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THE ALTON MAMMOTH *(MAMMUTHUS COLUMBI JEFFERSONII)* LOCALITY,CRAWFORD COUNTY, SOUTH-CENTRAL INDIANA

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ABSTRACT: Remains of a nearly full grown adult Jefferson's mammoth *(Mammuthus columbi jeffersonii)* were recovered from fine-grained sediments on an Ohio River terrace in Crawford County, Indiana. The skeleton was partially articulated in a sternally recumbent position, a "sudden death posture" in modern elephants. The remains were badly disintegrated, and only a few elements survived well enough for consolidation. Lamellar frequency, enamel thickness, and other dental criteria support the identification of *M. c. jeffersonii,* the only species of mammoth as yet recovered in Indiana. The exact age of the remains is uncertain, but there is evidence for middle Wisconsinan deposition. The associated fauna was sparse but included remains of the heather vole *(Phenacomys intermedius)* and the southern red-backed vole *(Clethrionomys gapperi),* which today have an area of sympatry in the cool, northern forests of Canada and on mountain tops in the western United States. These voles suggest cooler summer temperatures during deposition of the fauna.

INTRODUCTION

Mammoth remains are known from many Indiana localities (e.g., Hay, 1912, 1923; Richards, 1984), and all remains appear to be of the Jefferson's mammoth *(Mammuthus columbi jeffersonii),* although there is not a consensus on which name to apply to the various taxa (Skeels, 1962; Aguirre, 1969; Maglio, 1973; Madden, 1978; Kurten and Anderson, 1980; Graham, 1986). Jefferson's mammoth is thought to have inhabited open prairies, feeding primarily upon grasses, though it was also capable of browsing; it became extinct about 11,000 years ago (Haynes, 1990; Kurten and Anderson, 1980). Only one Indiana mammoth (Haley site) has been systematically excavated from primary context using supportive interpretive studies (Pace, 1976). None of the Indiana mammoth studies have included washing sediments to recover small vertebrates, which provide information on environmental conditions during deposit formation.

On December 19, 1989, bulldozer operator Richard McLaine cut through portions of tusk and large teeth while grading an access road at a proposed resort site just east of Alton, Crawford County, south-central Indiana. The remains were encountered at approximately 440 feet above sea level, ½ mile ENE of the confluence of the Little Blue River and the Ohio River (NE¼, SE¼, SE¼, SE¼, Sec. 33, T4S, R1E, Alton Quad.). McLaine took a tooth to the Floyd County Historical Museum and was referred to Philip DiBlasi, Department of Archaeology, University of Louisville, who identified the tooth as that of a mammoth *(Mammuthus).* When notified, the author (Indiana State Museum) contacted the property owner for permission to investigate the locality. On December 28, 1989, Donald Cochran, William Wepler, and the author met with McLaine at the discovery site. Portions of tusk, a disintegrated mandible with a shattered tooth, a decomposed cervical vertebra, and portions of a rib were located *in situ,* the latter extending under an undisturbed bank. The "Alton Mammoth" appeared to be in primary context in an unusual upland setting. Additional elements appeared to be present in undisturbed soils, presenting an opportunity to wash the sediments for small vertebrates. Delay of pending construction and especially digging at the site by vandals forced the immediate excavation of the site.

