Proceedings of the Indiana Academy of Science
(1987) Volume 97 p. 571-581.

The Dollens Mastodon (*Mammut americanum*) Locality, Madison County, East Central Indiana

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Abstract

Excavation in a peat deposit, Madison County, east-central Indiana has produced 11 elements of a young adult American mastodon (*Mammut americanum*). Most of the bones were poorly preserved due to subaerial exposure after deposition; a few elements endured well enough for consolidation. Extensive washing of the surrounding sediments (approx. 8.2 cubic meters) produced only a sparse semiaquatic fauna.

A pollen profile which included pollen of both submersed and emergent aquatic plants and remains of algae indicates that the bones were deposited in a grass-sedge fen which maintained standing water for much of the year. Activities of beaver (*Castor canadensis*) and muskrat (*Ondatra zibethicus*) were apparent. The predominant arboreal pollen type is spruce (*Picea*), with some hardwood genera present. Wood from a peat layer immediately below the mastodon skull gave an age of $12,240 \pm 80$ ybp. More extensive analysis of pollen and plant macrofossils is in progress.

Introduction

On August 3, 1986 crane operator Mike Jordan uncovered some large bones while digging a recreational pond in a peat deposit 1 1/2 miles east of Alexandria (SW 1/4, NW 1/4, NE 1/4, NE 1/4, Sec. 29, T 21 N, R 8 E, Anderson North Quad.) Madison County, IN. The property owners, Randy and Cindy Dollens, contacted the Archaeological Resources Management Service, Ball State University, who in turn notified the Indiana State Museum.

The bone deposit occurred in a peat accumulation on the Tipton Till Plain, a flat to gently rolling plain (23), locally formed on tills of the Trafalgar Formation (31; Fig. 1A). The Trafalgar tills were depostied during the fourth advance of the Huron-Erie Lobe of the Laurentide ice sheet (Woodfordian Phase II, after 21,000 ybp; 6). The site occurs less than 1 km southwest of the Union City Moraine, a recessional feature of Woodfordian Phase III, deposited by 14,000 ybp. The sediments of the Dollens locality are typical of those of the paludal facies of the Martinsville Formation, usually deposited within the past 13,000 years (30). The bone bearing peat represents terminal sedimentation of a "kettle" lake basin, formed by the melting of accumulated ice within the Wisconsinan till (24). These peat and often associated marl deposits favored the accumulation of Quaternary vertebrates. Remains of the

