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A Primary Mammoth Site with Associated Fauna in Pottawattamie County, Iowa

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SYNOPSIS. A primary mammoth site with associated fauna in Pottawattamie County, Iowa. *Proc. Iowa Acad. Sci.*, 79(2):62-65, 1972. In August 1970, an investigation was made of the remains of a mammoth, *Mammuthus* cf. *M. columbi,* exposed west of Oakland, in Pottawattamie County, Iowa. A segment of proboscidian tusk, a lower third molar, and additional skeletal fragments were collected from the Wisconsin loess. Associated with the mammoth was a small-mammal fauna consisting of *Phenacomys intermedius* (heather vole), *Microtus pennsylvanicus* (meadow vole), and *Vulpes vulpes* (red fox), extant species with an area of sympatry immediately north of the Minnesota-Canadian border. This fauna, here designated the Oakland local fauna, supports cooler summers in western Iowa during Wisconsin loess deposition.

INDEX DESCRIPTORS: Vertebrate paleontology; Pleistocene stratigraphy; Proboscidian identification; small-mammal sympatry; paleoclimatology; Oakland local fauna, Pottawattamie County, Iowa.

During the first week of August 1970, a road-grading crew working on County Highway G-42 west of Oakland, Iowa, unearthed the remains of an Ice Age mammoth. The Pottawattamie County Highway Engineer, Paul Mahoney, contacted the Assistant State Archaeologist, Adrian Anderson, who was working near Glenwood with a small field party. Anderson's examination yielded one well-preserved molar and further exposed part of a tusk which had been sheared by the road-grading equipment. The find was reported to the Iowa Geological Survey and Department of Geology at the University of Iowa. On August 10th the authors made an investigation of the site in order to recover portions of the skeleton for identification, to determine its stratigraphic position within the Pleistocene sediments, and to search for possible association with early man and other mammals.

STRATIGRAPHY

The site is located at the crest of the west valley wall of the West Nishnabotna River, in a road cut which has exposed a Pleistocene section from Yarmouth through Wisconsin age. The skeletal material was exposed in the south face of the road cut, in Wisconsin loess. A summary of the stratigraphic sequence is presented below.

South side of County Highway G-42, two miles west of Oakland; NE/c, NW 1/4, NE 1/4, SW 1/4, Sec. 10, T. 75 N., R. 40 W., Pottawattamie County, Iowa. (See Oakland, Iowa, 7 1/2′ topographic quadrangle.)

Unit	*Description*	*Approx. thickness* (feet)
	Quaternary System	
	Pleistocene Series	
	Wisconsin	
	Peorian Loess	
4.	Loess: grayish-orange (10YR 7/4, "Rock Color Chart," National Research Council, 1951, based on the Munsell System; samples dry) to pale yellowish-brown (10YR 6/2), slightly calcareous, slightly micaceous, weakly mottled with iron and manganese oxides; contains carbonate concretions and fossil gastropods throughout; upper 18 inches contains surface soil, moderate yellowish-brown (10YR 5/4), non-calcareous, slightly micaceous	17′
3.	Loess: very pale yellowish-brown (10YR 7/2), leached, increased clay content, weakly mottled with manganese oxide, very slightly micaceous, no fossil gastropods; lower 18 inches fossil-bearing, yielding a segment of mammoth tusk, lower third molar and other mammoth skeletal fragments, and an associated small-mammal fauna	3′
	Basal Wisconsin Paleosol	
2.	Loess: light brown (5YR 6/4) to pale yellowish-brown (10YR 6/2), non-calcareous, clay content increases from top to base, traces of carbon, slightly mottled with manganese oxide, very slightly micaceous, weak platey structure	4′
	Sangamon Paleosol	
1.	Clay: light brown (5YR 5/6), non-calcareous, small manganese-oxide pellets, trace of medium sand-sized quartz grains, hard	1′
	Illinoian	
	Loveland Loess	
	Yarmouth Clay	
	Section covered at this point, but exposed down-slope at eastern end of the roadcut.	

The fossil-bearing zone is overlain by approximately 17 feet of calcareous Wisconsin loess described as Unit 4. Beneath this calcareous interval is a leached zone approximately three feet thick (Unit 3), the lower 18 inches of which has yielded the fossil vertebrates. The most distinct contact in the section is below the base of the mammoth horizon. Here, a sharp color change from the lighter-colored, over-lying Wisconsin loess to a dark basal Wisconsin paleosol (Unit 2) presents a strong reference plane (William H. Allen, Jr., Iowa State University, February 15, 1971, personal communication). Because of the differences in composition and structure between these two units, ground water has percolated along the contact and leached the zone above the paleosol. This probably accounts for the absence of gastropods and for the generally delicate condition of the fossil vertebrates. The basal Wisconsin paleosol (Unit 2) contains less organic carbon than is characteristic of the unit in other areas, and is more reddish in contrast to a usual brown color. This may be the result of incorporation of reworked Sangamon material from higher slopes during deposition. The contact of

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the basal Wisconsin paleosol with the underlying reddish, clayey, Sangamon paleosol (Unit 1) is gradational. An additional section exposed toward the eastern end of the roadcut shows the Sangamon paleosol to be developed in Loveland (Illinoian) loess, which is in turn underlain by a blocky, pinkish-brown clay considered to be Yarmouth (William H. Allen, Jr., Iowa State University, December 1, 1970, personal communication). No till was observed in the exposure.

