarity of these finds, little if any investigation has taken place into the origin of this material. It is likely this material is eroding out of weathered blue-gray or similar deposits whose origins probably reside with the same erosional events that shaped the other Pleistocene sites in the section.

Highland Rim

Nearly all of the Pleistocene localities within the Highland Rim section of Alabama are associated with cave deposits. Of these cave sites, only two have been dated by absolute methods (sites ACb-2 and ACb-3 in Colbert County). The Pleistocene material from site ACb-2 was first interpreted to be Late Wisconsinan to Early Holocene in age (Womochel and Barnett, 1980a, 1980b). Holman et al. (1990) later attempted to date bone samples from three distinct fossil-bearing layers within this site, two of which produced viable dates. Zone 4, the lowest stratigraphic layer in site ACb-2, yielded a date of 111,820 +480 to -500 B.P. while the upper layer, Zone 1/2, produced a date of 26,500 +870 to -900 B.P. (Holman et al., 1990). The intermediate level, Zone 3, did not yield enough datable bone material; however was seen as faunistically identical to Zone 1/2 and was interpreted to be age equivalent (Holman et al., 1990). In a review of mammalian material recovered from site ACb-2, remains of four taxa were identified that do not have a known stratigraphic range before the Wisconsinan: *Canis rufus, Martes americana, Nycticeius humeralis*, and *Sciurus niger* (see Kurtén and Anderson, 1980). This would further suggest the deposits within site ACb-2 are no older than Wisconsinan in age.

In 1992 Lively et al. published a series of uranium-series dates retrieved from flowstone imbedded in the bone-bearing layers within site ACb-3. Their interpretation of the dates from this stratified site suggests the cave was accumulating small vertebrate remains as early as 228,000 B.P. and from 170,000 to 115,000 B.P. (and possibly later) was visited by large vertebrates (Lively et al., 1992). Among the large vertebrates recovered from this site is one of the

world's largest concentrations of *M. jeffersonii* specimens (Shaver et al., 2006). If the dates by Lively et al. (1992) are correct, site ACb-3 is the oldest cave containing *M. jeffersonii* remains in North America (McDonald, 2003). The dates produced from site ACb-3 are also notable as they suggest the oldest small vertebrate assemblage recovered from the cave may be Illinoian in age. This would make site ACb-3 the oldest Pleistocene site yet known from the Alabama or Tennessee Highland Rim (see Corgan and Breitburg, 1996). Interestingly, remains of *Sciurus niger* were also recovered from this cave site. Identified within the upper levels at this site (but not the lowest), the presence of *S. niger* would suggests these layers are Wisconsinan in age.

Another cave site in the same county, site ACb-4, was not dated by absolute methods but was interpreted by Womochel (1982) to be Late Wisconsinan in age. Two other sites in the Highland Rim, sites F-12 and F-14 in Lauderdale and Limestone Counties, respectively, are unique to the section as they are associated with stream and river deposits (Curren, 1977a). Blue-gray clay deposits have been discovered at site F-12 suggesting these sites are lithostratigraphically similar to Pleistocene sites in the Gulf Coastal Plain and are likely Wisconsinan in age.

Cumberland Plateau and Valley and Ridge

A total of five localities containing Pleistocene taxa have been discovered in the Alabama Cumberland Plateau and Valley and Ridge sections. Of the four localities in the Cumberland Plateau, Russell Cave in Jackson County is unique as it is an archaeological site. At this site, remains of the extinct peccary *Mylohyus* were discovered within the lowest level, layer G (Weigel et al., 1974). Radiocarbon dates of this layer produced ages that ranged from 7565 +/- 250 to 8500 +/- 320 B.P. making this oldest layer Early Archaic in age (Griffin, 1974). Discoveries at another cave in this section, Fern Cave, include the extinct *Megalonyx jeffersonii, Dasypus bellus, Artodus simus,* and *Mylohyus nasutus* (Schubert, 2005). AMS 14C analyses of the ground sloth and armadillo date the material to the Late Pleistocene (Schubert, 2005). A single elk molar (BC 286) from AJ Cave in DeKalb County, while not dated, was also suggested to be Late Pleistocene in age (Martin and Sneed, 1989).

The other known Late Pleistocene locality in the Cumberland Plateau is site F-15 in Madison County. UAM locality records indicate a number of mastodon molar fragments were recovered from a point bar at this creek site and a blue-gray clay layer was observed along the banks. This site appears similar in nature to the lone Pleistocene locality from the Valley and Ridge section, site F-34 in Jefferson County. At this site, a historic *Mammut americanum* specimen was discovered along a creek and Curren (1977a), who later visited the site, observed blue-gray deposits within the banks. Like other Pleistocene localities that have been discovered along waterways in the state, these two sites appear lithostratigraphically similar to known Late Pleistocene sites in the Gulf Coastal Plain and are likely Wisconsinan in age.

CONCLUSIONS

From the data presented here, it is clear much more can be learned from Late Pleistocene deposits in Alabama. Not only is further investigation needed at known Pleistocene sites in the state, but it is likely that many more sites still await discovery. The Highland Rim, for example, contains more than a thousand recorded caves (Daniel and Coe, 1973), only a handful of which have been investigated for Pleistocene taxa. A systematic search along waterways in the Gulf Coastal Plain will certainly reveal new deposits of blue-gray Pleistocene clays and possible Pleistocene deposits in the Piedmont Upland and Valley and Ridge section have been largely unexplored. Additional investigations within existing localities are needed as well. The two most productive Pleistocene localities in Alabama, sites ACb-2 and ACb-3 for example, have only been partially sampled and a majority of the sites known in the Gulf Coastal Plain have not been visited since the late 1970s. Further studies are also needed to determine the ages of the Pleistocene faunas in the various physiographic sections. Confirmation of the age of the lower deposits in site ACb-3 for example may prove Illinoian faunal assemblages do exist in the state.

Further explorations of these localities are sure to produce a large diversity of fauna and flora previously unknown from the state. Taxa such as *Hemiauchenia macrocephala* and *Bison latifrons* have been reported from surrounding southeastern states. These animals most certainly had a natural biogeographic range in Alabama during the Late Pleistocene but have yet to be discovered in the state. Existing collections from the state need further study as well. Much of the material recovered from cave sites in the Highland Rim still need to be cleaned and identified. More in-depth studies of genera within these collections, such as *Equus, Microtus, Sorex,* and others, will undoubtedly reveal additional species previously unreported in the state. Not since 1910 has an intensive investigation of Pleistocene flora in the state been undertaken. Studies such as these will provide us with a better understanding of the paleobiogeography, paleoecology, and paleoclimate of the Late Pleistocene on a statewide, regional, and national level.

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A Review of the Chondrichthyans From the Mississippi System of Northern Alabama, USA

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ABSTRACT: Recent fieldwork has revealed that the number of chondrichthyan species occurring in upper Mississippian (primarily Chesterian) rocks of northern Alabama is greater than previously known. Combined with taxa documented prior to the present report, 24 chondrichthyans are found in calcareous strata within the Monteagle Limestone, Pride Mountain Formation, Bangor Limestone, Hartselle Sandstone, and Tuscumbia Limestone.

We emend several earlier taxonomic identifications, with *Cladodus newmani* herein reassigned to *C.* sp. cf. *C. bellifer*, and *C. magnificus* is *Saivodus striatus*. Newly documented species include *Polyrhizodus* sp. cf. *P. digitatus*, *Ctenoptychius apicalis*, *Deltodus* sp. cf. *D. undulatus*, and *Deltoptychius* sp. cf. *D. acutus*. In addition, occurrences of *Carcharopsis wortheni* are corroborated. We have no doubt that additional species will be discovered, especially when rock exposures are carefully inspected for macro- and microvertebrate remains.

INTRODUCTION

It has been over a century and a half since Tuomey's (1858) seminal work on the geology and paleontology of Alabama, wherein he provided the first descriptions of Mississippian chondrichthyans in the state. Since that time very little has been published on the subject, which is surprising given the extensive Mississippian age exposures found throughout northern Alabama. Additionally, casual observation of the limestone benches in and around north-central Alabama has revealed diverse and abundant chondrichthyan faunas, and vertebrate fossil occurrences appear to be well known to local collectors. To our knowledge, the only publications that discussed Mississippian chondrichthyan remains from Alabama include Newberry and Worthen (1866), St. John and Worthen (1875), Newberry (1889), Thurmond and Jones (1981), and Stahl and Cicimurri (2005).

In all, Tuomey (1858) described and illustrated three chondrichthyan species, including a ctenacanth spine that he named *Ctenacanthus elegans* (Fig. 1c) and two different cladodont teeth, *Cladodus magnificus* (Fig. 1a) and *C. newmani* (Fig. 1b). He also mentioned the occurrence of *Psammodus*, near Huntsville, within limestones that contain abundant *Pentremites florealis* and *P. pyriformis*. Unfortunately, Tuomey's specimens cannot be located in the UAM collections and may have been lost in the early 20th century (Parham, pers. comm.).

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Newberry and Worthen (1866) considered the quality of Tuomey's (1858) illustrations to be poor, but they tentatively identified a tooth from "Sub-carboniferous limestone in Huntsville" as *C. magnificus* (Fig. 1d, e). They also named a new species, *Carcharopsis wortheni* (Fig. 1 f, g), from the same deposits. In his monograph on Paleozoic fishes of North America, Newberry (1889) commented that the type material of *C. newmani* was "too imperfect for identification". Nearly 100 years later, Thurmond and Jones (1981) summarized the diversity of Mississippian chondrichthyans in Alabama. In addition to reproducing taxonomic accounts and illustrations from the older literature (utilizing the junior synonym of *Carcharopsis*, *Dicrenodus wortheni*), they also mentioned occurrences of the genera (but did not illustrate) *Psammodus* and *Petalodus*. Interestingly, Thurmond and Jones (1981) commented on their observation of complete psammodontid teeth in private collections that measure upwards of 8 centimeters in length. Stahl and Cicimurri (2005) studied a collection of 33 Mississippian chondrichthyan specimens recovered from the Monteagle Limestone near Huntsville, and their comprehensive report included 14 taxa of elasmobranchs and holocephalians.

It is beyond the scope of this paper to "right" what has largely been ignored, rather herein we provide a brief review of the work that has been performed on Mississippian chondrichthyan faunas from Alabama. In doing so, we discuss the current state of knowledge concerning the taxonomic ranking of species previously reported, identify and illustrate new material that has come to light in recent years, and outline directions for future work.

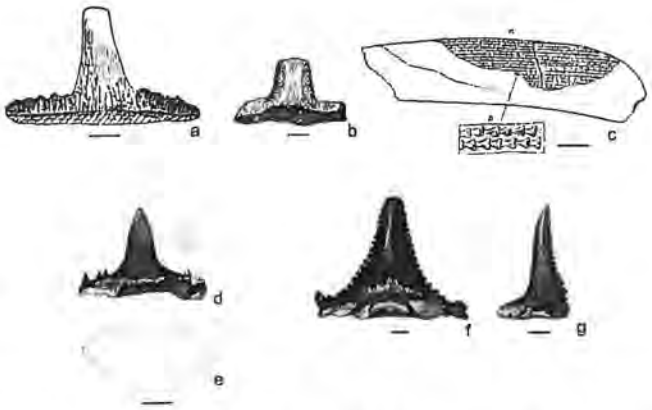

Figure 1. Mississippian chondrichthyan remains reported from Alabama prior to 1900. *Cladodus magnificus* (a) in labial view; b, *Cladodus newmani* in lingual(?) view; c, *Ctenacanthus elegans* in lateral view; d, *Cladodus magnificus* in lingual view; e, *C. magnificus* in basal view; f, *Carcharopsis wortheni*. Illustrations in a - c are reproduced from Toumey (1858), whereas illustrations in d – f are reproduced from Newberry and Worthen (1866). See text for discussions related to these taxa.

MISSISSIPPIAN SYSTEM OF NORTHERN ALABAMA

Mississippian rocks are exposed along the northeast-southwest trending Appalachian fold and thrust belt throughout the Black Warrior Basin and East Warrior Platform of northern Alabama (Thomas, 1972, 1979; Pashin and Rindsberg, 1993; Pashin, 1993) (Fig. 2). Formation of these geologic features was the result of the early phase of the Ouachita orogeny, and a complex interplay of tectonics, paleoclimate, and paleoenvironmental conditions led to the formation of several depositional systems (Pashin and Rindsberg, 1993; Pashin, 1993). In general, the Mississippian System in Alabama consists of two basic subdivisions, a lower division of chert and limestone (Fort Payne Chert and Tuscumbia Limestone) and an upper division that includes three distinctive lithofacies: a northwestward thickening carbonate facies in northeastern Alabama; an extensive southwestward thickening clastic facies in the Warrior Basin and along the Appalachian fold and thrust belt; and a generally time-equivalent carbonate facies in north-central Alabama (Thomas, 1972, 1979; Higginbotham, 1988). Specifically, the lithostratigraphic units exposed in the north-central Black Warrior basin within the northern tier of Alabama counties includes, but is not restricted to, the Meramecian age Tuscumbia Limestone and the Chesterian age Pride Mountain Formation, Hartselle Sandstone, Monteagle Limestone, and Bangor Limestone (Fig. 2; see Thomas, 1972, 1979), all of which yield chondrichthyan remains.