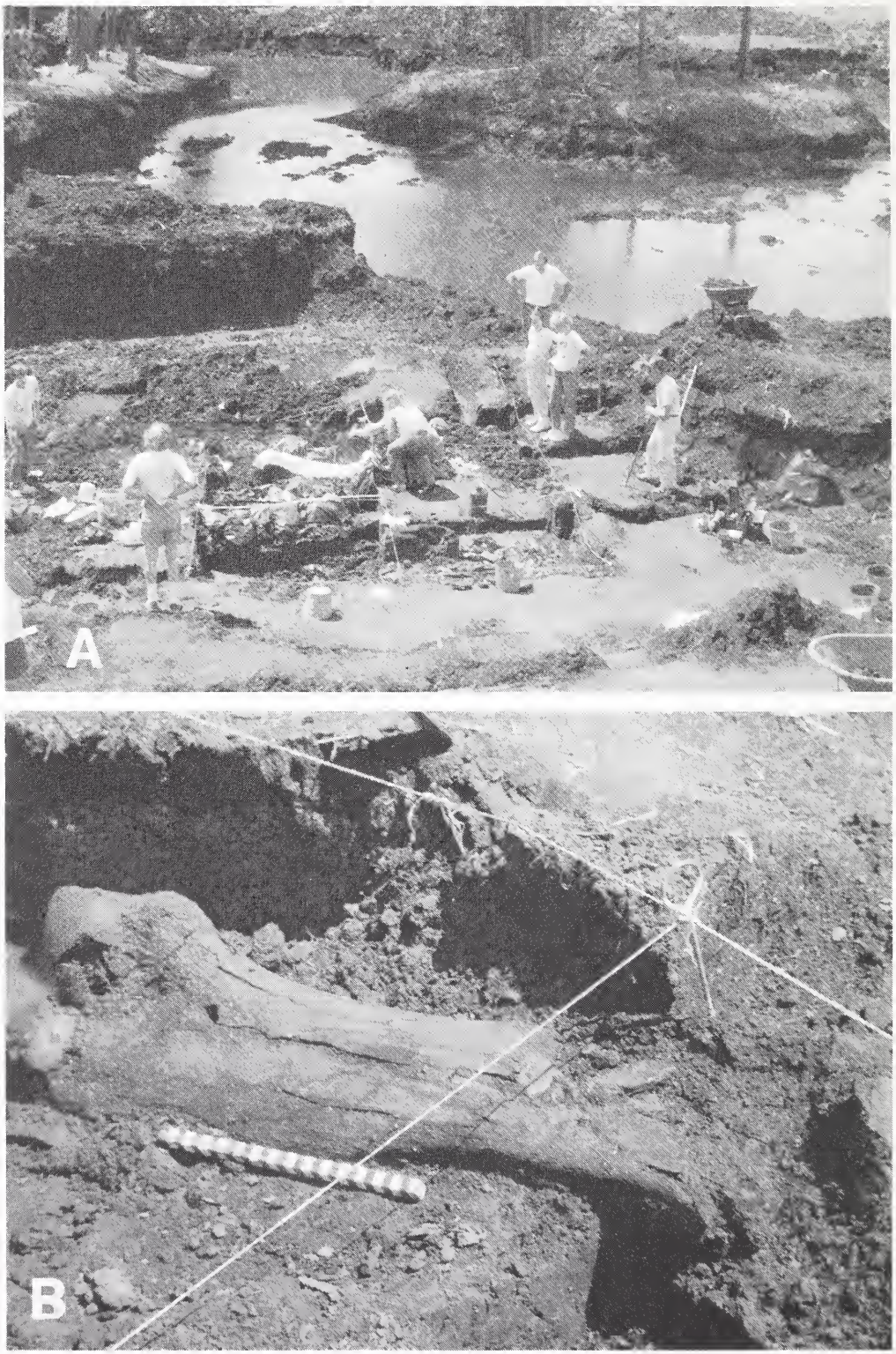

FIGURE 1. A. View (to west) of mastodon (*Mammut americanum*) bone occurrence, Dollens locality, Madison County, IN. Note plaster mold enclosing tusk. Pond previously excavated in peat is in upper right of photo. B. Posterior surface of R femur, exposed *in stiu*. Note general deterioration of bone and fragmentation of proximal end (to right). Scale in centimeters.

American mastodon, Jefferson's mammoth (*Mammuthus jeffersonii*) and giant beaver (*Castoroides ohioensis*) have previously been reported for Madison County (9; 16; 20).

Because much of the Dollens skeleton appeared undisturbed, it was thought that associations of other fauna, pollen and plant macrofossils might provide information on late Pleistocene paleoecology of the region. An excavation jointly sponsored by Ball State University and the Indiana State Museum was undertaken from August 6 through 13, 1986. Field labor was supplied by staff and volunteers of both institutions, as well as by volunteers from the site vicinity. Materials have been deposited in the Indiana State Museum, catalogue numbers 71.3.39 (mastodon) and 71.3.40 (other fauna/flora).

Methods

Large elements disturbed by the crane (mandible, L tusk, L scapula blade, L humerus, proximal end) were immersed in a water tank to prevent drying and cracking. To expedite entry into and below the bone levels, undisturbed overburden was stripped by heavy machinery to within 0.5 m of the top of the bone bed. A grid of eight two meter squares was staked out with transit and tape and a site map prepared. Large bones were located with steel probes and marked with pin flags. Entry into the bone level was by shovel, where bones were exposed with trowels and bamboo picks (Fig. 1B). Small bones were mapped and removed; large bones were left in place until all located elements were exposed (Fig. 2). Bones were covered with plastic bags to prevent drying, but required periodic moistening. Stratigraphy and slope was difficult to recognize in the poorly differientiated peat. Only one vertical datum, the interface of course brown peat overlying a more fibrous, greenish (while unoxidized) peat, occurred no less than 20 cm below the bone level, and sloped southwesterly into the apparent peat basin. The level containing the mastodon bone was considered as a single depositional unit. Elevation of individual bones was recorded, though not in relation to the peat interface. A 20 cm balk was left in the corner of each unit for pollen and microfauna samples. Pollen samples were removed at 5 cm intervals down one balk, spanning the R tusk tip, as well as from the tusk cavity. A core of 3.6 m of lake sediment beneath the peat layer was taken at a later date. Select wood samples were sealed in aluminum foil for radiocarbon dating. The fragile R tusk was molded *in situ* in plaster reinforced with burlap; this later provided a fiberglass cast of the tusk. After the exposed elements were photographed, mapped and numbered, they were sealed in plastic bags for transport. After all bones were removed, Unit 3 was deepened by 38 cm (encountering greenish peat at 10 cm), and a 54 cm^2 pit dug an additional 81 cm; coring 91 cm deeper revealed greenish peat and no bone. A final collapsing and backfilling of all unit floors 50 cm deeper with shovels revealed no large bone.