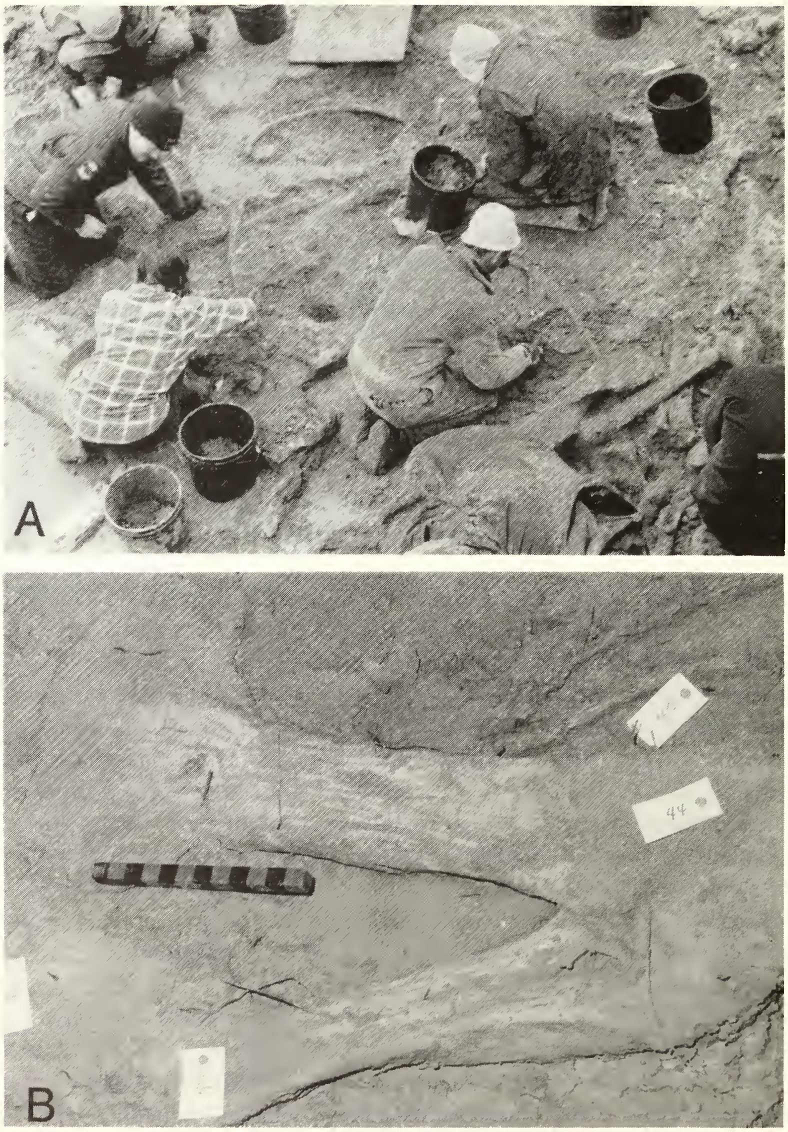

Figure 1. **A**. Alton mammoth during January, 1990 recovery (view toward east). Note flexed position of left humerus, ulna, and radius (lower right corner). **B**. Flexed right rear leg (#44, femur; #45, tibia). Scale in inches.