Organic material obtained from the basal Wisconsin paleosol near Hancock, Iowa, about five miles to the north, yielded dates of 22,750 ± 600 years B.P. and 22,200 ± 500 years B.P. (Ruhe, in press). As the Oakland local fauna is situated immediately above the contact with this basal Wisconsin zone, these dates indicate a maximum possible age for the mammoth and smaller mammals.

SYSTEMATIC PALEONTOLOGY

Order Lagomorpha

cf. *Lepus* or *Sylvilagus* snowshoe hare or cottontail rabbit
Material: left upper molar, left lower molar, left M_3, right P^2. S.U.I. 35218. Identified by Holmes A. Semken.

Order Rodentia

Phenacomys intermedius Merriam 1889. heather vole
Material: left M_1, S.U.I. 35220. Identified by Holmes A. Semken. *Phenacomys* cf. *P. ungava* has been reported from Iowa Co., Wisconsin by Rasmussen (1971), but the genus is rarely recorded in deposits of Wisconsin age in the north-central United States.

Microtus pennsylvanicus (Ord) 1815. meadow vole
Material: right M_1, S.U.I. 35219. Identified by Holmes A. Semken.

Order Carnivora

Vulpes vulpes (Linn.) 1758. red fox
Material: left P^2 - P^4, partial M^1, associated jaw fragments, S.U.I. 35296. Identified by Leo Carson Davis.

The fox remains were recovered within one foot of the mammoth tusk and approximately six inches below its stratigraphic position. The teeth were discovered in normal arrangement with the occlusal surfaces up. Postdepositional deformation resulted in a distance from the anterior margin of the P^2 to the posterior margin of the P^4 of 47.4 mm. Comparable measurements on Recent red fox skulls are 34.2 and 32.9 mm. This difference indicates considerable deformation of the jaw and prohibits measurement of the original tooth-row length.

When the length and anterior width of the fossil P^4 is compared to similar measurements on Recent red foxes (Figure 1), the Oakland specimen is within the range of variation characteristic of Indiana and Michigan individuals. Figure 1 suggests the presence of a north-south cline for this parameter of P^4's in red foxes. Churcher (1959) presents more evidence for geographic variation in *Vulpes*.

Order Proboscidia

Mammuthus cf. *M. columbi* (Falconer) 1857. Columbian mammoth.
Material: right M_3, S.U.I. 34868. Overall length–310 mm.; length of worn portion of crown–210 mm.; 25 ridge-plates

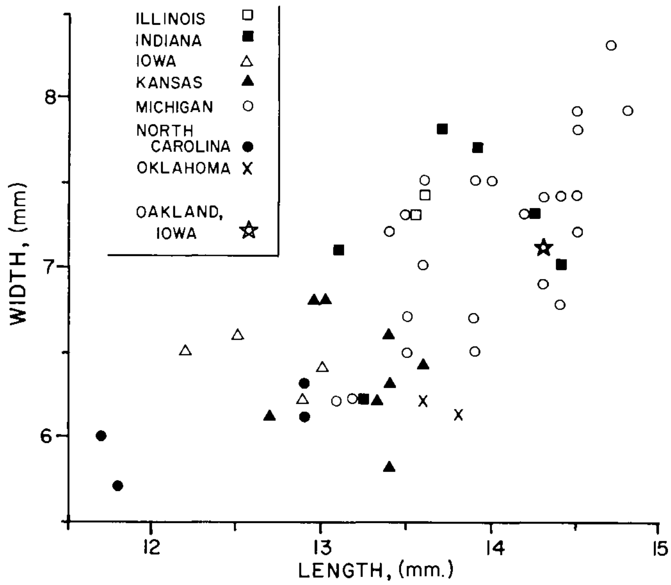

Figure 1. Scatter diagram of length vs. anterior width of P^4 in recent specimens of *Vulpes vulpes* compared with Oakland specimen.

with 17 within occluded portion; average ridge-plates per 100 mm.–8.3; maximum width of crown across occlusal surface–88 mm.; maximum width of molar at base–88 mm.; maximum height–161 mm.; estimated height before wear–210 mm.; average ridge-plate thickness on occlusal surface –5.3 mm.; average enamel thickness on occlusal surface–2.5 mm.; crimped enamel only on unworn plates and four posterior plates of the occluded surface; angle of occlusal plane–63° to 72°. A partial right tusk, S.U.I. 34869, consisting of only the posterior four feet and eight inches is preserved. Fragments of other teeth, tusk, and bone were recovered during excavation but not preserved. Identified by Ralph E. Eshelman. All specimens of the Oakland local fauna are reposited at the Department of Geology, University of Iowa (S.U.I.)