Sediment removed from the units was transported by wheelbarrow to the washing station ca. 100 meters away. A total of 8.1 cubic meters was washed through 6 mm mesh hardware cloth for recovery of plant and animal macrofossils. Water was pumped from an inundated dragline trench by a gasoline engine pump with a 3.81 cm (1 1/2″) delivery hose.

In the Museum, bones were lightly brushed under tap water, then sealed in plastic bags for slow drying (2-3 months). Dried bones and teeth were later immersed 2-3 times in a ca. 15% solution of glyptal, carried by acetone, and broken parts mended with epoxy. Most of the skull, much of the postcranial bone and some of the tusk was too disintegrated for reconstruction and cataloging into the curatorial collection. While most of the exterior laminae of the tusks did exfoliate, a fiberglass cast preserves the external detail of the R tusk. Several samples of beaver-gnawed wood were preserved by freeze-drying. Two samples of gnawed wood were air-dried to 25% of their original

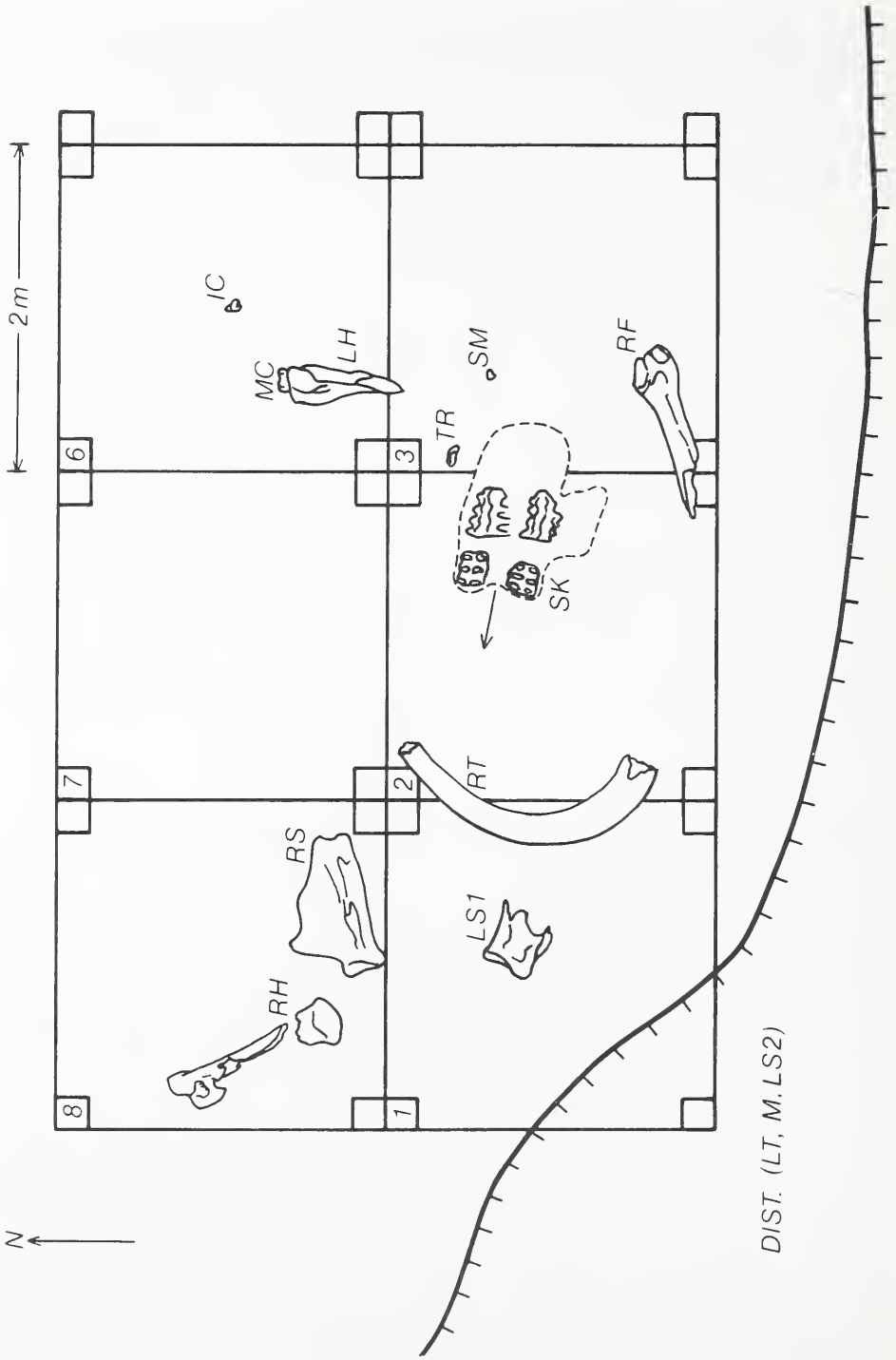

FIGURE 2. Plan view sketch of mastodon (*Mammut americanum*) remains recovered *in situ*, Dollens locality. South and southwest corner disturbed by crane upon discovery. Abbreviations: RH, right humerus; RS, right scapula; MC, right metacarpal IV (of manus); LH, left humerus; IC, left internal cuneiform (of pes); LS1, left scapula, glenoid cavity area; RT, right tusk; SK, skull, with four molars (arrow points anteriorly); TR, right trapezoid (of manus); SM, sesamoid (of manus/pes); RF, right femur; Dist., disturbed area; LT, left tusk; M, mandible; LS2, left scapula blade. Grids numbered in upper left corners.

volume. Recovered plant macrofossils were forwarded to Steve Jackson for identification. A total of .091 cubic meter (3.21 cubic feet) of peat from the balks and the greenish levels was washed through 1.2 mm mesh screen for microfauna recovery.

Results