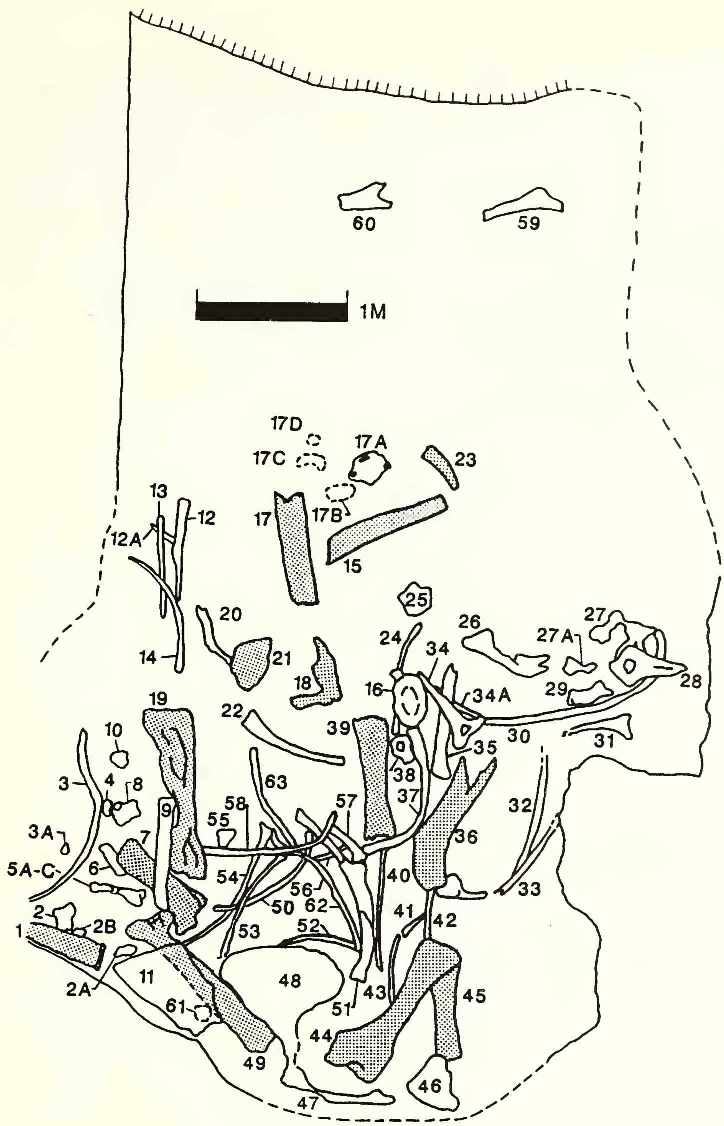

Figure 2. Plan view of field sketch of bone distribution of Alton mammoth, Crawford County, Indiana. Top of the map is north. Tusk(s), mandible, and major limb bones (stippled) indicate a sternally recumbent position with limbs flexed up under the body. Numbered elements: 1. L tibia; 2. L calcaneum and epiphysis; 2A. L navicular; 2B. L cuboid; 3. L (?) rib; 3A. ? bone; 4. L radius, distal epiphysis; 5A-C. L metacarpal II and epiphysis, L trapezoid, and L trapezium; 6. L metacarpal III and epiphysis; 7. L ulna; 8. L ulna, distal epiphysis; 9. L radius; 10. L magnum; 11. L (?) scapula; 12. ?; 12A. ?; 13. ? rib; 14. L (?) rib; 15. tusk section; 16. atlas; 17. tusk section; 17A. cervical vertebra; 17B-D. ? bone; 18. mandible, R ramus with m3; 19. L humerus; 20. rib, in part; 21. mandible, L ramus with tooth portion; 22. L (?) rib #1; 23. tusk portion; 24. rib; 25. cervical vertebra; 26. ? vertebra, in part; 27. ? podial, in part; 27A. ? vertebra portion; 28. thoracic vertebra; 29. metapodial; 30. R (?) rib; 31. ?; 32. rib; 33. rib; 34. thoracic vertebra; 34A. rib; 35. ? R radius; 36. R ulna; 37. rib; 38. axis, dens up; 39. R humerus; 40. rib; 41. ? rib; 42. rib; 43. rib; 44. R femur; 45. R tibia; 46. ? ilium of innominate; 47. ? innominate; 48. ? L ilium of innominate; 49. L femur; 50. rib; 51. rib and neural arch of thoracic vertebra; 52. rib; 53. rib; 54. rib; 55. ? vertebral centrum; 56. rib; 57. rib; 58. rib; 59. neural spine, thoracic vertebra; 60. ?; 61. L astragalus; 62. rib; 63. rib.

MATERIALS AND METHODS

Field excavation extended from January 17 through 20, 1990. The daily crew ranged from seven to twenty-two persons, largely of Indiana Department of Natural Resources staff and volunteers, and volunteers from nearby towns. Heavy and intermittent rain along with cool temperatures throughout the project hindered excavation. A backhoe and shovels were used to remove overburden and disturbed soils. Undisturbed bones were marked and left on blocks of sediment while exposing as much of the skeleton as possible (Fig. 1A). The bone was soft and minutely fractured, and many elements were heavily penetrated by rootlets. Some elements were so badly disintegrated that they were recognized only as discolorations and textural anomalies in the soil. A 2 m deep trench was dug across the north side of the site to determine lateral and vertical displacement of the skeleton. The skeleton itself served as the unit of excavation, so a gridding system was not employed. The site location was triangulated by use of a theodolite. Individual elements were mapped, numbered, and tentatively identified in the field (Fig. 2). Many elements could not be identified due to disintegration and obscuring muds. Bones were exposed using trowels and wooden awls and washed with brush and water prior to photography (Fig. 1B). Approximately 0.33 m^3 (87 gallons) of sediments were removed from near the bases of skeletal elements to be later washed to recover microfauna. Length measurements were taken on the larger bones while *in situ,* anticipating that the bones would fragment upon removal. Because the skeleton was badly disintegrated, the better preserved long bones (L femur and L tibia) were removed in plaster jackets; all other elements were removed with supporting sediments. This allowed detailed examination of elements in the lab for pathology, better identification of elements, collection of evidence of postdepositional disturbance (e.g., rodent gnawings), and provided an additional 25 gallons of sediment for recovery of associated microfauna and potential cultural debris.

After excavation, Gordon Fraser, Indiana Geological Survey, took sediment samples for textural analysis, and made observations on the geological context of the deposit. The site has since been destroyed by construction activities.