The Tuscumbia Limestone overlies the Fort Payne Chert and consists primarily of light gray bioclastic grainstones, wackstones, and mudstones, with scattered lenses of gray to black chert nodules and isolated pockets of caliche. Generally, the Tuscumbia Limestone gradationally overlies the Fort Payne Chert and can be difficult to distinguish using geophysical methods. Conodont analysis indicates a Meramecian age for the Tuscumbia Limestone (Pashin, 1993; Merril et al., 1988; Ruppel 1979) (Fig. 3). Stratigraphically, the Pride Mountain Formation overlies the Tuscumbia Limestone in northwest Alabama (Fig. 3). The Pride Mountain Formation is typically composed of gray clayey shales that may locally contain interbeds of sandstone and limestones. The basal-most beds of the unit commonly consist of oolitic and shaly limestones (Thomas, 1972, 1979). Toward the southwest, beyond the Hartselle Sandstone pinchout, the Pride Mountain is not differentiated from the Floyd Shale, while toward the northeast, the Pride Mountain grades into the Monteagle Limestone (Fig. 3) (Pashin and Rindsberg, 1993). The Monteagle Limestone consists of white to light gray crinoidal packstones and grainstones, cross-bedded, oolitic packstones and grainstones, and in portions calcareous mudstones (Stapor and Cleaves, 1992). Based upon similar sequence positions, the Monteagle Limestone and Pride Mountain Formation are considered laterally equivalent, with the high-energy shallow marine carbonates of the Monteagle

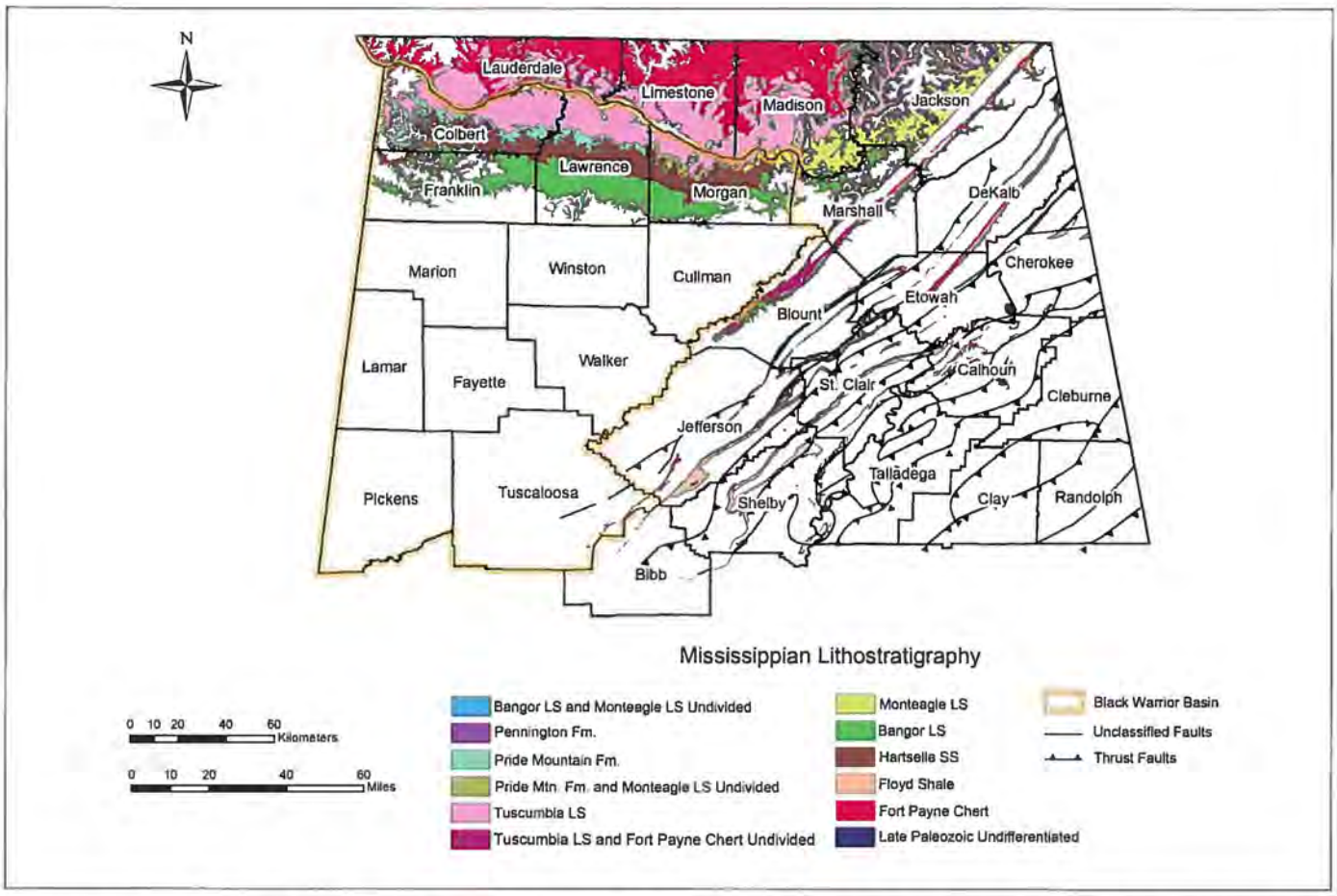

Figure 2. Geologic map showing the distributions of Mississippian strata in northern Alabama. Map produced in ArcMap©, data courtesy of USGS (Schruben et al., 1974).

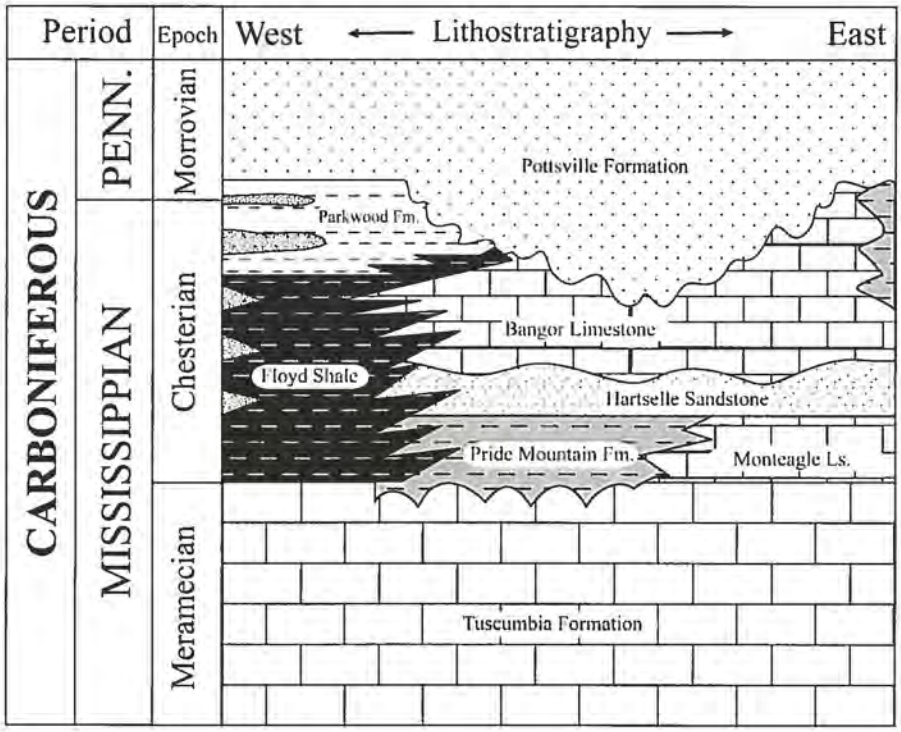

Figure 3. Stratigraphic relationships of Mississippian rocks of northern Alabama. Modified from Kopaska-Merkel and Haywick (2001).

Table 1. List of Mississippian chondrichthyan species and the lithostratigraphic units from which they are known to occur within northern Alabama.

LIST OF ALABAMA MISSISSIPPIAN CHONDRICHTHYANS					
Species		Lithological Unit			
	Bangor Ls.	Hartselle Ls.	Monteagle Ls.	Pride Mountain Fm.	Tuscumbia Ls.
Carcharopsis sp. cf. *C. wortheni*		+	+	+	
"*Ctenacanthus elegans*"	+				
cf. *Ctenoptychius apicalis*			+		
Chomatodus sp.	+		+		
Cladodus sp. cf. *C. bellifer*			+	+	+
Cochliodus leidyi			+		
Cochliodus sp. cf. *C. vanhorni*			+		
Deltodus sp.			+		
Deltodus sp. cf. *D. undulatus*	+			+	
Deltoptychius sp. cf. *D. acutus*			+		
Fissodus bifidus	+		+		
Helodus crenulatis	+		+		
Janassa sp. cf. *J. clarki*[1]			+		
Lisgodus serratus			+		
Orodus micropterygius			+		
cf. *O. mammillaris*			+		
Petalodus acuminatus	+		+		
Polyrhizodus sp.	+			+	
Psammodus sp.	+				
?*Psephodus reticularis*			+		
Saivodus striatus	+		+	+	
Sandalodus minor			+		
Sandalodus sp.			+		
Synthetodus sp. cf. *S. trisulcatus*			+		

Limestone grading southwestward into the regressive, marine clastic sequences of the Pride Mountain Formation (Thomas, 1972, 1979; Pashin, 1993) (Fig. 3).

The Hartselle Sandstone overlies the Monteagle Limestone and Pride Mountain Formation, underlies the Bangor Limestone, and crops out in a northwest – southeast band across northwestern and north-central Alabama (Fig. 3). Upper and lower formational contacts are sharp, and the dominant lithologies of the Hartselle Sandstone consist of variably bedded, light colored calcareous, quartz-rich sandstones, with interbedded dark gray shales. Sedimentological structures indicate wave dominated aggredational and progradational deltaic depositional environments. Inclusive invertebrate fauna most closely correlates with the Glen Dean Formation, but the stratigraphic position of Hartselle Sandstone correlates closely with the Hardinsburg Sandstone of Illinois (Stapor and Cleaves, 1992; Thomas 1972, 1973). The Bangor Limestone is composed of a number of varying carbonate lithofacies that occur in north-central Alabama, above the Hartselle Sandstone and below the Pottsville Formation. Bangor Limestone generally consists of bioclastic and oolitic limestones, although the unit may contain micrite or thin calcareous or argillaceous shale. Fossil faunas within the lower part of the Bangor Limestone belong to a characteristic Glen Dean fauna, whereas those from the upper portion of the formation most closely resemble faunas found within the Chesterian Grove Church and Kinkaid formations of the Mississippi Valley (Thomas 1972, 1973, 1979).

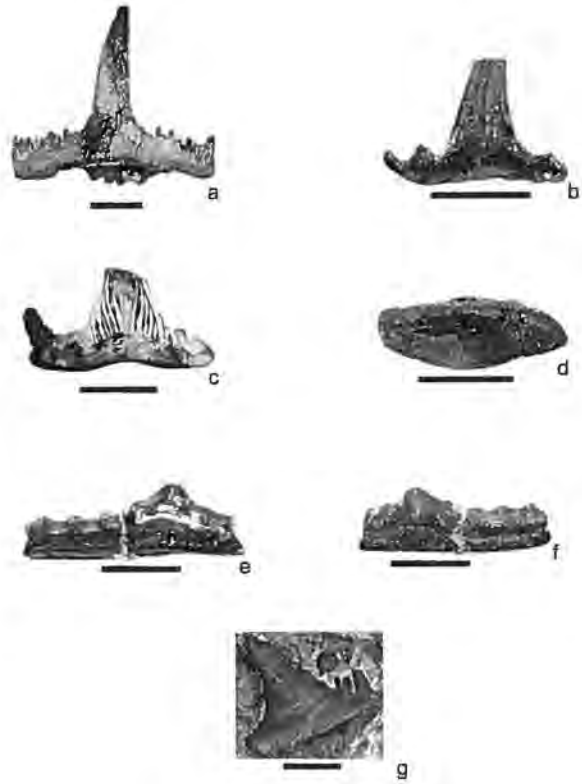

Figure 4. Mississippian Elasmobranchii teeth from Alabama. *Saivodus striatus*, a, BCGM 4864 in labial view. *Cladodus* sp. cf. *C. bellifer*, b-d, BCGM 4862 (b) in labial view; c, BCGM 1946 in labial view; d, BCGM 6289 in basal view (labial at top). *Orodus micropterygius*, e-f, BCGM 4868 in labial (e) and lingual (f) views. *Carcharopsis wortheni*, g, WSU-LC 334 in labial view, within matrix. Scale bars = 0.5 cm in a-f; 1.0 cm in g.