A partial skeleton of a young adult American mastodon was recovered along with isolated elements of 7 predominantly semiaquatic vertebrate species, plant macrofossils of predominately coniferous trees, a pollen spectrum and 2 radiocarbon dates.

The American mastodon (*Mammut americanum*) elements include: skull (very fragmented) with four molars (L,R M2 and M3); two tusks (one fragmented); mandible with four molars (L,R m2 and m3) (Fig. 3); R m1; L (fragmented), R scapulae; L,R humeri (fragmented); R femur (fragmented); R trapezoid and R metacarpal IV (of manus); L internal cuneiform (of pes); sesamoid. It appears to represent a young adult skeleton. Epiphyseal union is complete distally on the humeri and femur; the proximal epiphyses of the humeri were actively closing, with fusion complete on the anterior half of the shaft. The epiphyses of the femoral head and superior border of the scapulae were unfused. The isolated Rm1, removed from a peat heap, was actively being shed, and would not have maintained itself in the remodeled alveolus without gingival support. Only the anterior roots and alveoli of the m1 remain; the posterior root had been resorbed and the alveolus closed. The shedding of the m1, and the molar wear stages (m1, A/3, M2/m2, 2+; M3/m3, 1) indicate a young adult age of 26-28 ± 2 years, using the Boney Spring mastodon age structure as a template (22). Tooth wear and eruption are roughly equivalent to stages XVII-XIX of the African elephant (28-32 years of age; 15). An age of 30 African elephant years is suggested for the Dollens mastodon.

Tooth measurements are listed in Table 1. While some mastodon population samples display small teeth (Trollinger Spring, MO, 22; Christensen Site, IN, 8), other samples (Boney Spring, MO, 22), including those of diachronous age (Michigan sample, 28) display a great range of size. The Dollens teeth are clearly of intermediate size in the range displayed by the Boney Spring and Michigan specimens. Skeletal measurements (Table II) also indicate an average-sized individual (20).

