

FOSSIL *LEMMISCUS CURTATUS* (RODENTIA, ARVICOLINAE) FROM HAGERMAN FOSSIL BEDS NATIONAL MONUMENT, IDAHO

DENNIS R RUEZ, JR¹

Department of Geological Sciences, Jackson School of Geosciences, University of Texas, Austin, Texas 78712-0254

PHILIP A GENSLER

Hagerman Fossil Beds National Monument, 221 North State Street, PO Box 570, Hagerman, Idaho 83332

ABSTRACT—We describe molars that represent the 1st fossils of *Lemmiscus curtatus* from Hagerman Fossil Beds National Monument (HAFO), Idaho. This species figures prominently in the biochronology of North American terrestrial deposits, so the possible ages of these records are discussed in detail. Most fossils from HAFO are from the middle Blancan (middle Pliocene), but these molars are likely from the Pleistocene or Holocene epoch, which is consistent with the temporal distribution of *L. curtatus* elsewhere.

Key words: *Lemmiscus curtatus*, Pleistocene, Hagerman Fossil Beds National Monument, Idaho

Approximately 1 million years of the Blancan North American Land Mammal Age (Pliocene) is recorded by the thick fluvial and lacustrine sequences of the Glenns Ferry Formation within Hagerman Fossil Beds National Monument (HAFO) in southern Idaho. The fossiliferous beds have attracted notice for decades, resulting in large collections curated at the United States National Museum, University of Michigan Museum of Paleontology, Idaho Museum of Natural History, and the on-site facility maintained today by the National Park Service (McDonald and others 1996).

Although HAFO is most famous for horse fossils (*Equus shoshonensis*), arvicoline rodents are the most abundant mammalian taxa (not the extinct beaver, *Castor californicus*, as stated by McDonald and others 1996). The extinct arvicolines, *Cosomys primus*, *Ophiomys taylori*, and *Pliopotamys minor*, are the 3 most abundant taxa and are well known in published literature (for example, Zakrzewski 1969), while another arvicoline, *Mictomys vetus*, is represented at HAFO by only 2 specimens (pers. obs.).

Because *Lemmiscus* is unknown from the Pli-

ocene elsewhere, an origin in the Pliocene-age Glenns Ferry Formation is surprising. However, derivation from Pleistocene or Holocene sediments is also problematic for the HAFO specimens. We explore both possibilities.

SYSTEMATIC PALEONTOLOGY

Lemmiscus curtatus (Cope)

Lemmiscus curtatus (Cope). Barnosky and Bell 2003: p 2587.

Diagnosis

Terminology follows Repenning (1992). Molars rootless with cement in reentrant angles. Lower 1st molar with posterior loop, 5 closed triangles, and anterior cap; labial, but not lingual, secondary wing well-developed; triangles 1 and 2 approximately equal in size (following Bell, Repenning, and Barnosky 2004).

Referred Specimens

HAFO 5881 (Fig. 1A), left lower 1st molar; HAFO 5885 (Fig 1B), left lower 1st molar. A partial right lower 1st molar, HAFO 14293, is only tentatively referred to *L. curtatus*.

Locality

HAFO locality 503, Hagerman Fossil Beds National Monument, Twin Falls County, Idaho;

¹ Present address: *Department of Geology and Geography, 210 Petrie Hall, Auburn University, Auburn, Alabama 36849-5305; ruezden@auburn.edu.*