SYSTEMATIC PALEONTOLOGY

The taxonomy utilized below largely follows Ginter et al. (2010). Although Stahl (1999) included holocephalians within Subterbranchialia, we have placed this group within Euchondrocephali following Lund and Grogan (1997). A recent phylogenetic analysis of Chondrichthyes by Pradel et al. (2011) also groups Holocephalimorpha within Euchondrocephali. Specimens we examined occur in the following museum collections: Bob Campbell Geology Museum (BCGM), Clemson University, South Carolina; University of Alabama Museum (PV); Wright State University (WSU), Celina, Ohio.

Subclass Elasmobranchii Bonaparte, 1838
Order Ctenacanthiformes Glickman, 1964
Family Ctenacanthidae Dean, 1909
Genus *Cladodus* Agassiz, 1843
***Cladodus* sp. cf. *C. bellifer* St. John et al., 1875**
Figs. 1b, 4b-d

Material examined: Incomplete isolated teeth, including BCGM 1946, BCGM 4862, BCGM 4863, BCGM 6288, and BCGM 6289; PV2005.0006.0316, abraded tooth in matrix; WSU uncurated, tooth in matrix.

Description: The BCGM specimens are described by Stahl and Cicimurri (2005). PV2005.0006.0316 is embedded in matrix with its labial face exposed, and as preserved it measures approximately 2 cm in width and 0.8 cm in total height. The main cusp appears to have been broader than observed on the Monteagle Limestone specimens, but remnants of coarse vertical ridges and bases of two pairs of lateral cusplets are preserved.

WSU uncurated is embedded in matrix with its lingual side exposed. The main cusp is damaged at its apex, but as preserved measures approximately 1 cm in height. The lingual face is highly convex and ornamented with longitudinal ridges that extend at least to the broken apical portion. A pair of diverging cusplets is visible at the lateral-most ends of the tooth. The base extends lingually past the main cusp and measures 1.7 cm in width. It is convex dorsally and concave aborally, and there is a continuous orolingual ridge near the lingual margin.

Remarks: Tuomey (1858) was the first to describe ctenacanthid teeth from Alabama, but his original specimens have been lost. One of his species, *Cladodus newmani* (p. 39, fig. B), was considered to be too poorly preserved to be identified to the specific level (Newberry, 1889: 216). More recently, Thurmond and Jones (1981) reproduced Tuomey's original illustration and maintained the name *Cladodus newmani*. Stahl and Cicimurri (2005) reported several ctenacanthiform teeth from the Monteagle Limestone and tentatively identified them as "*Cladodus*" *newmani* (fig. 4A-C) based on Tuomey's report. Ginter et al. (2010) did not include *Cladodus newmani* in their review of *Cladodus* species, but they did questionably note *C. bellifer* as occurring in Carboniferous rocks of Alabama. This is presumably based on Tuomey (1858), Thurmond and Jones (1981), or Stahl and Cicimurri (2005), as no other report of similar teeth from the state has been published.

Unfortunately, all of the available Monteagle Limestone specimens are broken or embedded in matrix, but these ctenacanthid teeth can be assigned to *Cladodus* based on the presence of a continuous orolingual and basolingual ridge, and shallow basolabial depression. The orolingual and basolingual ridges are worn through post mortem abrasion, and the most obvious portions remaining occur as low bulges at the flanks of the ridges. Ginter et al. (2010) recognize only five species of *Cladodus*, but they noted the possibility that one, *C. vanhornei*, could represent an aberrant morphology of the type species *C. mirabilis* (see their listing in table 2, pp. 75-76, for species synonomies). According to Ginter et al. (2010), teeth of *C. marginatus* have non-branching basal crown ridges, whereas crowns of *C. vanhornei* are virtually smooth. The teeth of *C. mirabilis* differ from the Monteagle Limestone taxon in that the lateral cusplets are often much larger (up to 50% of the main cusp height), the distal-most cusplets are not highly diverging, and labial ornamentation on the main cusp consists of sinuous ridges that can be discontinuous. The labial crown ridges of *C. elegans* appear to be finer, straighter, and more numerous than on the Monteagle Limestone specimens, and the second pair of lateral cusplets is more divergent from the main cusp (see Newberry and Worthen, 1870; Ginter and Maisey, 2007)

Based on BCGM 1946 and BCGM 6288, labial ornamentation on the main cusp of the Monteagle Limestone taxon consists of an elongated carina that parallels the cutting edges, and from this carina a series of ridges branches off towards the cusp base, where they bifurcate and end before the tooth base. Additionally, the ridges are nearly vertical near the cusp base, but extending apically they trend outward towards the cutting edge and then curve back towards the center of the cusp. This feature is consistent with Ginter et al.'s (2010) description of the labial ornamentation of *Cladodus bellifer*. The Monteagle Limestone teeth also compare favorably to *C. bellifer* in having the first pair of lateral cusplets being situated slightly labially compared to the second pair of cusplets, and the lateral ends of the basolingual ridge are button-like. PV 2005.0006.0316 is considered to be a very abraded specimen of *C. bellifer*. This species also occurs in Mississippian rocks of Iowa.

Ctenacanthiformes incertae cedis
Genus *Saivodus* Duffin and Ginter, 2006
***Saivodus striatus* (Agassiz, 1843)**
Figs. 1a,d-e, 4a

Material examined: BCGM 4864, incomplete tooth; PV2005.0006.0358A, tooth crown; PV2005.0006.0355A, incomplete tooth; WSU uncurated 1, tooth in matrix; WSU uncurated 2, tooth in matrix (lacks main cusp).

Description: BCGM 4864 was previously described by Stahl and Cicimurri (2005). PV2005.0006.0038 represents the main cusp of a large tooth, and as preserved it measures 3 cm in height. It has a circular cross section and there are fine vertical ridges on labial and lingual faces. PV2005.0006.0355A is an incomplete tooth that lacks most of the main cusp and the distal-most portion of the tooth base. Maximum preserved tooth width measures 1.8 cm, and the overall morphology of PV2005.0006.0355A is very similar in to BCGM 4864 except that the labial crown margin does not appear to be as highly denticulated.

WSU uncurated 1 is a large tooth embedded in matrix with its labial face exposed. The exposed lower part of the tooth is damaged, and an unknown portion of the upper part of the crown is covered by matrix. As preserved, the base of the tooth measures 3.7 cm, and the exposed part of the crown measures 2.5 cm in height. Enough details are preserved on this specimen to show that the labial face of the main cusp is only weakly convex and ornamented with fine longitudinal ridges on its lower half. A cutting edge is distinct, and a pair of large diverging cusplets is found at the lateral-most ends of the crown. WSU uncurated 2 is embedded in matrix with its lingual side exposed. This tooth lacks its main cusp, but the base is well preserved and the entire dorsal surface is exposed. On one side of the crown, the bases of seven accessory cusplets are located between the main cusp and the outermost and apparently largest cusplet. The tooth base is as wide as the base of the crown but extends past the crown lingually, forming a shelf-like structure. The dorsal surface of the base is convex and the lingual margin is arcuate. It appears that the main cusp was lost and lateral cusplets abraded through post-mortem transport.

Remarks: Tuomey (1858) reported a second ctenacanthiform tooth morphology that was recovered from the same area as his *Cladodus newmani*. This taxon, which he named *C. magnificus*, has teeth consisting of a very tall and narrow main cusp, very wide tooth base, and multiple small cusplets along the labial margin of the crown (see

his figs. C and Cb). Thurmond and Jones (1981) followed Tuomey's classification, and Stahl and Cicimurri (2005) later questionably identified a single specimen from the Monteagle Limestone as "*Cladodus*" *magnificus* (fig. 4d). Newberry and Worthen (1866) commented on the poor quality of Tuomey's figures, and they noted the similarity of *C. newmani* to their new taxon, *C. grandis*. Both of these species have been synonymized with Agassiz' (1843) *Cladodus striatus* (see Duffin and Ginter, 2006; Ginter et al., 2010).

The *striatus* morphology differs in several ways from *Cladodus*, including having a very tall and narrow main cusp, more numerous pairs of lateral cusplets, multiple accessory cusplets along the labial crown margin, and a base having a basolabial parapet on each side of a median depression. These characteristics were used by Duffin and Ginter (2006) to characterize their new genus *Saivodus*, and because these features are also evident on the specimens listed above (as well as fine, parallel vertical ridges on the lower two thirds of the main cusp) we identify them as *Saivods striatus*. See table 2 of Ginter et al. (2010: 75-76) for additional species synonymized with *Saivodus striatus*.

In North America, *Saivodus striatus* occurs in Carboniferous strata of Illinois, Indiana, Arkansas, Alabama, Missouri, and possibly Montana (Ginter et al., 2010; Newberry 1889; Newberry and Worthen, 1866; St. John and Worthen, 1875).

Elasmobranchii incertae cedis
Genus *Carcharopsis* Agassiz, 1843
***Carcharopsis wortheni* Newberry and Worthen, 1866**
Figs. 1f,g, 4g

Material examined: WSU-LC 343, tooth in matrix.

Description: WSU-LC 343 is embedded in matrix with its lingual face exposed. As preserved it measures approximately 1 cm in width and 1 cm in total height. The tooth has a broad crown, but it is relatively low and the cusp apex is distally oriented due to a rather straight mesial cutting edge and concave distal edge.

The exposed lingual crown face is strongly convex. The lingual (?) edge is thin. The mesial side is coarsely serrated, nearly continuous along the entire crown. Three large cusplets project at the lateral-most end of the mesial side of the crown. The outermost cusplet is the largest and is weakly divergent. The tooth base is very low and projects slightly lingually past the crown, and in aboral view it is concave and has a reniform outline. The tooth base near the distal (lingual?) crown-base junction is punctuated by seven conspicuous foramina.

Remarks: *Carcharopsis* teeth are distinct in having coarsely serrated cutting edges. This feature is not unique among Paleozoic sharks, as several edestoids have serrated sympyseal teeth. However, *Carcharopsis* teeth are easily distinguished in having labio-lingually compressed teeth (convex lingual face and nearly flat labial face) as opposed to laterally compressed (bi-convex). In addition, *Carcharopsis* crowns are crenulated basally, and there are distinct lateral cusplets. Also, the tooth base is meso-distally wide, very short, and concave aborally, and in contrast edestoid tooth bases are laterally compressed, lingually elongated, and often dorsally channeled.

The specimen that we examined is considered to be conspecific with *Carcharopsis wortheni* Newberry and Worthen (1866: pl. 4, fig. 14), but the location of their original specimen is unknown and we cannot make a direct comparison. However, there is no reason to believe that more than one species occurs within the upper Mississippian rocks of northern Alabama, and variation from the illustrated type is considered to represent heterodonty within *C. wortheni*.

Subclass Euchondrocephali Lund and Grogan, 1997
Order Orodontiformes Zangerl, 1981
Family Orodontidae DeKoninck, 1878
Genus *Orodus* Agassiz, 1838 (in 1843)
***Orodus micropterygius* Zangerl, 1981**
Fig. 4e,f

Material examined: BCGM 4868, incomplete tooth, BCGM 6287, complete tooth.

Remarks: The only published record of *Orodus* in Alabama is from the Monteagle Limestone, and that material was identified as *O. micropterygius* (Stahl and Cicimurri, 2005: 5, fig. 4E-H). Ginter et al. (2010) commented that the teeth of *O. micropterygius* do not display any taxonomically significant features, but the Monteagle Limestone specimens closely match the description and illustrations of the species provided by Zangerl (1981: 94, fib. 107A-B) in being asymmetrical (as in other *Orodus* species), having a bulbous main cusp and lateral cusplets (particularly on the labial side), and being devoid of crown ornamentation. These features, in combination with small tooth size, distinguish *O. micropterygius* from other described *Orodus* species, which often lack lateral cusplets and/or are ornamented with vertical ridges (see Ginter et al., 2010 for a variety of species assigned to the genus).

The Monteagle Limestone occurrence represents the only record of *O. micropterygius* outside of the middle Pennsylvainian of Indiana (see Zangerl, 1981).