The Dollens mandible displays some traits suggestive of a female such as lack of mandibular tusks and a "U" shaped lingual gutter (22), but a sexed series of mandibles is not available for comparison.

An elliptical area (50 mm × 41 mm) of reactive bone growth is present on the midline of the L mandibular ramus, below the m3 tetartolophid. This may or may not represent a healed, puncture injury.

Many of the bones are rodent gnawed on the upper surfaces more readily exposed during burial. These include the L condyle and coronoid processes of the mandible; base of R tusk; L humerus, distal end; L scapula, anterior and lateral margins of glenoid cavity, anterior and posterior blade margins and spine border; R scapula, blade margins. The large size of the gnawings suggest such rodents as muskrat, beaver, or porcupine. The gnawing indicates subaerial weathering of the bones for some time after deposition, and with the freeze-thaw conditions of shallow burial, allowed for deterioration of the bones.

Washing produced the following sparse, predominantly semiaquatic fauna (M, indicates elements recovered from the 1.2 mm mesh):

Fish sp. (71.3.40.1). MATERIALS: Two minute, unidentified bone scraps (M).
Rana sp., frog (71.3.40.2). MATERIALS: R maxilla, anterior portion (M). COMMENTS: 50-60 mm body length.

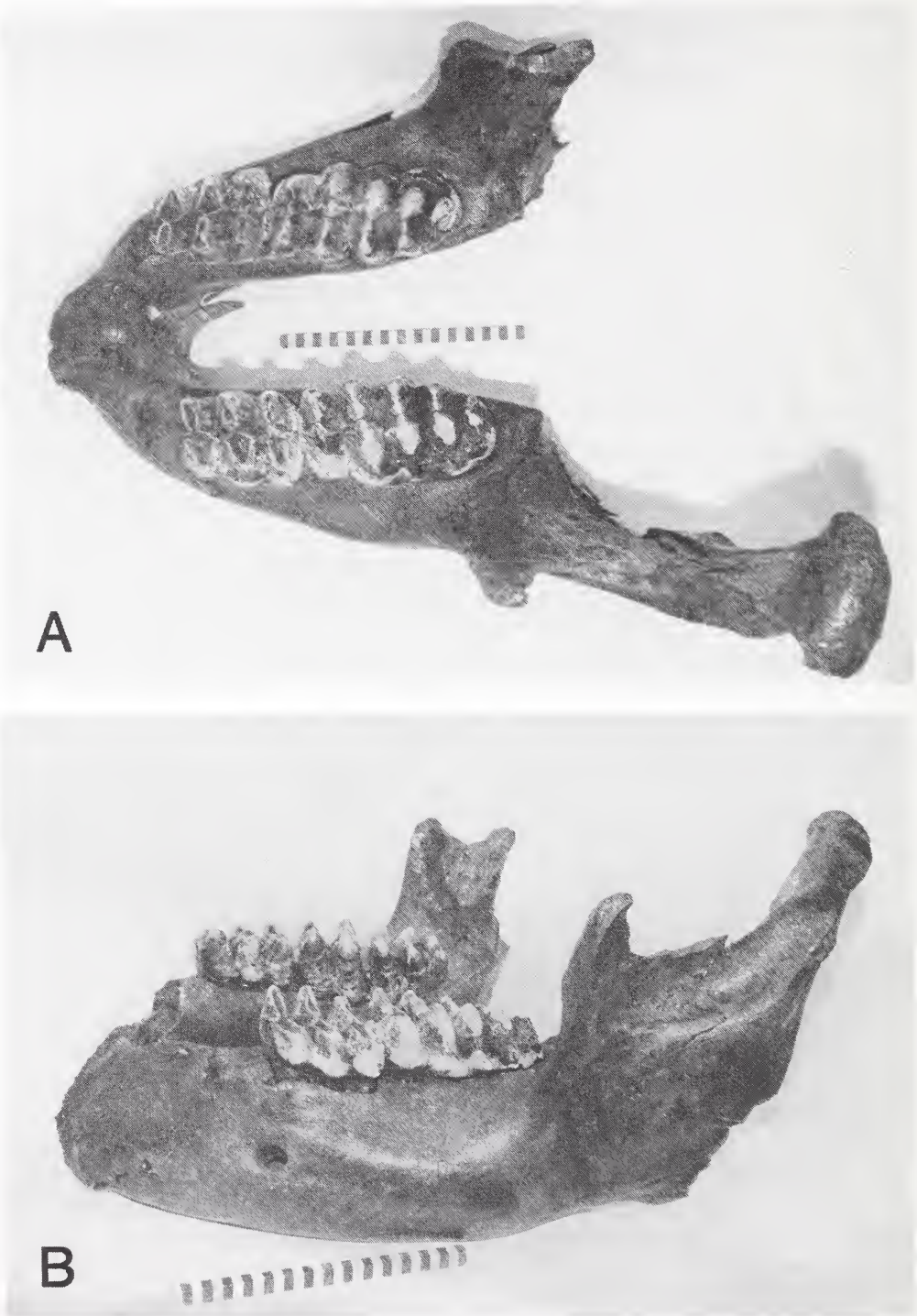

FIGURE 3. Mandible, Dollens mastodon (*Mammut americanum*). A. Occlusal view. Note alveoli for only anterior roots, indicating active shedding (or loss) of the first lower molar. Scale in centimeters. B. Left oblique view. Much of the missing coronoid areas are heavily rodent gnawed.

TABLE 1. Tooth measurements, *Mammut americanum*, Dollens Locality, (mm).[1,2]

Placement	Cat. #	Length	Width	Maximum width across:			
				Protoloph(-id)	Metaloph(-id)	Tritoloph(-id)	Tetartoloph(-id)
LM2	71.3.39.10	119.5	95.5	90.9	94.6	94.8	
RM2	71.3.39.9	121	95.0	89.4	95.0	94.1	