Skeels, (1962, p. 116) differentiates between species of mammoths on number of molar ridge-plates per 100 mm., thickness of enamel, and anterior-posterior distance between plates. However, other than Aguirre's (1969) paper on the "Evolutionary History of the Elephant," in which he gives some data on enamel thickness and lamellar spacing, few comparative measurements are available.

Meiring (1955), utilizing Arambourg's (1938) method in studying the width and height of South African mammoth teeth, demonstrated that a graphic comparison of the width/height index (width X 100/height) was more useful for taxonomic purposes than the commonly used length/width index (length X 100/width). By the former index, teeth which are broken or only partially complete can be tentatively classified.

Cooke (1961), building upon Arambourg's (1938) ratio of height/breadth as a measure for hypsodonty, proposed the ratio of height X 100/breadth and called it the "index of hypsodonty". Cooke found that this "index of hypsodonty" combined with the length/lamellae ratio provided a useful method for graphically representing dimensional features of elephant molar teeth. Aguirre (1969) plotted the "index of hypsodonty" for 43 upper and lower molars of American mammoths against the functional density of plates (Q), where "Q" is equal to 100 X the number of plates functioning in the occlusal surface/length of occlusal surface. Aside from Aguirre's work, the paper by Whitmore, *et al.* (1967), is the only other published work on North American elephants which utilizes the "index of hypsodonty" with lamellar frequency to separate mammoth teeth into species.

The authors feel that both Aguirre's (1969) and Whitmore's (1967) techniques, which use modifications of Cooke's "index of hypsodonty", are the best methods for determining species of mammoths from molars. This is true because as the molars erupt, they move forward along the jaw while being worn. During this process the tooth rotates in a plane parallel to the orientation of the jaw, so that the angle between the occlusal surface and the enamel plates is constantly changing (Whitmore). In addition, the enamel plates diverge ventrally (with wear there are fewer plates per equal anterior-posterior distance), making it difficult to compare teeth at different stages of wear. The graphic representations used by Whitmore and Aguirre attempt to minimize these variables.

Aguirre's (1969, p. 1373) plot of third molars of American mammoths attempts to minimize variations between different molars (M_1 - M_3) of one species. This still does not nullify variation between superior (upper) and inferior (lower) molars as noted by Osborn (1942). The Oakland mammoth tooth, a lower right third molar, when plotted on Aguirre's graph (Fig. 2), falls within the lowermost range of *Mammuthus columbi* and within the range of *M. jeffersoni.* However, Aguirre (1969, p. 1373) did not regard the characteristics of *M. jeffersoni* as diagnostic. If the Oakland molar is plotted following Whitmore, *et al.* (1967), the tooth falls within the range of both *M. primigenius* and *M. jeffersoni.*

Based on the enamel thickness (*Mammuthus primigenius* 1.2 to 2.1 mm.; *M columbi* 1.8 to 2.4 mm.) from Aguirre's (1969, p. 1367) paper, the Oakland tooth (2.5 mm.) compares favorably with the measurements of *M. columbi.* The Oakland tooth is certainly not referable to *M. primigenius.* Enamel thickness for *M. jeffersoni* was not included in Aguirre's work.

Based on the belief that *Mammuthus columbi* is part of a single lineage initiated with *M. meridionalis* in the Old World and followed by *M. imperator* and *M. columbi,* intermediate specimens should be found which cannot be placed absolutely in any of these arbitrary taxa (Vincent J. Maglio, Harvard University, April 19, 1971, personal correspondence). Whether *M. jeffersoni* is a species in its own right, or a northerly distributed subspecies of *M. columbi,* will only be settled by further study. The Oakland specimen appears to be intermediate between *M. columbi* and *M. jeffersoni.* The authors therefore regard the Oakland mammoth as *M.* cf. *columbi.*

CLIMATIC INTERPRETATIONS

The distribution of *Phenacomys intermedius* largely determines the area where the three extant identifiable species coexist. This area of sympatry (Figure 3) includes most of southern Canada, except for the coast of British Columbia and the grasslands of Alberta and Saskatchewan. It extends into the Yukon and Northwest Territories of Canada and the Rocky Mountain areas of the United States.