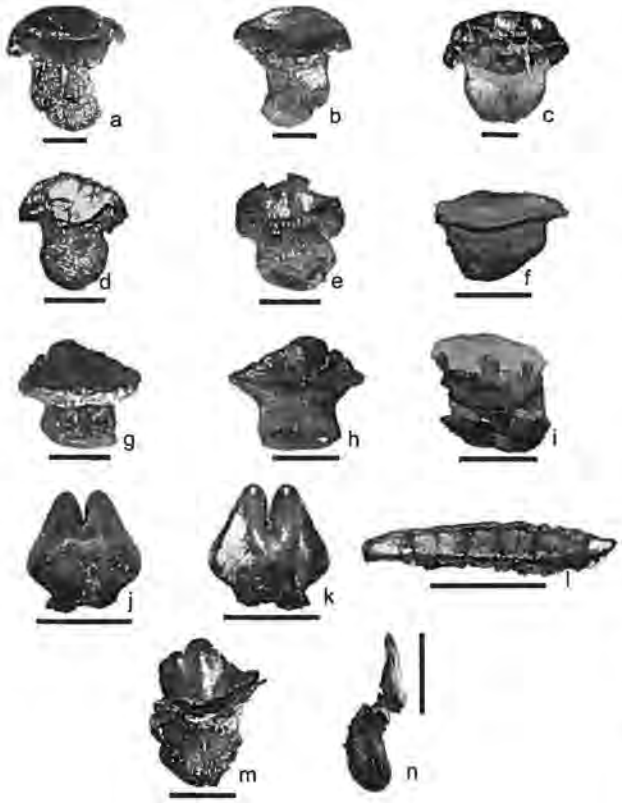

Figure 5. Mississippian Euchondrocephalii teeth from Alabama. *Petalodus acuminatus*, a-f, BCGM 4865 in labial (a) and lingual (b) views; c, BCGM 1941 in lingual view; d, BCGM 1943 in labial view; e, BCGM 1942 in labial view; f, PV2005.0006.0037 in lingual view. *Lisgodus serratus*, g-h, BCGM 4867 in labial (g) and lingual (h) views. *Polyrhizodus* sp. cf *P. digitatus*, i, PV.2005.0006.0358B in lingual view (note that tooth base is at top). *Fissodus bifidus*, j-k, BCGM 6290 in labial (j) and lingual (k) views. *Chomatodus* sp., l, BCGM 4866 in lingual view. cf. *Ctenopetalus apicalis*, m-n, BCGM 6684 in labial (m) and distal (n) views. Specimens in c-f, l, and m-n were digitally removed from matrix for clarity. Scale bars = 1 cm in a-c, f, i, l; 0.5 cm in d-e, j-k, m-n; 0.25 cm in g-h.

Order Petalodontiformes Zangerl, 1981
Family Janassidae Jaekel, 1899
Genus *Fissodus* St. John et al., 1875
***Fissodus bifidus* St. John et al., 1875**
Fig. 5l-m

Material examined: BCGM 6290, tooth crown.

Description: BCGM 6290 was described by Stahl and Cicimurri (2005) and is unique in having a roughly diamond shaped crown that is bifid apically (divided into two rounded cusps), and the cutting edge is weakly serrated. The tooth base is missing, but the broken area at the bottom of the lingual face indicates that it intersected with the crown at a 90° angle.

Remarks: Stahl and Cicimurri (2005) identified BCGM 6290 as *Fissodus bifidus* because of its close comparison to teeth illustrated by St. John and Worthen (1875: pl. 13, figs. 1-2). Lund (1989) suggested that teeth with two cusps formed part of the lower dentition. The only other record of *Fissodus bifidus* is from the late Mississippian (Chesterian) of Illinois (St. John and Worthen, 1875), and Ginter et al. (2010) noted that *Fissodus* teeth occurring in Mississippian rocks are smaller and more gracile than those occurring in Pennsylvanian rocks.

Family Petalodontidae Newberry and Worthen, 1866
Genus *Chomatodus* Agassiz, 1838 (in 1843)
***Chomatodus* sp.**
Fig. 5l

Material examined: BCGM 4866, tooth crown; incomplete teeth, including BCGM 6284, BCGM 6285, BCGM 6286.

Remarks: Stahl and Cicimurri (2005) noted that the four specimens recovered from the Monteagle Limestone were too imperfectly preserved to allow for more than a generic identification, but that the material within their sample fell within the morphological range of several species, including *C. cultellus*, *C. multiplicatus*, and *C. loriformis* (see also Newberry and Worthen, 1866). They also commented that the genus is in need of revision and questioned the validity of the 35 species that were recognized by Zangerl (1981). This need was also stated by Ginter et al. (2010), who considered the taxonomy of *Chomatodus* to be confused and only recognized 24 species (plus three questionable), many from Carboniferous strata of the US mid-continent (see also Newberry and Worthen, 1866; St. John et al., 1875).

Genus *Lisgodus* St. John et al., 1875
***Lisgodus serratus* St. John et al., 1875**
Fig. 5g,h

Material examined: BCGM 4867, isolated tooth.

Remarks: The isolated tooth reported by Stahl and Cicimurri (2005) from the Monteagle Limestone was tentatively identified as *Lisgodus serratus*, but further comparison of BCGM 4867 with the specimens illustrated by St. John et al. (1875, pl. 10, figs. 17-18) leads us to more confidently assign the tooth to this species. The known range of the species is from Mississippian strata of Alabama, Iowa, and Illinois (St. John et al., 1875; Stahl and Cicimurri, 2005).

Genus *Petalodus* Owen, 1840 (in Owen, 1845)
***Petalodus acuminatus* (Agassiz, 1838 (in 1843)**
Fig. 5a-f

Material examined: BCGM 1941, lateral tooth; BCGM 1942, small anterior tooth; BCGM 1943, small anterior tooth; BCGM 4865, large lateral tooth; PV2005.0006.0337, anterior tooth with damaged base.

Description: The BCGM specimens were previously described by Stahl and Cicimurri (2005). In summary, BCGM 1942 and BCGM 1943 are both embedded in limestone matrix with their labial face exposed, and both measure 9 mm in total tooth height (crowns measure 8 mm wide and 4 mm high). BCGM 1941 is embedded in matrix and is exposed lingual face up, but BCGM 4865 is free of matrix. These specimens are 32 mm in total tooth height and have crowns measuring 36 and 30 mm wide, respectively.

PV2005.0006.0037 is a large tooth embedded in matrix with the lingual face exposed. It has a low, weakly acuminate crown and linguiform tooth base. There distal side of the tooth is damaged, but as preserved it measures 3.8 cm wide and 2.3 cm in total height (1.3 cm crown height). The lingual crown face is concave and there is a thin band of imbricated ridges across the entire base. There are several foramina, some very large, perforating the labial face of the tooth base.

Remarks: BCGM 1942 and BCGM are virtually identical to each other, and Stahl and Cicimurri (2005) considered these two teeth to be from anterior positions. The lingual faces of BCGM 1941 and BCGM 4865 are damaged, but remnants of the imbricated base indicate it was not very wide, and it does not appear that the crown heel formed a near 90° angle to the vertical part of the crown as in *Antliodus* species (see Ginter et al., 2010).

Numerous *Petalodus* species have been named (see Newberry and Worthen, 1866, 1870; St. John et al., 1875), but work remains to be done to determine if all are valid or if the remains represent morphological variation within fewer species. BCGM 1941 and BCGM 4865 are similar to Newberry and Worthen's (1866) *P. linguifer* (pl. 2, figs. 4-5; see also Branson, 1906), but we believe that they represent lateral teeth of *P. acuminatus* (particularly PV2005.0006.0337) based on their more elliptical cutting edges having a shallow concavity at one end. Ginter et al. (2010) reported that the most common late Mississippian species in North America is *P. acuminatus*.

We believe that the variations observed on the specimens we examined represent variation within a single species (ontogenetic, dignathic and/or monognathic heterodonty), but without additional teeth it is difficult to determine if more than one species occurs in the upper Mississippian rocks of northern Alabama.

Genus *Polyrhizodus* McCoy, 1848
***Polyrhizodus* sp. cf. *P. digitatus* Leidy, 1857**
Fig. 5i

Material examined: PV2005.0006.0358B, incomplete tooth.

Description: PV2005.0006.0358B is partially embedded in matrix. It lacks the mesial and distal ends of the tooth, and as preserved it measures 1.6 cm in width. Total tooth height measures 1.1 cm. The crown is wide and labio-lingually thin, with a weakly convex labial face and weakly concave lingual face. The crown is very weakly acuminate and the cutting edge is continuous across the preserved portion. The tooth base is partially embedded in matrix (lingual side visible), approximately as high as the crown, and is characteristically developed into a series of fingerlike projections.

Remarks: The crown of this tooth is similar to *Petalodus* (see above), but *Polyrhizodus* is easily distinguished by the fingerlike projections on the tooth base. Ginter et al. (2010) listed 24 named species of *Polyrhizodus*, many of which were reported from Mississippian strata of the US midcontinent (see Newberry and Worthen, 1866; St. John et al., 1875). Lund (1989) reconstructed part of a *Polyrhizodus* dentition based on a specimen from the Mississippian of Montana, and his effort led him to synonomize a number of described species with *P. digitatus*. He also noted that *P. digitatus* differs from species like *P. porosus* in having a rather low crown compared to crown width, but he could not determine, in the absence of additional dentitions, if the variation was related to multiple species or heterodonty within a single taxon. PV2005.0006.0358B conforms with the morphology of *P. digitatus*, and we believe that the specimen represents a lateral tooth because, based on Lund's (1989) reconstruction, the tooth width and number of fingerlike projections on the base of *Polyrhizodus* teeth increases towards the posterior end of the jaws.

Family Belantseidae Lund, 1989
Genus *Ctenoptychius* Agassiz, 1838 (in 1843)
cf. *Ctenoptychius apicalis* Agassiz, 1838 (in 1843)
Fig. 5g,m-n

Material examined: BCGM 6684, damaged tooth.

Description: BCGM 6684 is preserved with the lingual side of the tooth base and lower part of the crown embedded in matrix. The exposed crown is damaged but measures 5 mm in height and was at least 8 mm wide, and in oral view it has a weak lingual curvature. The labial crown face is very weakly convex and has a single wide U-shaped ridge spanning its width. The lingual crown face is concave at least to its lower part. An apical cutting

edge spans the width of the preserved crown, and a wide but blunt medial cusp is separated from multiple lateral cusplets by short, shallow sulci. The exposed portion of the root shows that it is linguiform, constricted just below the crown but bulbous basally, and intersects the crown at nearly a 90° angle.

Remarks: This specimen is superficially similar to *Belantsea* in that it is denticulated, but it differs from the latter taxon in having a single labial ridge instead of imbricated ridges, and the cross section of BCGM 6684 shows only a single enameloid layer, not two, covering the crown (Lund, 1989; Ginter et al., 2010). BCGM 6684 is more similar to *Ctenoptychius* in having robust cusplets, a single labial transverse ridge, and the tooth base is globular basally. Ginter et al. (2010) considered *Ctenoptychius* to be monospecific and only recognized *C. apicalis* as valid; St. John et al. (1875) *C. stevensoni* is a junior synonym of *C. apicalis*. This genus is only known from Pennsylvanian strata, and the record from Alabama represents a significant range extension into the late Mississippian. The bluntness of the cusp apices of the Alabama specimen is considered to be an artifact of in vivo usage. Ginter et al. (2010) noted that teeth with globular bases are from medial positions within the jaws.

Superorder Holocephalimorpha Grogan and Lund, 2004
Order Helodontiformes Patterson, 1965
Family Helodontidae Patterson, 1965
Genus *Helodus* Agassiz, 1838 (in 1843)
***Helodus crenulatis* Newberry and Worthen, 1866**
Fig. 6c-g

Material examined: BCGM 4869, BCGM 6291, BCGM 6680, BCGM 6681, BCGM 6682, all isolated teeth.

Remarks: *Helodus* is the most common holocephalian that was recovered from the Monteagle Limestone (Stahl and Cicimurri, 2005). The crowns of BCGM 6291 and BCGM 6680 have a high, circular, flat-topped cusp that is well separated from the lateral margins. BCGM 4869 has a lower cusp that is rather broad, and BCGM 6681 and 6682 are without cusps but have an overall convex occlusal surface.

These features are similar to some Cretaceous *Ptychodus* species, and we interpret the high-cusped teeth as occupying anterior positions, with crown height diminishing posteriorly within the jaws. The robust crown morphology indicates that *Helodus* teeth were used to pound the shells of invertebrates.

Figure 6. Mississippian Subterbranchialia teeth from Alabama. *?Psephodus reticularis*, a, BCGM 6182 in oral view. *Deltoptychius* sp. cf. *D. acutus*, b, BCGM 10200 in oral view. *Helodus crenulatis*, c, BCGM 6682 in oral view; d-e, BCGM 6681 in labial (d) and lingual (e) views; f-g, BCGM 6680 in occlusal (f) and labial (g) views. Specimens in b and c were digitally removed from matrix for clarity. Scale bars = 0.5 cm in a, c-g; 1 cm in b.

Order Cochliodontiformes Obruchev, 1953
Family Psephodontidae Zangerl, 1981
Genus *Psephodus* Morris and Roberts, 1862
***?Psephodus reticularis* St. John and Worthen, 1883**
Fig. 6a

Material examined: BCGM 6182, incomplete plate.

Remarks: Stahl and Cicimurri (2005)identified this specimen based on the work of St. John and Worthen (1883). The uncertainty of identification is related to the fact that the plates lack crenulations around the plate margins as seen in other species within *Psephodus* (see Stahl, 1999).

Family Cochliodontidae Owen, 1867
Genus *Cochliodus* Agassiz, 1838 (in 1843)
***Cochliodus leidyi* St. John and Worthen, 1883**
Fig. 7e,g

Material examined: BCGM 1944, lower left posterior tooth plate; BCGM 6295, lower right posterior tooth plate.