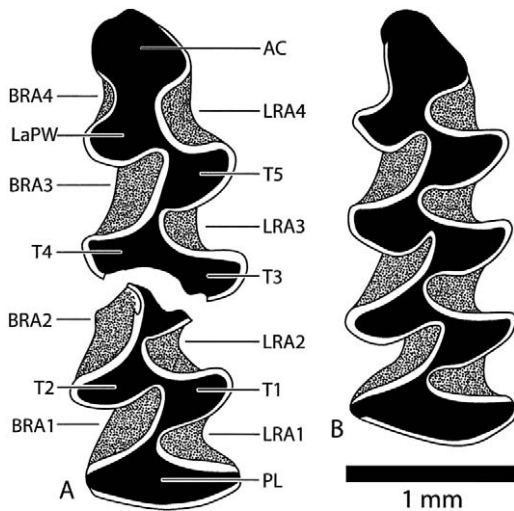


FIGURE 1. *Lemmiscus curtatus* recovered from Hagerman Fossil Beds National Monument. Enamel is white, dentine is black, and cement is stippled. Anterior is to the top of the page; labial is to the left. Abbreviations: AC, anterior cap; BRA, buccal reentrant angle; LaPW, labial primary wing; LRA, lingual reentrant angle; PL, posterior loop; T, triangle. A, HAFO 5881, left m1; B, HAFO 5885, left m1.

elevation 952 m above mean sea level (m amsl). This locality is a blowout, and fossils from it were collected directly from the surface. More precise locality information is maintained by HAFO. Although stratigraphic relationships are not firmly established, an age range for the Glens Ferry Formation at this locality can be established using recent argon-argon radiometric dates from a basaltic ash at 946 m amsl (3.79 ± 0.03 million years ago) and basalt at 960 m amsl (3.68 ± 0.02 million years ago; Hart and Brueseke 1999).

Description of the Fossil Material

Both complete molars lack roots and have cement in the reentrant angles. Each has a posterior loop (PL), 5 closed triangles, and an anterior cap (AC) with a labial, but not lingual secondary wing. Enamel interruptions occur on the anterior edge of the AC, and the labial and lingual apices of the PL. Enamel on the anterior faces of most triangles is thicker than that on the posterior face. In the buccal reentrant angles (BRA), the cement is attached to the entire length of the anterior face of the triangles, but to only slightly more than half the length

of the posterior faces. There is no cement in the 4th BRA of HAFO 5885. The extent of cement varies in the lingual reentrant angles (LRA). The 1st LRA has cement nearly to the enamel interruption at the lingual edge of the PL, but only half of the posterior face of triangle 1 is covered. The 2nd and 3rd LRAs have cement covering half of both the posterior and anterior faces of the enclosing triangles. Cement in the 4th LRA covers the entire posterolingual surface of the AC, but is variable along triangle 5.

AGE OF *LEMMISCUS CURTATUS* FROM HAFO

The presence of *Lemmiscus* figures prominently in the biochronology of Pleistocene terrestrial deposits in North America (for example, Repenning 1980, 1987; Repenning and others 1990; Bell 2000). Therefore we closely examined the age of the records of *L. curtatus* from HAFO. Early versions of arvicoline biochronology and its divisions of the North American Land Mammal Ages split the Rancholabrean Land Mammal Age (late Pleistocene) into 2 parts, with the presumed immigration of *Lemmiscus* into the New World marking the beginning of the earlier Rancholabrean I (Repenning 1980, 1987). With the recognition of a single undifferentiated Rancholabrean (Lundelius and others 1987), the Rancholabrean I was reclassified as the youngest part of the Irvingtonian Land Mammal Age (Repenning and others 1990). Subsequently, *Lemmiscus* was reported from localities that date to even earlier in the Irvingtonian (Wood and Barnosky 1994; Bell 1995, 2000; Gillette and others 1999; Bell and Barnosky 2000; Rogers and others 2000; Barnosky and Bell 2003, 2004; Bell, Repenning, and Barnosky 2004).