In the laboratory, bones and encasing sediments were slowly dried in plastic bags, somewhat hardening the bones. Better preserved items were cleaned on one side with a soft jet of water, dental picks, and brushes to clear away deflocculating silts. When dry, the cleaned surfaces were saturated with glyptal consolidant. The procedure was repeated for the other side of the bone, and the more stable podials were later immersed in consolidant. Disintegrated remains were cleaned under a soft jet of water to recover the more durable cortical bone surfaces. Tooth portions were consolidated in glyptal under vacuum. Broken tooth and bone parts were mended with Elmers E601 epoxy. Approximately 0.42 m^3 (112 gallons) of soil recovered both from the field and laboratory were washed through 1.2 mm mesh hardware cloth for the recovery of small vertebrates. Additional bone-contact soil samples were sent to the Indiana Geological Survey for textural analysis. Approximately 1000 g of mammoth limb bone were submitted to Beta Analytical, Inc. for radiocarbon dating.

Abbreviations used in this report include: L, R, left, right; I, M, upper incisor and molar, respectively; i, m, lower teeth; MNI, minimum number of individuals; NIP, number of identified pieces; inc., incomplete; and asl, above sea level.

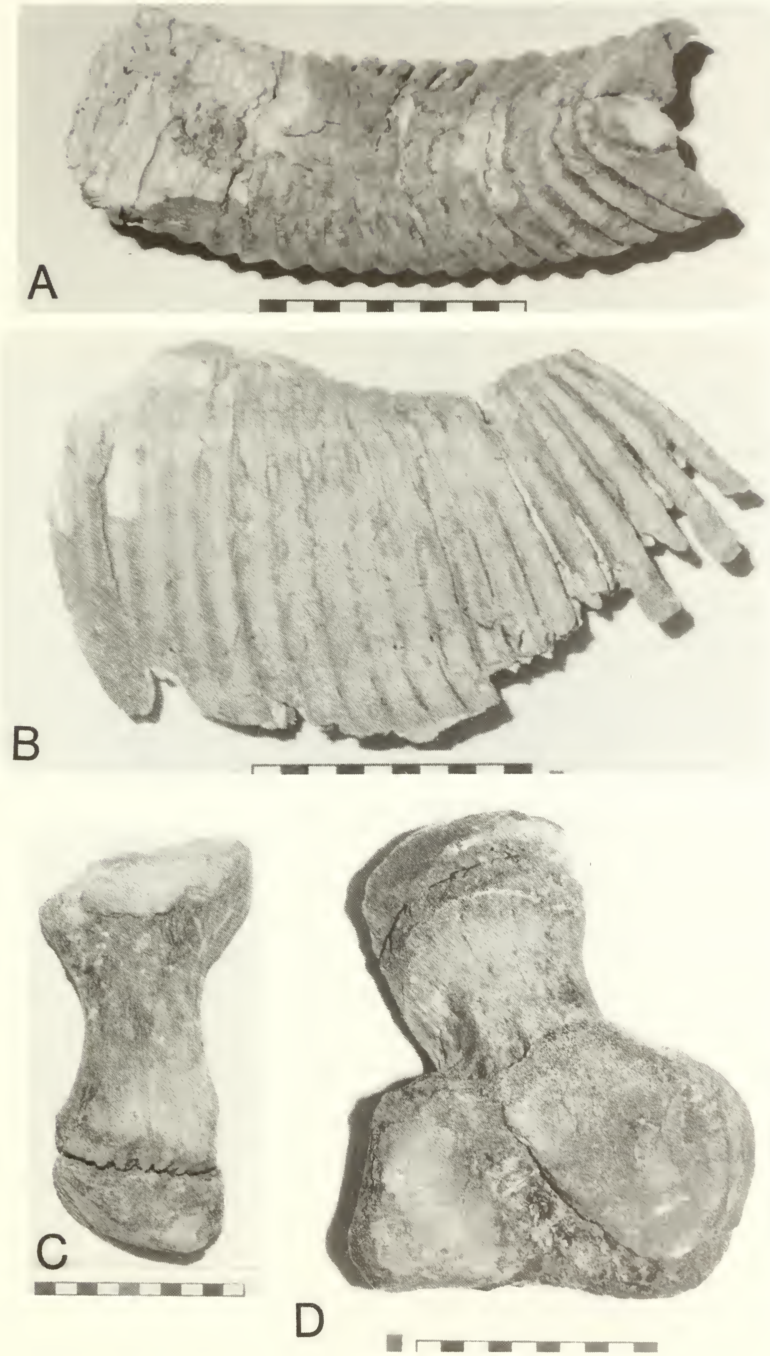

Figure 3. Alton mammoth *(Mammuthus columbi jeffersonii),* better preserved elements. **A**. Lower R molar 3 (occlusal view; note bulldozer damage to crown). **B**. Same, left lateral view. **C**. L metacarpal II, left lateral view (note separate epiphysis). **D**. L calcaneum, anterior view (note separate epiphysis). All scales are in centimeters.