Remarks: Both specimens are lower tooth plates, with BCGM 1944 being from the left side and BCGM 6295 from the right. They are easily distinguished from all other holocephalian plates discussed herein by having a robust teardrop-shaped boss.

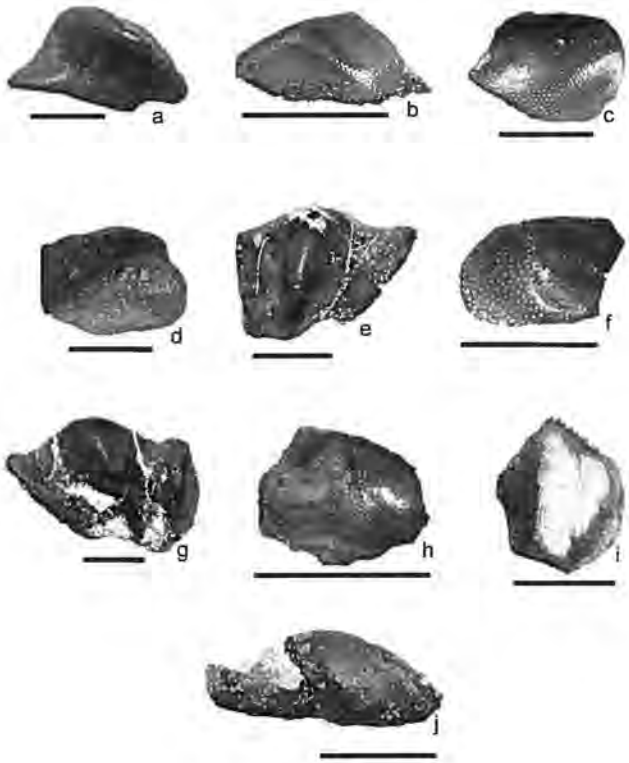

Figure 7. Mississippian Subterbranchialia teeth from Alabama. *Deltodus* sp. cf. *D. undulatus*, a, PV2005.0006.0355B in oral view (from labial side). *Deltodus* sp., b, BCGM 6292 in oral view; c, BCGM 6294 in oral view. *Sandalodus* sp., d, BCGM 4871 in oral view; j, BCGM 6293 in oral view. *Cochliodus leidyi*, e, BCGM 1944 in oral view; g, BCGM 6295 in oral view. *Cochliodus* sp. cf. *C. vanhorni*, f, BCGM 6181 in oral view. *Synthetodus* sp. cf. *S. trisulcatus*, h, BCGM 4870 in oral view. *Sandalodus minor*, i, BCGM 1945 in oral view. *Sandalodus* sp., j, BCGM 6293 in oral view. Specimens in e, f, i-k were digitally removed from matrix for clarity. Scale bars = 1 cm in a, e, j; 0.5 cm in b-c, f-i; 0.25 cm in d.

C. sp. cf. *C. vanhorni* St. John and Worthen, 1866
Fig. 7f

Material examined: BCGM 6181, incomplete plate.

Remarks: This specimen exhibits the morphology attributed to *Streblodus*, but it occurs as part of the dentition of *Cochliodus* (see Stahl, 1999). BCGM 6181 is very similar to maxillary teeth of *C. vanhorni*, but Stahl and Cicimurri (2005) only tentatively referred the plate to this species because the groove located near the center of the plate is not as deep as in similar teeth illustrated by St. John and Worthen (1883: pl. 7, figs. 1, 11, 12).

Genus *Deltodus* Morris and Roberts, 1862
Deltodus sp. cf. *D. undulatus* Newberry and Worthen, 1866
Fig. 7a

Material examined: PV2005.0006.0355B, upper left tooth plate.

Description: PV2005.0006.0355B measures 2.4 cm from mesial tip to distal tip. In oral view the symphyeal margin is convex, and in symphyseal view the plate has a slight aboral coil. A large ridge is located very close to the symphyseal margin, and it is narrow and high where it forms the mesial tip of the plate, but wider and lower where it meets the lingual border. Posteriorly the plate becomes flattened and expanded into a wing-like projection, and the labial margin of this wing curls upward (especially near the distal tip). The oral surface of the plate is divided into several broad transverse bands by shallow furrows that extend from the symphyseal to the labial margins.

Remarks: In terms of overall morphology, the specimen compares favorably to an upper right tooth plate from the Mississippian Keokuk Limestone of Iowa that was illustrated by Newberry and Worthen (1866: pl. 9, fig. 5) and especially to an additional upper left plate shown by Stahl (1999: fig. 72, H).

Deltodus sp.
Fig. 7b,c

Material examined: BCGM 6292 and BCGM 6294, incomplete tooth plates.

Remarks: These very small and incomplete plates were originally described by Stahl and Cicimurri (2005), and according to these authors both specimens are within the morphological range of *Deltodus*. They also indicated that the specimens are similar to *D. mercurei* in lacking undulations parallel to the lingual margin. BCGM 6294 may represent a lower posterior tooth plate.

Genus *Sandalodus* Newberry and Worthen, 1866
Sandalodus minor (Davis, 1884)
Fig. 7i

Material examined: BCGM 1945, isolated plate.

Remarks: This species occurs in Mississippian strata of England, and Stahl and Cicimurri (2005) considered the single specimen from the Monteagle Limestone to compare well with a plate identified as *Sandalodus minor* by Bryant and Johnson (1936).

***Sandalodus* sp.**
Fig. 7d, j

Material examined: BCGM 4871, isolated plate; BCGM 6180, incomplete plate; BCGM 6293, isolated plate.

Remarks: BCGM 4871 and BCGM 6293 compare well to material identified as *Vaticinodus simils* and *V. simplex* (see St. John and Worthen, 1883), whereas BCGM 6180 is similar to *Stenopterodus parvulus* St. John and Worthen (1883), the genus was synonymized with *Sandalodus* by Stahl (1999). Stahl and Cicimurri (2005) noted that some species of *Sandalodus* are synonymous with *Deltodus* (see also Stahl and Hansen, 2000), representing upper/lower tooth plates of the same taxon, but they chose to consider *Sandalodus* as a valid taxon and did not assign the three plates to any particular species because of the limited sample size and incompleteness of the material.

Order Copodontiformes Obruchev, 1953
Family Copodontidae incertae cedis
Genus *Synthetodus* Eastman, 1908
***Synthetodus* sp. cf. *S. trisulcatus* Eastman, 1897**
Fig. 7h

Material examined: BCGM 4870, incomplete plate.

Remarks: This specimen was tentatively identified as *Synthetodus trisulcatus*, a taxon known from the late Devonian of Iowa (St. John and Worthen, 1883), by Stahl and Cicimurri (2005) because the preserved portion of the plate is divided into three parts by shallow sulci. In addition, although it is smaller than other specimens referred to the species, they considered the possibility that BCGM 4870 represents an immature growth stage (ontogenetic heterodonty within the species).

Order Menaspiformes Obruchev, 1953
Family Deltopthychiidae Patterson, 1965
Genus *Deltoptychius* Morris and Roberts, 1862
***Deltoptychius* sp. aff. *D. acutus* McCoy, 1855**
Fig. 6b

Material examined: BCGM 10200, lower right tooth plate.

Description: The specimen is embedded in matrix with the oral surface visible, and it is complete except for minor damage to flanges along the symphyseal and labial margins. The plate measures 1.5 cm from the mesial angle to the distal angle, and 8 mm along the symphyseal margin, which is nearly straight, has a slightly concave surface, and is separated from a central ridge by a shallow trough. The central ridge extends from near the mesial tip to the middle of the lingual margin, becoming more conspicuous in this direction. Much of the labial margin consists of a low ridge that begins 3 mm from the mesial tip and becomes more prominent towards the distal tip. This labial ridge is separated from the central ridge by a trough. The lingual margin of the plate is convex.

Remarks: This specimen was only recently discovered in a collection of material housed in the Clemson University geology department that was originally collected in 2000 or 2002. Morphologically the plate is similar to lower plates of Mississippian *Deltoptychius wachsmuthi* described by St. John and Worthen (1883: pl. 5, figs. 1 and 2), but Stahl (1999) considered their material to be based on"*Streblodus*-like" plates. Patterson (1965) synonymized *Streblodus* with *Deltoptychius*, but Stahl (1999) considered the genus synonymous with *Cochliodus*.

In comparison, BCGM 10200 is only slightly smaller in overall size than the lower right plate of *Cochliodus leidyi* discussed above (BCGM 6295). The two plates differ significantly in that BCGM 10200 has a triangular as opposed to trapezoidal oral outline like BCGM 1944 and BCGM 6295, and both of these plates have a large teardrop-shaped boss dominating the oral surface. However, BCGM 10200 matches Stahl's (1999) description of *Deltoptychius* plates, and our specimen compares well to lower right plates of *Deltoptychius acutus* she illustrates in figures 96A and C. Patterson (1965) stated that the lower plates of *D. acutus* were indistinguishable from those of *D. armigerus*, but that the two species more than likely differed in aspects of the head armor. Based on the similarities in lower tooth plate morphology, we tentatively assign the Monteagle Limestone specimen to *D. acutus* and note that a more precise identification should await the discovery of other material, particularly non-tooth plate elements.

CONCLUSIONS

The Mississippian chondrichthyan remains we examined consist primarily of isolated teeth and tooth plates. As a result of reexamining previously reported specimens (or original illustrations if specimens have been lost), observing new material made available to us, and incorporating recent taxonomic studies, at least 10 genera of sharks and eight genera of holocephalians occur in Mississippian rocks of northern Alabama. The Monteagle Limestone currently has the best known Mississippian elasmobranch fauna in Alabama, with 14 taxa (excluding *Sandalodus* sp.) reported by Stahl and Cicimurri (2005). The authors indicated (p. 12) that additional taxa would be found, and in fact *Carcharopsis* and *Ctenoptychius* can be added to the species list. The Monteagle Limestone paleofauna may be biased towards species that can be seen with the unaided eye, and analysis of potential microfauna has yet to be undertaken.

Other carbonate units in northern Alabama will con-

tain chondrichthyan faunas, and preliminary fieldwork by us and examination of a private collection indicates that these faunas will be very similar to the Monteagle Limestone. For example, the Pride Mountain Formation also includes *Cladodus* sp. cf. *C. bellifer*, *Saivodus striatus*, and *Carcharopsis*, with additional taxa represented by *Polyrhizodus* sp. and *Deltodus* sp. cf. *D. undulatus*. Like the Monteagle Limestone, the Bangor Limestone contains *S. striatus*, *Fissodus bifidus*, *Petalodus acuminatus*, and *Chomatodus*. The Hartselle Sandstone also has *P. acuminatus* and *Carcharopsis* (and a large ctenacanthiform tooth was observed in the field by DJC but not collected).

Much more work remains to be done in order to gain a better understanding of the Mississippian chondrichthyan faunas of northern Alabama. As has been demonstrated for the Monteagle Limestone, more than a cursory examination of Bangor Limestone, Pride Mountain Formation, and Hartselle Sandstone exposures will likely yield additional material than is currently known from museum collections. Important specimens are known to be part of private collections, but utilization of these fossils by other researchers can be hampered by the fact that: 1) they may not be available to researchers; 2) they can be sold or otherwise disappear; 3) the data associated can be questionable; 4) they are often not sufficiently curated.

Our future studies of Mississippian chondrichthyans in northern Alabama will focus not only on examination of exposures in the field to identify macroscopic remains, but also to collect and process matrix in order to recover microscopic remains. Most of the taxa reported herein are based on remains that are at least 1cm in greatest dimension, and occurrences of species with remains smaller than *Lisgodus serratus* (the smallest tooth we examined) are unknown. However, initial analysis of microscopic concentrates recovered from the Pride Mountain Formation has shown that chondrichthyan microfaunas are present (and diverse). By combining these methods, in addition to collaborating with local collectors, we will obtain detailed knowledge of the species that inhabited particular environments, and we may also be able to determine variations in species compositions as environments changed both laterally (geographically) and vertically (temporally).

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A Review of Non-Avian Dinosaurs from the Late Cretaceous of Alabama, Mississippi, Georgia, and Tennessee

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ABSTRACT: The purpose of this paper is to compile and summarize records of southeastern non-avian dinosaur material collected from the Upper Cretaceous Gulf Coastal Plain units in Alabama, Mississippi, Georgia, and Tennessee. In all, information on 155 non-avian dinosaur specimens were compiled (Tables 1-9) from twelve institutions including national museums, state museums, and university collections. Specimens represent hadrosaurs, ankylosaurs, ornithomimids, dromaeosaurs, and tyrannosaurs as well as additional material not identified to lower taxa. This additional material comprises 21% of the total specimen records compiled. Two holotypes (both from Alabama) were represented in the compiled data: the hadrosaur *Lophorhothon atopus* Langston, 1960 and the tyrannosauroid *Appalachiosaurus montgomeriensis* Carr, Williamson, and Schwimmer 2005. With such a significant number of specimens yet to be further identified and two holotypes from the study area, additional research on southeastern dinosaurs is needed.