Fossils from this HAFO locality 503 are predominantly fish and frog elements, but 14 molars of *Cosomys primus* (HAFO 5882–5884, 5886–5896) and a right dentary with 1st and 2nd lower molars of the extinct shrew *Paracryptotis gidleyi* (HAFO 5879) are included. *Cosomys primus* and *P. gidleyi* are confined exclusively to the Blancan (~5 to 1.5 million years ago; Bell, Lundelius, and others 2004) and are abundant at many Glens Ferry Formation localities in HAFO (Zakrzewski 1969). Excluding *L. curtatus*, taxa recovered from HAFO locality 503 suggest assignment to the Blancan North American Land Mammal Age. Identification of *Lemmiscus curtatus* from this Blancan locality is

problematic because elsewhere *Lemmiscus* is not known to occur prior to about 1 million years ago (Barnosky and Bell 2004). The HAFO specimens appear similar in preservation to other teeth from the Glenns Ferry Formation; the fossils described here uniquely match the morphology of *Lemmiscus curtatus* and are inconsistent with any other known species.

Evidence for Pliocene Age

As mentioned, only the identification of *Lemmiscus curtatus* conflicts with the Blancan age assessment for HAFO locality 503. The fossil molars were collected concurrently with typical Blancan taxa. These new records of *Lemmiscus* from HAFO are fossil specimens and show the same preservation as that seen on most teeth derived from the Glenns Ferry Formation at HAFO.

There are multiple lines of evidence to support the hypothesis that the fossils were not transported or reworked. First is the presence of at least 2 individuals of *Lemmiscus*, but no other specimens of Pleistocene/Holocene forms. Second, because of the fragile nature of the fossils (HAFO 5881 was damaged after collection), significant transport would destroy the specimens. Finally, the position of HAFO locality 503 and exposures of Pleistocene/Holocene sediments make transportation unlikely.

Most of the sediments near HAFO locality 503 are exposures of the Pliocene Glenns Ferry Formation. The Tuana Gravel, which caps the Glenns Ferry Formation to the west of HAFO, is the origin of a few mammalian fossils (Schultz and others in Malde and Powers 1962; Sadler and others 1997), but the coarse nature of much of the sediments makes preservation of such small rodent teeth unlikely. Additionally, the age of the Tuana Gravel is late Pliocene (Amini and others 1984; Malde 1991), which is also much older than previously accepted fossil *Lemmiscus*.

Pleistocene and Holocene sediments in the HAFO area are minor amounts of Yahoo Clay, Crowsnest Gravel, and alluvium. Exposures of both Yahoo Clay and Crowsnest Gravel are approximately 1.5 km south of HAFO locality 503. The intermediate topography, however, is rough and would require transportation over several ridges exceeding 100 m. HAFO locality 503 is nearly 2.5 km from the nearest mapped alluvium deposits (Malde and Powers 1972).

The late Pleistocene Yahoo Clay consists of lake sediments resulting from the impounding of the Snake River by the McKinney Basalt (Malde 1982, 1991). The collections at HAFO contain 5 vertebrate fossils (HAFO localities 418–419) with field documentation (housed at HAFO) noting derivation from the Yahoo Clay, but locality data are incomplete and the fragmentary nature of the fossils precludes identification more precise than Mammalia. No fossils are currently known from the late Pleistocene Crowsnest Gravel or the Holocene alluvium deposits.

To examine the possibility that unknown Pleistocene or Holocene fossiliferous sediments exist near HAFO locality 503, fossils from nearby sites were examined. Within about a 100-m radius of locality 503 there are 18 documented fossil-producing sites, but there is no evidence of Pleistocene/Holocene species in any of these localities. Additionally, sediment attached to the teeth is consistent with that of the Glenns Ferry Formation.

Evidence for Pleistocene/Holocene Age

All previously documented fossils of *Lemmiscus* are from localities demonstrated to be Pleistocene or Holocene in age. More specifically, based on the relatively similar-age earliest occurrences in the Porcupine Cave Pit sequence, Colorado; SAM Cave, New Mexico; and Cathedral Cave, Nevada, the origin of *Lemmiscus* was estimated at just prior to about 840 thousand years ago (Barnosky and Bell 2003).