Table1. Quantitative characters and measurements, *Mammuthus columbi jeffersonii,* Crawford County, Indiana (measurements in mm).

Teeth	Lm_3	Rm_3	(?R) M^3
Number of preserved plates	17+	20+	8+
Number of plates within occluded portion	ca. 8	ca. 7	7
Greatest preserved length	230 (inc.)	230 (inc.)	95 (inc.)
Width (at plate no.)	85 (P6)	86 (P13)	85+ (P8)
Height (at plate no.)	136 (P10)	143 (P8)	----
Lamellar frequency	9.0	9.2	8.5
Average enamel thickness	1.44	1.43	1.37
Hypsodonty Index (height/width x 100)	160	166	----

Postcranial	
(? L) scapula, length from glenoid cavity to top of scapula along spine (*in situ)*	735
L humerus, total length (*in situ)*	1060±10
L ulna, greatest length (lacking distal epiphysis; *in situ)*	784+
R femur, greatest length, from caput *(in situ)*	1183
L femur, least transverse diameter of shaft	139
L femur, greatest tranverse width of distal end (normal to articular surface)	234
L tibia, greatest length *(in situ)*	692
L tibia, transverse width of proximal end (normal to plane of posterior edge of femur facets)	219
L calcaneum, greatest length from tuber calci	218
L calcaneum, greatest width, normal to articular surfaces for astragalus	171

Metacarpals	L II	LIII
Greatest length (with epiphysis in position)	192	204
Least tranverse width of shaft (normal to anterior face)	62	59
Greatest distal breadth	88	84

RESULTS

Geological context. The mammoth was recovered from a small, heavily dissected terrace attached to a southeast-facing valley wall of the Ohio River near the mouth of the Little Blue River. The terrace ranges in elevation from about 440 to 450 feet asl and slopes gently to the west. It is bounded on the south by a pronounced slope break, where it steps down to a lower terrace at an elevation of about 420 feet asl. It is bounded to the north and east by the bedrock of the valley wall and to the west by the Little Blue River.

Along the Ohio River near the study site are Wisconsinan-aged sand and gravel deposited as valley train along the Ohio River glacial sluiceway. To the north, terraces along the Little Blue River preserve slack-water sediments, deposited in tributary lakes along the Ohio River sluiceway (Gray, 1989).

Two profiles at the study site, of eight and nine feet in height, were examined and sampled at one foot intervals. Both profiles were deeply weathered. The sediments were unstratified, orangish brown to red in color and totally lacking in $CaCO_3$. They consist predominantly of silt with lesser amounts of clay, except at the base of the sequence where clay is the dominant constituent. Sand occurs in very minor amounts except in a few horizons, and gravel, in the form of granules and fine pebbles, occurs only at the base of both profiles.

Mammoth. The skeleton is referred to that of the Jefferson's mammoth, *Mammuthus columbi jeffersonii.* Most of the skeleton was present at recovery, though the skull could not be distinguished. The few elements that survived well enough for consolidation include: L, RM^3 portions; L, Rm_3 (fragmented; Fig. 3A-B); lower molar portion; postzygaphyses, lumbar vertebra #1 or #2; sections of 3 ribs; condyle portion, proximal end of L humerus; medial articular facet, semilunar notch of L ulna; distal epiphysis (fragmented) of L ulna; distal epiphysis (fragmented), L radius; L magnum; L trapezoid; L metacarpals II (Fig. 3C) and III (both with distal epiphyses); L femur, distal ½; L tibia portions; L astragalus; L calcaneum (with epiphysis; Fig. 3D); L navicular; L cuboid; and sesamoid. Measurements of the teeth and postcranial elements are presented in Table 1.

All teeth required reconstruction, having been damaged by the bulldozer at discovery. The L lower m_3 consisted of 17 and the R lower m_3 of 20 plates; an upper M^3 is represented by 8 plates (Fig. 3A-B; Table 1). The third molars display an average lamellar frequency (number of plates/100 mm) of 8.9, with an average enamel thickness of 1.41 mm. Fragments of two other molars have enamel thicknesses of 1.56 mm and 1.81 mm. These characteristics fall within the range (lamellar frequency, 7-9; enamel thickness, 1.5-2.0 mm) of "progressive" populations (Jeffersonian mammoths) of

Mammuthus columbi (Maglio, 1973; Kurten and Anderson, 1980), referred here to *Mammuthus columbi jeffersonii.* The teeth are comparable with other Indiana teeth in the Indiana State Museum collection (Richards, 1984). Jefferson's mammoth *(M. c. jeffersonii)* is the "typical elephant of the Sangamon and Wisconsin" (Maglio, 1973).