INTRODUCTION

Although much has been known about Late Cretaceous dinosaurs from the western United States, less is known about dinosaurs of the southeastern states. This paper presents the results of an extensive collections search of non-avian dinosaur material previously collected from Upper Cretaceous Coastal Plain units in Alabama, Mississippi, Georgia, and Tennessee. Because this paper was written for an Alabama Museum of Natural History bulletin, the study area reflects an emphasis on Alabama and its neighboring states. This paper is an effort to record dinosaur material currently in scientific collections, but not to identify, revise, or theorize on taxonomic identifications. It is the hope of the authors that publishing the list of collected material will increase awareness and interest in further research of southeastern dinosaurs.

Study Area

During the Late Cretaceous thermal maximum, eustatic sea level was much higher than today. The northern extent of the Gulf of Mexico stretched up into western Tennessee, northeastern Mississippi, central Alabama, and central Georgia. In the states within the study area, there are Upper Cretaceous units ranging from Cenomanian to Maastrichtian (Figs. 1 and 2) nonmarine clastic, and transgressive and regressive marine clastic and carbonate facies.

Methods

Data was compiled from scientific collections catalogs from twelve museums and universities (see list below) from May through August 2011. Institutions whose dino-

Bull. Alabama Mus. Nat. Hist. 28:81–93

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Fig. 1. Paleogeographic map of the Late Cretaceous southeastern United States. Light blue denotes area covered by water, light green denotes land, and the dashed curved line across the study area represents an estimated coastline during the late Late Cretaceous. States included in the study area are outlined in red (AL, Alabama; MS, Mississippi; GA, Georgia; TN, Tennessee).

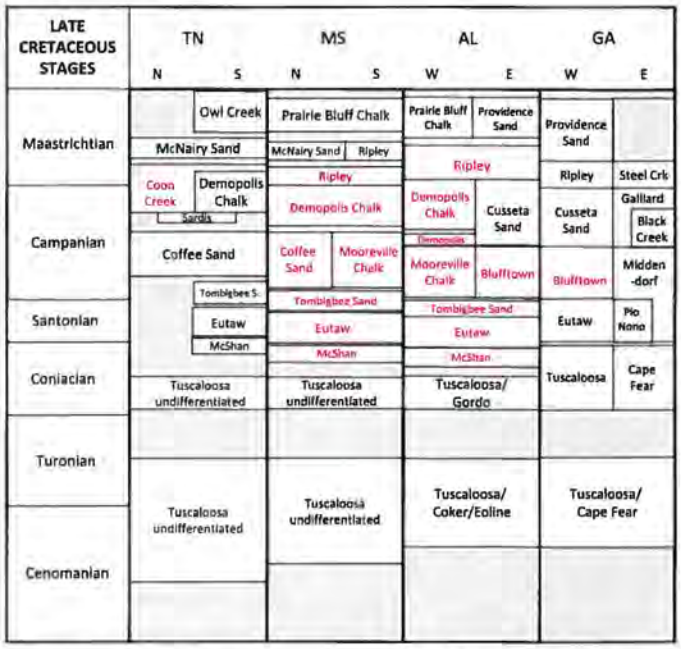

Fig. 2. Upper Cretaceous stratigraphic units with surface exposure in the study area. Red font indicates formations from which dinosaur material is recorded. N, S, E, and W indicate direction along the outcrop belt of the state. Stratigraphic chart modified from multiple sources: Russell and Parks, 1975; Mancini et al., 1996; Falls and Prowell, 2001; and Clarke et al., 1994. Gray areas represent time-rock units missing from the stratigraphic record (unconformities

saur specimens are recorded in this paper are listed below in alphabetic order of institution abbreviation used in the tables of this paper.

Institutional Abbreviations:

AMNH: American Museum of Natural History, New York, NY; **AUMP**: Auburn University Museum of Paleontology, Auburn, AL; **CCK**: Cretaceous research collections at Columbus State University, Columbus, GA; **FHMM**: Frank H. McKlung Museum, Knoxville, TN; **FMNH**: Field Museum of Natural History, Chicago, IL; **MMNS**: Mississippi Museum of Natural Science, Jackson, MS; **MOG**: Mississippi Office of Geology, Jackson, MS; **MCWSC**: McWane Science Center, Birmingham, AL; **PPM**: Memphis Pink Palace Museum, Memphis, TN; **UAM**: University of Alabama Museums, Tuscaloosa, AL; **UM**: University of Memphis, Memphis, TN; **USNM**: U.S. National Museum, Washington, D.C.

RESULTS

This section summarizes the data collected for this project. Taxa reported in the results section and the associated tables are as they are recorded in scientific collections catalogs and specimen labels and have not been re-identified or revised.

Dinosaurian taxa recorded

Of the collections information compiled, a total of 155 dinosaur specimens were recorded from states within the study area. In total they include specimens identified as dinosaur, ornithopod, hadrosaur, ankylosaur, theropod, ornithomimid, dromaeosaur, and tyrannosaur. Two holotypes from the study area and are indicated in the below taxa list by bold font. Of all dinosaur specimens recorded, 55% belong to the family Hadrosauridae (Fig. 3). The second largest percentage (21%) of all specimens is uncertain dinosaur taxa (lower taxonomic unit uncertain). The third largest percentage of the specimens is tyrannosauroid, and the remaining smaller percentages include dromaeosaurids, ankylosaurs, and ornithomimids.

Non-avian Dinosaur Taxa from the Study Area

Ornithischia
- Ankylosauria
  - Nodosauridae
    - Gen. undet.
- Ornithopoda
  - Hadrosauridae
    - Lophorhothon Langston, 1960
      - **Lophorhothon atopus Langston, 1960**

Table 1. Dinosaur specimens not identified to lower taxa.

Institution	Collection Number	Material	County	State	Formation	Age
MMNS	VP 4742	Vertebra	Sumter	AL	Lower Eutaw [McShan?]	Coniacian
MCWSC	RMM 3474	Fragmentary claw?	Greene	AL	Tombigbee Sand Mbr., Eutaw Fm.	Late Santonian-early Campanian
UAM	PV1992.46.2	2 bones	Sumter	AL	Demopolis Chalk	Campanian
UAM	PV1993.1.2.2	Bone	Unspecified	AL	Mooreville Chalk	Santonian-Campanian
MMNS	VP 3754	Medial phalanx	Lowndes	MS	Lower Eutaw [McShan?]	Coniacian
MMNS	VP 4253	Partial rib	Lowndes	MS	Lower Eutaw [McShan?]	Coniacian
MMNS	VP 3056	Propodial, proximal portion	Monroe	MS	Mooreville Chalk	Santonian-Campanian
MMNS	VP 3870	Fragment	Monroe	MS	Mooreville Chalk	Santonian-Campanian
MMNS	VP 3048	Vertebra	Unknown	MS	Selma Group	Santonian-Maastrichtian
MMNS	VP 3052	Vertebra	Unknown	MS	Selma Group?	Santonian-Maastrichtian
MMNS	VP 5608	Vertebral centrum	Lowndes	MS	Tombigbee Sand Mbr., Eutaw Fm.	Late Santonian-early Campanian
MMNS	VP 620	Fibula, proximal fragment	Monroe	MS	Tombigbee Sand Mbr., Eutaw Fm.	Late Santonian-early Campanian
MMNS	VP 5875	Tooth	Lowndes	MS	Tombigbee Sand Mbr.?, Eutaw Fm.	Late Santonian-early Campanian
MMNS	VP 3040	Phalanx, proximal	Monroe	MS	Unspecified	Unknown

Saurischia

Theropoda

Ornithomimidae

Gen. undet.

Dromaeosauridae

Saurornitholestes Sues, 1978

Tyrannosauroidea

Appalachiosaurus Carr, Williamson, and Schwimmer, 2005

Appalachiosaurus montgomeriensis Carr, Williamson, and Schwimmer, 2005

Dinosauria

Of the 155 dinosaur specimens recorded from the study area, 14 are not identified in more detail than "dinosaur" (Table 1). All 14 specimens were collected in Alabama and Mississippi. One unique specimen not recorded in Table 2 is an amniote egg (AUMP 1235) found in Dallas County, Alabama in the 1980s and described by Dobie (1978). The egg is elliptical and exhibits a distinct textured exterior. The egg was prepped some years later, to reveal tiny bones of what may be dinosaur. This embryonic skeleton may be a hadrosaur (J. Lamb, pers. comm.), but research is still being conducted and taxon determination is still in question.

Ornithischia

While the vast majority of 98 ornithischian specimens are hadrosaur, six have not been identified to a lower taxon other than ornithischian or ornithopod; 84 are hadrosaur; and the remaining eight ornithischians are ankylosaur and nodosaur (Table 2).

Hadrosauridae

Of the 155 dinosaur specimens from the study area, 84 are identified as hadrosaur (Table 3). Only one hadrosaur

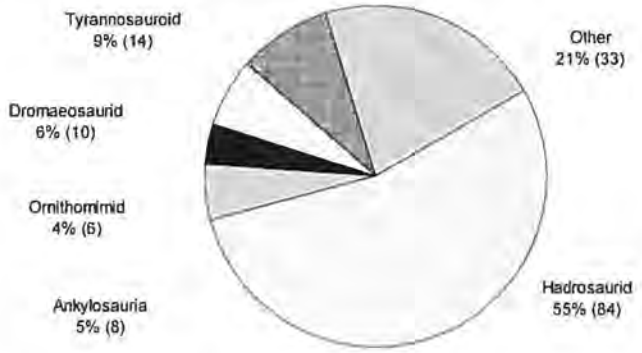

Fig. 3 Taxonomic precentages of the total recorded dinosaur sepcimens from the study area.

Table 2. Ornithopods and other ornithischians.

Institution	Collection Number	Material	County	State	Formation	Age
USNM	V 6523	Partial axial elements, partial appendicular elements, partial femur, partial tibia, partial astragalus, partial metatarsal, partial fibula (Ornithopod)	Autauga	AL	Rotten Limestone [Ripley?]	Campanian-Maastrichtian
USNM	V 6524	Axial elements, 21 partial vertebrae, appendicular elements, partial femur, partial tibia, partial fibula, partial humerus, partial metatarsal (Ornithopod)	Dallas	AL	Rotten Limestone [Ripley?]	Campanian-Maastrichtian
USNM	PAL 442503	Appendicular element, proximal tibia, distal tibia (Ornithopod)	Perry	AL	Rotten Limestone [Ripley?]	Campanian-Maastrichtian
MMNS	VP 5071	Teeth (Ornithopod)	Lowndes	MS	Lower Eutaw [McShan?]	Coniacian
USNM	PAL 337988	Appendicular element, partial tibia (Ornithopod)	Unknown	MS	Ripley	Campanian-Maastrichtian
MMNS	VP 6016	Left tibia, proximal half (Ornithischia)	Tippah?	MS	Selma Group	Santonian-Maastrichtian

species is identified in the collections records: *Lophorothon atopus*. Of the *L. atopus* specimens, all six are from Alabama. Although Lamb (1998) hypothesized *Lophorothon* to be an iguanodontian, Horner et al. (2004) consider *L. atopus* to be a basal hadrosaur as originally described by Langston (1960). The holotype of *L. atopus* (FMNH specimen P 27383) is from Dallas County (Langston, 1960), and although the holotype is only partial skull material, a recent discovery of another *L. atopus* in Alabama (MCWSC 26037) represents the most complete skull of *L. atopus* found to date (J. Ebersole, pers. comm.).

Ankylosauria

Eight specimens of Akylosauria are recorded from the study area: five from Alabama and three from Mississippi (Table 4). None of the material is identified to species or genus. Although most material is individual teeth and bones, the McWane Science Center specimen RMM 1224 includes 17 vertebrae, one tibia, one neural arch, a proximal portion of ischium, a basisphenoid-basioccipital, the anterior end of the right dentary, teeth, and unidentified skull fragments. This specimen is the most complete nodosaur specimen described from east of the Mississippi River.

Saurischia

Three specimens are recorded as Saurischia without more detailed taxonomic identification (Table 5), although one of these specimens (AMNH specimen FR 21584) may be from South Carolina as questioned in the specimen catalog.

Theropoda

Thirty-seven theropods are recorded, including six ornithomimids, ten dromaeosaurids, and 14 tyrannosauroids (Tables 6, 7, 8, and 9). Seven theropods are not identified to a lower taxonomic level. One specimen (MCWSC 2290) is identified as "Carnosauria" in the collections catalog. The term "Carnosauria" here was used simply to indicate the specimen as a large carnivorous dinosaur, not in reference to the Carnosauria clade.

Ornithomimidae

Six Late Cretaceous ornithomimid specimens are recorded from the study area (Table 7). None have been identified to a lower taxon within the collections databases. All but one of the ornithomimid specimens are from the Late Santonian to early Campanian Tombigbee Sand Member of the Eutaw Formation in Mississippi. Within eastern North America, only one genus of ornithomimid

Table 3. Hadrosaur specimens (asterick following specimen number denotes *L. atopus*)..