In SAM Cave, New Mexico, teeth referable to *Lemmiscus* were recovered from a stratigraphic section that includes paleomagnetic data, and from 4 isolated deposits within the cave that were determined biochronologically to be older than all levels of the stratigraphic section (Rogers and others 2000). All specimens of *Lemmiscus* in the stratigraphic section occur below the Bruhnes-Matuyama magnetic reversal (Rogers and others 2000), which is dated at 0.78 million years ago (Berggren and others 1995). The co-occurrence of *Allphaiomys* and *Mictomys kansansensis* was used to bracket the age of the *Lemmiscus*-bearing isolated deposits at SAM Cave to between 1.3 and 0.85 million years ago (Rogers and others 2000). The older bracketing age is still about 2.5 million years younger than the Glenns Ferry Formation at HAFO locality 503.

In the Porcupine Cave Pit sequence (PCPS),

Colorado, specimens of *Lemmiscus curtatus* are present in levels 1 through 10 (Barnosky and Bell 2003). Sediments below level 7 were deposited during an interval of reversed magnetic polarity and therefore considered older than the Bruhnes-Matuyama boundary (Barnosky and others 1996; Bell and Barnosky 2000). Subsequently, levels 4 through 10 were interpreted as being older than the Bruhnes-Matuyama boundary, but there is no indication of any levels older than about 1 million years (Barnosky and Bell 2003, 2004).

The co-occurrence of *L. curtatus* with *Phenacomys gryci* at Cathedral Cave, Nevada (Bell 1995; Owen and others 2000), suggests a similar age to the older deposits in the PCPS. There are no published descriptions of the rodents from this site, however, and the chronology of the deposits is still being studied (CN Jass, The University of Texas at Austin, Austin, TX, pers. comm.).

In spite of the long history of paleontological work on the Glens Ferry Formation at HAFO (for example, McDonald and others 1996), *Lemmiscus* was not reported previously. Additionally, *Lemmiscus* is not known from younger portions of the Glens Ferry Formation (for example, Conrad 1980; Repenning and others 1995). The lack of *Lemmiscus* from any other locality in the well-studied Pliocene-age Glens Ferry Formation suggests an origin for fossils described above in Pleistocene or Holocene sediments, in congruence with the currently known temporal range of *L. curtatus*.

CONCLUSIONS

Fossils of *Lemmiscus curtatus* from HAFO are problematic regardless of age assignment. If these specimens were derived from the Pliocene Glens Ferry Formation, the temporal distribution of *Lemmiscus* is increased nearly 4-fold. If the specimens are late Pleistocene or Holocene in age, the sediments from which they are derived is unknown and their presence with typical Blancan taxa is puzzling.

HAFO locality 503 could have been exposed at the surface as early as the late Pleistocene during the repeated scouring of the Hagerman Valley by the Snake River. Subsequent to these erosive events, damming of the Snake River allowed deposition of sediments (such as the Yahoo Clay) directly on the Pliocene Glens Ferry Formation. The fossils of *L. curtatus* described

above could have been deposited in this lacustrine setting, or afterwards as an isolated event, such as a raptor pellet. Deposition directly on exposed surfaces of Glens Ferry Formation could cause Pleistocene/Holocene fossils to seemingly co-occur with the typical Pliocene species. All the fossils, both Pliocene and Pleistocene/Holocene, would then be influenced by the mineralogical conditions of the Glens Ferry Formation, and alteration of all the fossils, and their resulting appearance, might be similar.

We tentatively suggest that the specimens of *Lemmiscus curtatus* from HAFO were deposited during the late Pleistocene or early Holocene. This scenario is consistent with the known temporal distribution of *Lemmiscus* elsewhere and the timing of relatively recent deposits at HAFO. However, we cannot completely discount the possibility of an origin for these fossils in the Pliocene Glens Ferry Formation; this is important because of the large temporal extension of *L. curtatus* that would be required in order to recognize a range into the middle Pliocene.

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