Tooth wear suggests an African elephant age equivalent of 34 years (wear stage XX of Laws, 1966). The long bones show that growth was not complete, as epiphyseal union had not commenced on the proximal and distal ends of the tibiae and femora, distal ends of the ulnae, radii, metacarpals II and III, and the tuberosity of the calcaneum (Fig. 3C-D). The proximal epiphysis of the humerus, however, appears to be undergoing fusion with the diaphysis. The progress of epiphyseal union is consistent with that expected for a 34 year old male African elephant (Haynes, 1990). Haynes (1984, 1990) considers African elephants over 12 years of age to be mature adults, though growth is not yet complete.

The tusk(s), mandible, pelvis, and major limb bones revealed the general orientation of the mammoth (Fig. 2). The skeleton faced downslope with the head towards the north, dorsal side up, and the limbs drawn up under the body. The front legs and right rear leg were flexed (Fig. 1B); the left rear leg may also have been flexed. Many of the vertebrae and ribs were located within 2.5 m of their anatomical position, often downslope towards the west or east. Some elements, however, were recovered as far as 4 m downslope to the north.

The mammoth remains did not reveal rodent gnawings or other marks that suggested disturbance after the death of the animal. Mammoth bone samples submitted for radiocarbon age determination contained no identifiable collagen for dating (Beta-40037).

Associated fauna. A total of 48 pieces of bone and teeth comprising 5 mammalian species were associated with the mammoth (Table 2). Mollusks were absent from the leached soils.

Name: Bat, sp. indet.
    Materials: 2 phalanges.
Name: *Phenacomys intermedius,* heather vole.
    Materials: RM^2; $?RM^2$, partial; Lm_2; Lm_3; molar fragment.
    Comments: The teeth display two stages of wear (MNI = 2).
Name: *Clethrionomys gapperi,* southern red-backed vole.
    Materials: RM^3; Lm_1, partial; molar fragment.
Name: *Microtus pennsylvanicus,* meadow vole.
    Materials: RM^3, partial.
Name: *Microtus* sp., meadow voles and mice.
    Materials: LM^1; Rm_1, partial; Lm_3; molar, disintegrated; 9 molar fragments.
Name: Mouse, sp. undet.
    Materials: femur shaft; 7L, 4Ri enamel "rinds"; 3L, 4RI enamel "rinds."
Name: Leporidae, sp. undet., cottontail/hare.
    Materials: 12 cheek tooth enamel faces (ca 4 teeth); molar dentine fragment.

The recovered specimens are housed at the Indiana State Museum (INSM) under catalog numbers 71.3.84 (mammoth) and 71.3.85 (associated remains). The L lower molar 3 is reposited at the Floyd County Historical Museum in New Albany, Indiana.

Table 2. Fauna associated with the Alton mammoth, Crawford County, Indiana.

Species	MNI	NIP
Bat, sp. undet.	1	2
Phenacomys intermedius, heather vole	2	5
Clethrionomys gapperi, southern red-backed vole	1	3
Microtus pennsylvanicus, meadow vole	1	1
Microtus sp.	-	5
Mouse, sp. undet.	3	19
Leporid, sp. undet.	1	13
Totals: 5 species	9	48

DISCUSSION

An entire mammoth carcass became buried upon what is today a small terrace of the Ohio River. Just when this occurred is not clear. This terrace was mapped by Straw (1968), who proposed that it was a remnant of Illinoian-age slack-water deposits. The relatively undisturbed, articulated nature of the skeleton suggests rapid burial and perhaps also slack water deposition in a ponded environment. The apparent deep weathering of the sediments is consistent with a pre-Wisconsinan age, but the mammoth's dentition suggests Wisconsinan or Sangamonian age. The presence of the boreal voles *Phenacomys intermedius* and *Clethrionomys gapperi* support the notion of glacial age (i.e., Wisconsinan) deposition. Textural characteristics of the sediments are similar to Wisconsinan lacustrine sediments deposited in tributary lakes associated with the Ohio River. The terrace at Alton, however, is not in a tributary valley, and the soil profile at the mammoth site is significantly different from the profiles in the lacustrine terraces in the tributary valleys.