Institution	Collection Number	Material	County	State	Formation	Age
AUMP	AUMP 3083	Left metatarsal IV	Russell	AL	Blufftown	Campanian
AUMP	AUMP 3026	Ablated tooth crowns	Russell	AL	Blufftown	Campanian
CCK	CCK-90-6-1	Ablated tooth crowns	Barbour	AL	Blufftown	Campanian
CCK	CCK-87-20-4	Tibia and ablated astragalus	Russell	AL	Blufftown	Campanian
CCK	CCK-87-20-1	Fibula	Russell	AL	Blufftown	Campanian
CCK	CCK-87-20-5	Digit IV phalanges	Russell	AL	Blufftown	Campanian
CCK	CCK-87-20-6	Digit IV phalanges	Russell	AL	Blufftown	Campanian
CCK	CCK-87-20-7	Digit IV phalanges	Russell	AL	Blufftown	Campanian
CCK	CCK-87-20-8	Digit IV phalanges	Russell	AL	Blufftown	Campanian
CCK	CCK-87-20-3	Metatarsal II	Russell	AL	Blufftown	Campanian
CCK	CCK-87-20-2	Metatarsal III	Russell	AL	Blufftown	Campanian
CCK	CCK-87-20-9	Distal tarsal	Russell	AL	Blufftown	Campanian
MCWSC	MCWSC 6087	Distal femur		AL	Tombigbee Sand Mbr., Eutaw Fm.	Late Santonian-early Campanian
UAM	PV2005.6.112	8 caudal vertebrae, and one bone fragment	Dallas	AL	Mooreville Chalk	Santonian-Campanian
UAM	PV1993.1.2.1	Metatarsal	Greene	AL	Mooreville Chalk	Santonian-Campanian
UAM	PV1995.3.1	Bone	Greene	AL	Mooreville Chalk	Santonian-Campanian
UAM	PV2005.6.342	Caudal vertebra	Greene	AL	Mooreville Chalk	Santonian-Campanian
UAM	PV2005.6.414	17 bone frags	Greene	AL	Mooreville Chalk	Santonian-Campanian
UAM	PV2005.6.315	Partial bone	Pickens	AL	Mooreville Chalk	Santonian-Campanian
UAM	PV1985.72.6	Caudal vertebra	Unknown	AL	Mooreville?	Santonian-Campanian
UAM	PV2005.6.287	6 bone fragments	Bullock	AL	Ripley	Campanian-Maastrichtian
UAM	PV2005.6.352	Large bone fragment	Lowndes	AL	Ripley	Campanian-Maastrichtian
UAM	PV1990.9	Proximal femur	Montgomery	AL	Tombigbee Sand Mbr., Eutaw Fm.	Late Santonian-early Campanian
UAM	PV1985.72.2	Long bone fragment	Unknown	AL	Tombigbee Sand Mbr., Eutaw Fm.	Late Santonian-early Campanian
UAM	PV1985.72.8	Bone fragment	Unknown	AL	Tombigbee Sand Mbr., Eutaw Fm.	Late Santonian-early Campanian
UAM	PV1985.72.9	Bone fragment	Unknown	AL	Tombigbee Sand Mbr., Eutaw Fm.	Late Santonian-early Campanian

Table 3. Hadrosaur specimens, *continued.*

Institution	Collection Number	Material	County	State	Formation	Age
USNM	PAL 508515	Skull element, tooth	Bullock	AL	Unspecified	Unknown
FMNH	P 27383*	HOLOTYPE; Skull, jaws, vertebrae, ribs, limb bones	Dallas	AL	Mooreville Chalk	Santonian-Campanian
MCWSC	RMM 2985*	4 anterior phalanges (1 terminal)	Greene	AL	Mooreville Chalk	Santonian-Campanian
MCWSC	MCWSC 1319*	6 bones from the tarsus	Hale	AL	Mooreville Chalk	Santonian-Campanian
MCWSC	MCWSC 26037*	Skull material	Unknown	AL	Tombigbee Sand Mbr.?, Eutaw Fm.	Late Santonian-early Campanian
AUMP	AUMP 982*	Left jaw	Montgomery	AL	Selma Group	Santonian-Maastrichtian
UAM	V993.1.2.2	Metatarsal	Dallas	AL	Mooreville Chalk	Santonian-Campanian
MCWSC	MCWSC 12620*	Vertebrae and bone fragments	Hale	AL	Unspecified	Unknown
CCK	CCK-79-3-1	Partial posterior left dentary	Stewart	GA	Blufftown	Santonian-Campanian
CCK	CCK-85-2-1	Distal third of a left metacarpal III	Stewart	GA	Blufftown	Santonian-Campanian
CCK	CCK-88-16-1	Posterior caudal vertebra	Stewart	GA	Blufftown	Santonian-Campanian
CCK	CCK-90-17-1	Posterior caudal vertebra	Stewart	GA	Blufftown	Santonian-Campanian
CCK	CCK-90-4-1	Dentary tooth crown and partial root	Stewart	GA	Blufftown	Santonian-Campanian
CCK	CCK-79-03	Jaw fragment	Stewart	GA	Blufftown	Santonian-Campanian
MMNS	VP 4633	Tooth	Lowndes	MS	Basal Mooreville	Santonian
MMNS	VP 118	Tooth, maxillary	Lee	MS	Coffee Sand?	Campanian
MMNS	VP 5118	Left femur (missing distal epiphysis)	Union	MS	Coon Creek	Campanian-Maastrichtian
MMNS	VP 5917	Tooth, crown	Union	MS	Coon Creek	Campanian-Maastrichtian
MMNS	VP 5275	Phalanx, ungual, 2nd pedal digit, left	Monroe	MS	Demopolis Chalk	Campanian
MMNS	VP 3242	Tooth, partial	Noxubee	MS	Demopolis/Mooreville contact zone	Campanian
MMNS	VP 292	Tooth	Clay	MS	Eutaw	Santonian
MMNS	VP 675	Femur, left, distal end	Lowndes	MS	Eutaw	Santonian
MMNS	VP 108	Phalanx, pedal, digit II, first, right	Monroe	MS	Eutaw?	Santonian
MMNS	VP 111	Limb bone fragment	Monroe	MS	Eutaw?	Santonian
MMNS	VP 112	Centrum, caudal	Monroe	MS	Eutaw?	Santonian
MMNS	VP 3057	Tooth	Lowndes	MS	Lower Eutaw [McShan?]	Coniacian
MMNS	VP 3759	Tooth	Lowndes	MS	Lower Eutaw [McShan?]	Coniacian

Table 3. Hadrosaur specimens, *continued.*

Institution	Collection Number	Material	County	State	Formation	Age
MMNS	VP 3777	Tooth	Lowndes	MS	Lower Eutaw [McShan?]	Coniacian
MMNS	VP 3058	Vertebrae, caudal, proximal	Clay	MS	Mooreville Chalk	Santonian-Campanian
MMNS	VP 3073	Postzygaphosis	Monroe	MS	Mooreville Chalk	Santonian-Campanian
MMNS	VP 3039	Phalanx, pedal, partial	Monroe	MS	Mooreville Chalk	Santonian-Campanian
MMNS	VP 3053	Phalanx, ungual	Monroe	MS	Mooreville Chalk	Santonian-Campanian
MMNS	VP 3042	Vertebra, caudal	Unknown	MS	Mooreville Chalk?	Santonian-Campanian
MMNS	VP 2991	Tibia, left, distal	Lowndes (or Clay)	MS	Mooreville, lower	Santonian-Campanian
MMNS	VP 3046	Vertebra, caudal	Monroe	MS	Selma Group	Santonian-Maastrichtian
MMNS	VP 3047	Vertebra, caudal	Monroe/Lee	MS	Selma Group	Santonian-Maastrichtian
MMNS	VP 3043	Tibia?, left, proximal	Unknown	MS	Selma Group	Santonian-Maastrichtian
MMNS	VP 3059	Sacral centra?, caudal centra?, right ulna (2 pieces), distal right MT4, prox phalanx #4, neural arch caudal vertebra & neural arch ant thoracic vertebra	Lowndes	MS	Tombigbee Sand Mbr., Eutaw Fm.	Late Santonian-early Campanian
MMNS	VP 4757	Humerus, left, partial	Lowndes	MS	Tombigbee Sand Mbr., Eutaw Fm.	Late Santonian-early Campanian
MMNS	VP 5510	Teeth, crowns	Lowndes	MS	Tombigbee Sand Mbr., Eutaw Fm.	Late Santonian-early Campanian
MMNS	VP 5947	Caudal vertebra	Lowndes	MS	Tombigbee Sand Mbr., Eutaw Fm.	Late Santonian-early Campanian
MMNS	VP 5952	Tooth	Lowndes	MS	Tombigbee Sand Mbr., Eutaw Fm.	Late Santonian-early Campanian
MMNS	VP 3037	Tooth	Lowndes	MS	Unspecified	Unknown
MOG	no number	Limb, pelvic, and vertebrae	Lee	MS	Demopolis Chalk	Campanian
MOG	no number	Leg bone	Lee	MS	Demopolis Chalk	Campanian
MOG	no number	Toe bone	Lee	MS	Demopolis Chalk	Campanian
PPM	1990.47.1	Tooth	Prentiss	MS	Coffee Sand	Campanian
PPM	1991.29.1	Tooth	Prentiss	MS	Coffee Sand	Campanian
PPM	1997.16.2	Vertebra	Prentiss	MS	Tombigbee Sand Member, Eutaw Fm.	Late Santonian-early Campanian
PPM	1998.1.18	Tooth	Prentiss	MS	Tombigbee Sand Member, Eutaw Fm.	Late Santonian-early Campanian
UAM	PV2005.11.7	2 bone fragments	Lowndes	MS	Unspecified	Unknown
UAM	PV2005.5.196	1 tooth	Lowndes	MS	Unspecified	Unknown

Table 3. Hadrosaur specimens, *continued.*

Institution	Collection Number	Material	County	State	Formation	Age
USNM	PAL 175583	Skull element, right dentary, axial elements, left femur, left tibia, right proximal ulna, distal right radius, metatarsal-3+4, phalange	Lee	MS	Eutaw	Santonian
USNM	PAL 487107	Appendicular element, distal femur	Lowdnes	MS	Unspecified	Unknown
MMNS	VP 3055	Dental battery, edentulous, fragment	Clay	MS	Mooreville Chalk	Santonian-Campanian
FHMM	1989.29.1	Posterior caudal vertebra; middle caudal vertebra; large vertebral centrum	Unknown	TN	Demopolis?	Campanian
PPM	2005.6.1	Tooth	Decatur	TN	Coon Creek	Campanian-Maastrichtian
UM	no current number	Skull	Unknown	TN	Coon Creek	Campanian-Maastrichtian

Table 4. Specimens of Ankylosauria.

Institution	Collection Number	Material	County	State	Formation	Age
MCWSC	RMM 3277	1 dermal scute and associated fragments, first ankylosaur from Tombigbee member	Hale	AL	Tombigbee Sand Mbr., Eutaw Fm.	Late Santonian-early Campanian
FMNH	P 27469	Ilium	Dallas	AL	Mooreville Chalk	Santonian-Campanian
MCWSC	RMM 1224	17 vertebrae, 1 tibia, 1 neural arch, proximal portion of ischium, basisphenoid-basioccipital, anterior end of right dentary, teeth, other unidentified skull fragments. Donated by BSC,2 labels in box with two tylosaurs and a dinosaur. Partial scapula and unidentified bone.	Lowndes	AL	Ripley?	Campanian-Maastrichtian
MCWSC	MCWSC 13942	Scute, coracoid, phalange, unidentified elements	Montgomery	AL	Unspecified	Unknown
UAM	PV2005.5.192	1 (toe?) bone	Greene	AL	Mooreville Chalk	Santonian-Campanian
MMNS	VP 104	Partial presacral rod	Monroe	MS	Eutaw?	Santonian
MMNS	VP 3088	Tooth	Lowndes	MS	Lower Eutaw [McShan?]	Coniacian
MMNS	VP 5254	Tooth, with nearly complete root	Clay	MS	Tombigbee Sand Mbr., Eutaw Fm.	Late Santonian-early Campanian

Table 5. Saurischia specimens not identified to lower taxa.

Institution	Collection Number	Material	County	State	Formation	Age
AMNH	FR 21584	Phalanx	Unknown	AL or SC	Unspecified	Unknown
UAM	PV2005.5.197	Phalanx	Lowndes	MS	Unspecified	Unknown
USNM	V 4869	Appendicular elements, right femur-A-B, partial fibula	Lee	MS	Eutaw	Santonian

Table 6. Theropod specimens not identified to lower taxa.