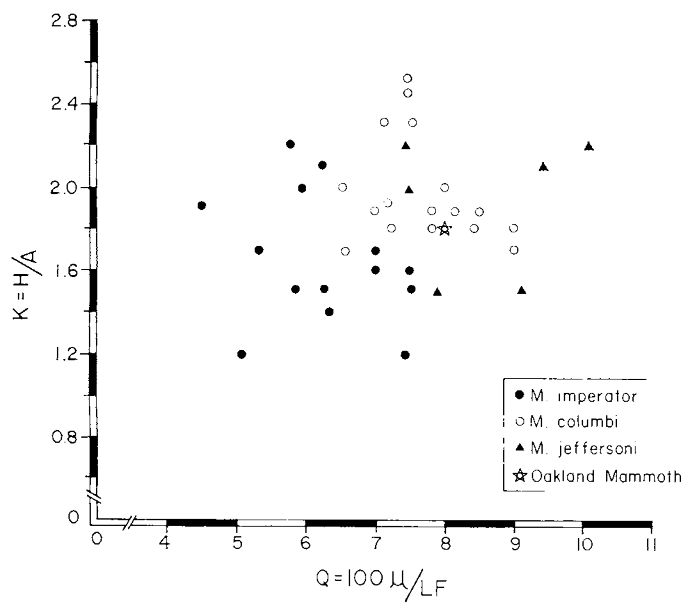

Figure 2. Plotting of 37 specimens of the third molars of *Mammuthus columbi, M. jeffersoni, M. imperator,* and the Oakland mammoth tooth relative to hypsodonty (K) and functional plate-density (Q). Modified after Aguirre (1969, p. 1373).

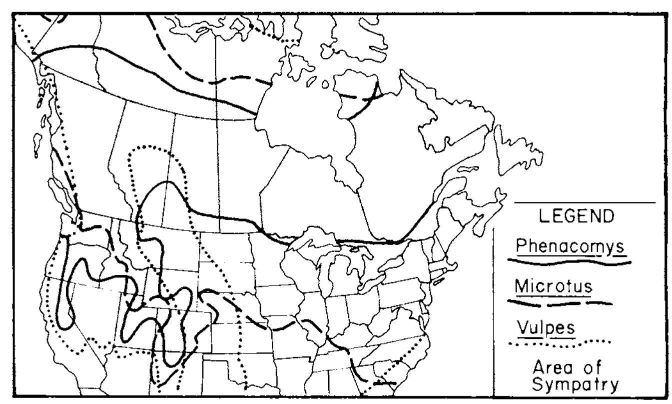

Figure 3. Area of sympatry for the Oakland local fauna as defined by the distributions of *Phenacomys intermedius, Microtus pennsylvanicus,* and *Vulpes vulpes.* Mammal distributions after Burt and Grossenheider (1964).

Essentially, this area is the spruce-moose biome (coniferous forest) of Shelford (1945) or the Hudsonian and Montanian biotic provinces of Dice (1952). In the Köppen classification of climate the area of sympatry is expressed as H (undifferentiated highlands) in the western United States and Dcf (humid microthermal, subarctic) through most of Canada. As "undifferentiated highlands" does not describe

Iowa, the latter category, Dcf, is more appropriate. It implies cool, short summers with fewer than four months of the year over 50°F (10°C), the warmest month having an average temperature less than 71.6°F (22°C). These parameters suggest the conditions in southwest Iowa at the time the Oakland local fauna lived.

Southwest Iowa today is in the grama grass-antelope biome (grassland) of Shelford and the Illinoian biotic province of Dice. Its Köppen classification is Daf, again implying a humid microthermal climate with no dry season. This is a humid continental climate with long, hot summers in which the average temperature of the warmest month is over 71.6° F.

CONCLUSIONS

The Oakland mammoth is of interest because the nature of the skeletal remains indicates that the animal died at this location (a primary site), rather than being redeposited subsequent to death (a secondary site). This is demonstrated by the variety of elements recovered and the association with an upland loess deposit. Lack of articulation and the fragmentary nature of the mammoth bones indicate scavenger activity and some exposure to weathering. However, preservation of the bones at this location also indicates rapid deposition of loess, a circumstance noted by Ruhe (in press) to have followed development of the basal Wisconsin paleosol.

The fauna associated with the mammoth provides one of the few instances in which climate can be inferred from vertebrates for *Mammuthus* and for the late Wisconsin in the north-central United States. Study of the area of sympatry for the small-mammal fauna indicates a colder climate and a coniferous flora in southwest Iowa at the time *Mammuthus* cf. *columbi* occupied the region. No evidence of early man was found associated with the site.

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