These seemingly contradictory data present three potential explanations for the origin of the terrace and the burial of the mammoth:

1. The terrace may be of Illinoian age, and the mammoth buried when the river was rapidly being aggraded with glacial outwash. However, mammoth tooth characters suggest Wisconsinan age, and the overlying sediment is much finer-grained than that which normally occurs in valley train outwash.
2. The terrace may be of Wisconsinan age. The terrace elevation, however, is 20 to 30 feet higher than terraces of probable late Wisconsinan age along the river. Although it is only 10 feet higher than the lacustrine terraces in nearby tributary valleys, its occurrence along the Ohio River shows that it did not originate in a tributary lake.
3. The most likely explanation is that the bulk of the terrace is Illinoian, and that it was mantled by overbank flood deposits of the Ohio River during the Wisconsinan.

The terrace occurs just downstream from a sharp bend in the river where flow separation would contribute to rapid deposition of silt and clay; this would explain the occurrence of fine-grained sediments along the valley wall. The high clay content at the base of the profile suggests the occurrence of a buried paleosol. If the overlaying sediments were of Wisconsinan age, then the paleosol could have formed during the Sangamonian interstade on sediments deposited during theIllinoian. Sedimentation could have occurred either during the middle or late Wisconsinan, when glacial ice of the Huron-Erie Lobe entered the drainage basin of the Whitewater-Miami river system and supplied meltwater and outwash to the Ohio River. The degree of weathering suggests that the older age is more likely and that the underlying soil formed during Sangamonian times.

The site had been heavily leached by groundwater, badly disintegrating the mammoth skeleton, and selectively disintegrating all but the most durable elements of the microfauna, the latter surviving largely as enamel "rinds" of teeth. Interestingly, the stout, rooted molars of adult *Phenacomys intermedius* (heather voles) and *Clethrionomys gapperi* (red-backed voles) were preserved relatively intact, while the unrooted teeth of *Microtus* were quite fragile and often represented by detached enamel faces. This suggests a preservation bias for *Phenacomys* and *Clethrionomys.* It is not clear if the bones of fishes or shells of snails had been selectively leached from the deposit.

Neither the heather nor the red-backed vole occurs in Indiana today. The heather

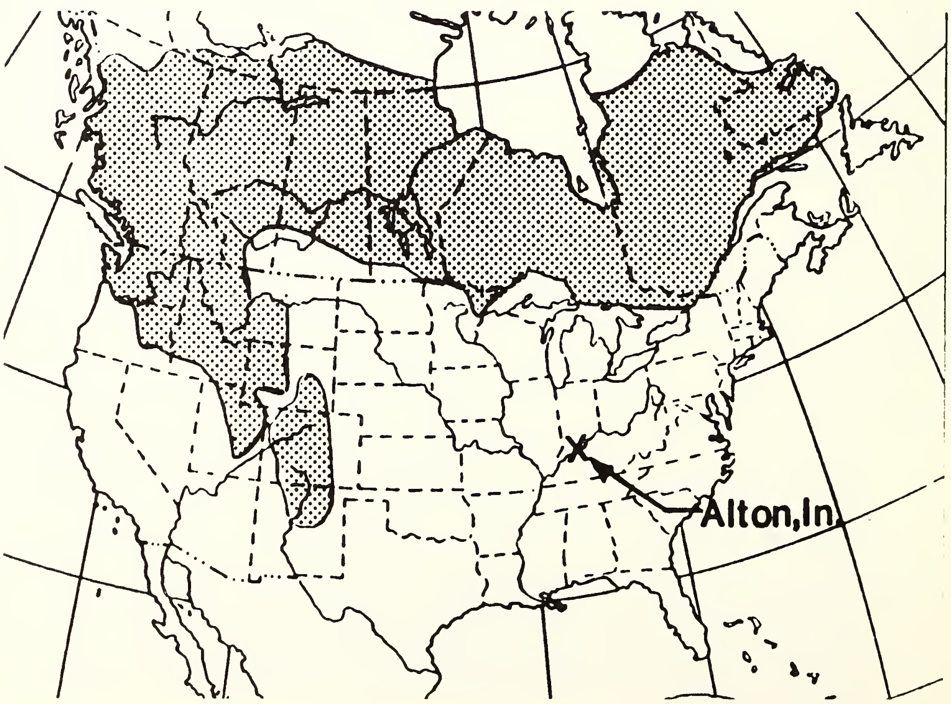

Figure 4. Modern area of sympatry (shaded), heather vole *(Phenacomys intermedius)*, southern red-backed vole *(Clethrionomys gapperi)*, and meadow vole *(Microtus pennsylvanicus)*. All co-existed in southern Indiana during the deposition of the Alton mammoth.