Institution	Collection Number	Material	County	State	Formation	Age
FMNH	P 27398	Foot bone	Dallas	AL	Mooreville Chalk	Santonian-Campanian
MCWSC	RMM 2577	Bone fragments	Dallas	AL	Mooreville Chalk	Santonian-Campanian
MCWSC	MCWSC 2290	Carnosauria caudal centrum	Hale	AL	Tombigbee Sand Mbr., Eutaw Fm.	Late Santonian-early Campanian
MMNS	VP 4949	Phalanx, proximal, pedal, 3rd digit	Lowndes	MS	Eutaw	Santonian
MMNS	VP 103	Phalanx, pedal, proximal, right	Monroe	MS	Eutaw?	Santonian
MMNS	VP 113	Centrum, caudal, anterior half	Monroe	MS	Eutaw?	Santonian
MMNS	VP 3763	Vertebra, caudal	Lowndes	MS	Tombigbee Sand Mbr., Eutaw Fm.	Late Santonian-early Campanian
MMNS	VP 5597	Phalanx, proximal, proximal fragment	Lowndes	MS	Tombigbee Sand Mbr., Eutaw Fm.	Late Santonian-early Campanian
MOG	no number	Toe bone	Lowndes	MS	Tombigbee Sand Mbr., Eutaw Fm.	Late Santonian-early Campanian
PPM	1999.1.5	Carnivorous dinosaur tooth	Prentiss	MS	Tombigbee Sand Member, Eutaw Fm.	Late Santonian-early Campanian

Table 7. Ornithomimid specimens.

Institution	Collection Number	Material	County	State	Formation	Age
CCK	CCK-85-1-1	Partial proximal right tibial shaft	Stewart	GA	Blufftown	Santonian-Campanian
MMNS	VP 3087	Phalanx, ungual, pedal	Lowndes	MS	Lower Eutaw [McShan?]	Coniacian
MMNS	VP 3931	Vertebral centrum, caudal	Lowndes	MS	Tombigbee Sand Mbr., Eutaw Fm.	Late Santonian-early Campanian
MMNS	VP 5595	Ungual phalanx	Lowndes	MS	Tombigbee Sand Mbr., Eutaw Fm.	Late Santonian-early Campanian
MOG	no number	Claw	Lowndes	MS	Tombigbee Sand Mbr., Eutaw Fm.	Late Santonian-early Campanian
MCWSC	MCWSC 13939	Third metatarsal	Lowndes	MS	Tombigbee Sand Mbr./ Eutaw Fm. contact	Late Santonian-early Campanian

Table 8. Dromaeosaur specimens.

Institution	Collection Number	Material	County	State	Formation	Age
UAM	2001.1?	1 tooth	Greene	AL	Mooreville Chalk	Santonian-Campanian
CCK	CCK-93-12-1	Distal tibiotarsal	Stewart	GA	Blufftown	Santonian-Campanian
CCK	CCK-93-12-2	Distal tibiotarsal	Stewart	GA	Blufftown	Santonian-Campanian
CCK	CCK-93-12-3	Distal tibiotarsal	Stewart	GA	Blufftown	Santonian-Campanian
MMNS	VP 4882	Teeth	Lowndes	MS	Eutaw	Santonian
MMNS	VP 3051	Tooth, partial	Lowndes	MS	Lower Eutaw [McShan?]	Coniacian
MMNS	VP 4300	Tooth	Clay	MS	Tombigbee Sand Mbr., Eutaw Fm.	Late Santonian-early Campanian
MMNS	VP 5820	Tooth, partial, eroded	Lowndes	MS	Tombigbee Sand Mbr.?, Eutaw Fm.	Late Santonian-early Campanian
MCWSC	MCWSC 13940	3 teeth	Lowndes	MS	Tombigbee Sand Mbr./ Eutaw Fm. contact	Late Santonian-early Campanian
UAM	PV2000.2.2	1 small tooth	Lowndes	MS	Unspecified	Unknown

has been named – *Coelosaurus antiquus* Leidy 1865 – from the northeastern states and North Carolina (Makovicky et al. 2004; Weishampel et al., 2004). Whether the ornithomimid material from this study area is a different genus or species from that of *C. antiquus* is yet to be determined.

Dromaeosauridae

Ten dromaeosaurid specimens are recorded from the study area (Table 8). Seven specimens are teeth, and three are bone material – all specimens are from Santonian-Campanian units. Of the dromaeosaur material, only one genus has been suggested based on tooth morphology – the velociraptorine *Saurornitholestes* (Kiernan and Schwimmer, 2004).

Tyrannosauroidea

Fourteen tyrannosaur specimens are recorded from the study area (Table 9). One species is identified in the records and the holotype for that species is from Alabama – *Appalachiosaurus montgomeriensis* (McWane specimen RMM 6670). The holotype was collected in Montgomery County, Alabama, from the Campanian Demopolis Chalk. The specimen includes skull bones, two hind limbs, humerus, pelvis, vertebra, and rib and is described by Carr et al. (2005). The holotype of *A. montgomeriensis* (RMM 6670) is only one of two known tyrannosaurs identified to species from the eastern half of the country (Carr et al., 2005). This specimen is also the most complete tyrannosaur from the eastern US. Previously other tyrannosauroid material from the study area was compared with *Albertosaurus* (Schwimmer et al., 1993; Carr et al., 2005), however, currently all tyrannosauroid material from this area is now regarded as *A. montgomeriensis* (D. Schwimmer, pers. comm.).

Summary of dinosaur material by state

Geographic and Stratigraphic Distribution

Of the four states within the study area, all have yielded Late Cretaceous dinosaur specimens (Fig. 4). Records indicate 55 specimens from 11 counties in Alabama, 83 specimens from eight counties in Mississippi, 12 specimens from one county in Georgia, and three specimens from one county in Tennessee. From the recorded data, geologic units from which specimens were collected ranged from Santonian through Maastrichtian and the majority of the dinosaur material was collected from the Mooreville Chalk, Blufftown, and Eutaw Formations.

Table 9. Tyrannosauroid specimens.

Institution	Collection Number	Material	County	State	Formation	Age
CCK	CCK-83-81-7	Bone shafts (*A. montgomeriensis*)	Barbour	AL	Blufftown	Santonian-Campanian
MCWSC	RMM 6670	HOLOTYPE; Skull, 2 hind limbs, humerus, pelvis, verts, rib (*A. montgomeriensis*)	Montgomery	AL	Demopolis Chalk	Campanian
UAM	PV 85.72.76	Limb bone	Hale	AL	Mooreville Chalk	Santonian-Campanian
CCK	CCK-94-5-1	Tooth (*A. montgomeriensis*)	Bullock	AL	Blufftown	Santonian-Campanian
CCK	CCK-90-1-2	Phalangeal fragment (*A. montgomeriensis*)	Stewart	GA	Blufftown	Santonian-Campanian
CCK	CCK-85-1-2	Bone shafts (*A. montgomeriensis*)	Stewart	GA	Blufftown	Santonian-Campanian
MOG	no number	Toe bone	Monroe	MS	McShan	Coniacian
MOG	no number	Toe bone	Monroe	MS	McShan	Coniacian
MOG	no number	Vertebra	Monroe	MS	McShan	Coniacian
MOG	no number	Toe bone	Lowndes	MS	Tombigbee Sand Mbr., Eutaw Fm.	Late Santonian-early Campanian
UAM	PV2005.5.195	1 bone	Lowndes	MS	Unspecified	Unknown
UAM	PV2000.2.3	1 tooth	Lowndes	MS	Unspecified	Unknown
MCWSC	MCWSC 10942	Proximal femur	Unknown		Unspecified	Unknown
MCWSC	RMM 6150	Proximal femur	Unknown		Unspecified	Unknown

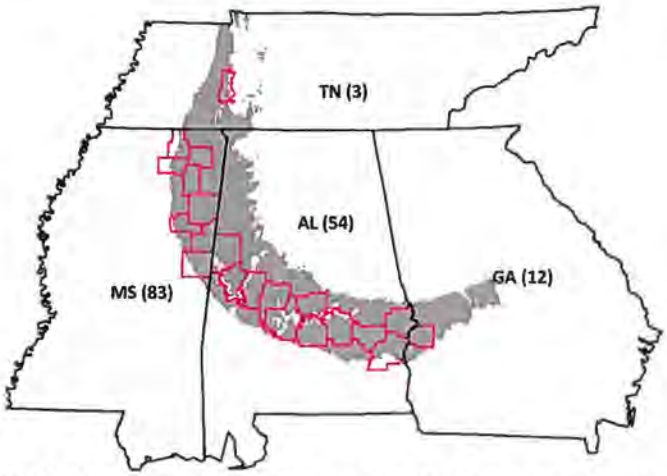

Fig.4. Dinosaur material from the study are as noted in this paper. Upper Cretaceous outcrop belts shown as gray. Counties from which dinosaur material has been collected are outlined in red. Number of dinosaur specimens are shown in each state.

Alabama

A wide outcrop belt of Upper Cretaceous units curves through Alabama from the northwestern corner down to the southeastern part of the state outlining the northern extent of the Gulf Coastal Plain. Collection of dinosaur material in Alabama dates back to the late 1800s as noted in the records of the US National Museum. Of the 55 dinosaur specimens recorded from Alabama, 36 are hadrosaur (Table 3), five are nodosaur (Table 4), four are tyrannosaur (Table 9), and one is dromaeosaur (Table 8). The remaining dinosaur material has not been identified in more detail (Tables 1, 2, 5, 6). The major-

ity of the material is held at collections within the state including the University of Alabama Museums, McWane Science Center, and Auburn University. Most specimens were collected from Santonian and Campanian units of western Alabama including the Blufftown, Mooreville Chalk, and Eutaw Formations. Two dinosaur holotypes are also from Alabama: Appalachiosaurus montgomeriensis (McWane specimen RMM 6670; Carr et al., 2005) and Lophorhothon atopus (FMNH specimen P 27383; Langston, 1960).

Also of note are the recent findings in the Ingersoll Shale Member of the Eutaw Formation in easternmost Alabama. According to Knight et al. (2011), the excavated site in Russell County contains the most feathers found in Mesozoic rocks of North America, a finding that could help expand our understanding of Late Cretaceous feathered dinosaurs.

Mississippi

In Mississippi, the Upper Cretaceous outcrop belt is found in the northeastern quadrant of the state, curving along the inflection point between the Gulf Coastal Plain and the Mississippi Embayment. A total of 83 dinosaur specimens are recorded for Mississippi. Records of collected dinosaur material go back to the late 1800s and include 41 hadrosaur (Table 3), three nodosaur (Table 4) five ornithomimid (Table 7), six dromaeosaur (Table 8), six tyrannosaur (Table 9), and 22 additional specimens not identified to family (Table 1, 2, 5, 6). While material has been collected from eight counties, the most productive sites have been those within the Santonian Eutaw Formation, particularly the upper and lower facies of the formation. The uppermost facies of the Eutaw is the Tombigbee Sand Member, considered to be a marine lag deposit (Russell and Parks, 1975).

Georgia

In Georgia, the Upper Cretaceous outcrop belt extends from west central Georgia into the central part of the state. Georgia dinosaur material includes 12 specimens – hadrosaur (Table 3), ornithomimid (Table 7), dromaeosaur (Table 8), and tyrannosauroid (Table 9). All specimens are from the Campanian Blufftown Formation in Stewart County, Georgia. Although Schwimmer et al. (1993) referred to the tyrannosauroid material as *Albertosaurus*, this may actually be *Appalachiosaurus*, which was described later by Schwimmer and others in Carr et al. (2005). Of special note are the three distal tibiotarsal specimens (CCK-93-12-1, CCK-93-12-2, and CCK-93-12-3) which represent the only dromaeosaur bone material from the study area.

Tennessee

In Tennessee, Upper Cretaceous deposits run along the eastern edge of the Mississippi Embayment cropping out in a northerly stretching belt through western Tennessee. Dinosaur material from Tennessee includes three hadrosaur specimens (Table 3). The first described dinosaur specimen from Tennessee includes hadrosaur bones (FHMM 1989.29.1) from an unknown location in western Tennessee. According to Bryan et al. (1991), the material was brought from the Tennessee Division of Geology to the University of Tennessee, Knoxville with minimal information regarding place of collection other than "west Tennessee." Gray chalky matrix on the bones yielded a Campanian nannofossil assemblage which suggests the bones may have been collected from the Demopolis Chalk (Bryan et al., 1991). Additional hadrosaur material, a partial tooth (PPM 2005.6.1) and a hadrosaur jaw found in 2009 (Markin and Gibson, 2010; UM unnumbered specimen), were collected in Decatur County from the Coon Creek Formation. The Decatur County site is the only site with known locality to produce material in Tennessee.

CONCLUSIONS

Wang and Dodson (2006) calculated that as much as 71% of dinosaur genera have yet to be identified, and the greatest dinosaur diversity is within the Campanian and Maastrichtian (Dodson, 1990). The study area has much to offer with respect to Wang and Dodson's findings given the following: 1) Of the specimens recorded, 21% have not yet been identified to lower taxa and 2) The majority of the Cretaceous outcrop belt in the study area is Campanian and Maastrichtian. Considering these points, there may be more taxa within this region waiting to be discovered and described, adding to our understanding of Late Cretaceous dinosaurian diversity, biogeography, and evolution.

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