vole occupies a variety of habitats (pine and spruce forests, grassy and rocky mountain slopes, and tundra) in cold forested regions of Canada and mountain tops of the western United States; the red-backed vole inhabits damp environments in coniferous, deciduous, or mixed forests of Canada, extreme northern United States, and mountain regions of the western and eastern United States (Burt and Grossenheider, 1964). The meadow vole *(Microtus pennsylvanicus)* occurs in Indiana today, inhabiting low marshy areas and meadows, lake shores and stream sides, and relatively dry upland fields (Mumford and Whitaker, 1982). When the modern distribution ranges of these three identifiable species are overlain (Fig. 4), the area of sympatry suggests that those three species could only co-occur today in the cool, boreal forest region (taiga) of Canada. The southern limit of distribution of northern species can be correlated with summer high temperature extremes; conversely, the northern limit of distribution of southern species can be correlated with winter low temperature extremes (Graham, 1976). The presence of extralimital boreal voles at the Alton mammoth locality suggests cooler summers at the time of deposition of the fauna. A Wisconsinan-aged mammoth locality in Iowa with a similar associated fauna has led to similar environmental implications (Davis, *et al.*, 1972-73).

The stature of the Alton mammoth can be estimated by the length of select long bones. The Jonesboro, Grant County, Indiana specimen (*Mammuthus columbi jeffersonii,* AMNH 9950) was mounted with a shoulder height of 3.2 m using restored radii and ulnae. Hay (1912) believed that more accurate restoration would have lowered the shoulder height to 3.0 meters. Comparison of the Alton femur length to the ratio of femur length to adjusted shoulder height of the Grant County specimen suggests that the Alton mammoth would have stood 2.86 m (9'5") at the shoulder. Harington, *et al.* (1974) used the length of the humerus to calculate the shoulder height of the Babine Lake mammoth. This method (humerus length = 34% shoulder height) suggests that the Alton mammoth stood somewhat higher (3.12 m; 10'3"), reaching 3.26 m (10'9") in the flesh. Kurten and Anderson (1980) give the range of adult shoulder height of Jefferson's mammoth at 3.2-3.4 meters. Haynes (1990) gives 3.2-3.95 m as the probable range for *M. columbi.*

The upland occurrence of the Alton mammoth in fine-grained sediments is unusual. Munson (in prep.) suggested that many of the muskoxen remains deposited south of the Wisconsinan glacial boundary in Indiana had occurred as bloated carcasses rafted down glacial meltwater channels, many kilometers from the source of death. If so, the Alton mammoth could have originated upstream and have been deposited as a bloated carcass along the bank of a slackwater ravine of the Ohio River.

The sternally recumbent posture of the Alton mammoth skeleton was also unusual. Haynes (1988) related that most modern elephants die lying on one side and that adult elephants are rarely mired. The Alton mammoth skeleton occurred in the "sudden death posture" where the animal, for various reasons, collapses straight down upon its brisket, mandible, tusks, and belly (Haynes, 1988). In these instances, as at Alton, the forelegs are often flexed and the rear legs are either flexed or extended in a feeble attempt to stand. In a living elephant, this position will result in anoxia and cardiac failure within an hour or two (Haynes, 1988). The actual cause of death of the Alton mammoth is speculative. Mature male African elephants live apart from mixed herds for most of the year, and experience relatively high mortality between the ages of 35 to 50 years (Haynes, 1990). Although we do not know the sex of the Alton mammoth, its solitary occurrence and age at death is consistent with bull elephant behavior. The Hot Springs

Mammoth Site, South Dakota, appears to have been selective for 12 to 30 year-old male mammoths (Agenbroad, 1990).

Although the Alton skeleton did not display the disturbance and trampling common to modern African elephant herd-frequenting sites (Haynes, 1988), its fractured and displaced tusk(s) are difficult to interpret. In modern elephant carcasses, the scapulae slide downward relatively early, with the ribs falling from position as decay proceeds (Haynes, 1988); this could account for displacement of those elements at Alton. The foot bones are among the first elements to detach during the decay of modern elephant carcasses; they are highly susceptible to scavenging (Haynes, 1988). Many of the foot bones at Alton were in expected anatomical proximity. Because there appears to have been relatively little damage by scavengers or trampling mammoths, the carcass may have been buried or submerged soon after displacement of the scapulae and dispersion of the vertebrae and ribs.

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