LM3	71.3.39.12	187.0	103.5	102.3	103.8	100.1	90.2
RM3	71.3.39.11	194.5	103.5	101.2	106.0	101.5	92.2
Rm1	71.3.39.2	98.5	74.5	62.9	76.2	71.7	
Lm2	71.3.39.1	114.5	98.0	77.7	95.8	94.5	
Rm2	71.3.39.1	112.0	94.0	77.2	94.1	93.6	
Lm3	71.3.39.1	196.0	108.0	90.4	109.1	103.0	91.9
Rm3	71.3.39.1	192.0	107.0	91.3	107.7	101.8	90.7

[1] Terminology from Saunders (22).

[2] Tusk dimensions: R tusk, preserved length (outside curve): 1920 mm; R tusk, greatest diameter (not at base): 179 mm; L tusk, 950 mm section of tip retained integrity.

Chelydra serpentina, common snapping turtle (71.3.40.3). MATERIALS: L femur, proximal end.

Castor canadensis, beaver (71.3.40.4-.6). MATERIALS: L dentary, anterior portion with p4 and m1 from the peat heap; upper molar; thoracic vertebra.

Mouse sp. Indet. (71.3.40.20). MATERIALS: upper incisor enamel fragment (M).

Ondatra zibethicus, muskrat (71.3.7-.19). MATERIALS: R dentary with i; Lm1; LM1; R nasal, posterior portion (M); 10 cheek tooth enamel plates (M); caudal vertebra; R humerus; L innominate, fragmented; L femur, proximal end; R, fragmented L tibiofibula. COMMENTS: Tibiofibulae from different individuals. Enamel plates represent disintegrated cheek teeth.

Sciuridae cf. *Sciurus* sp., tree squirrel (71.3.40.21). MATERIALS: distal phalange (M). COMMENTS: Recovered from the upper deciduous pollen zone.

TABLE II. Skeletal Measurements, *Mammut americanum*, Dollens Locality (mm)

Element/Measurement	Left	Median	Right
Mandible			
Height of condyles above lower border of jaw:	466		
Length of symphysis:		146+	
Height of jaw at front of m3:	169		177
Thickness of jaw at front of m3:	150		147
Greatest thickness of jaws (through anterior insertion of ascending ramus):	173		ca. 168
Scapula			
Greatest length from coracoid process to top of scapula, along axis of spine (lacking epiphysis):			806
External distance from inner border of glenoid cavity to top of spine (lacking epiphysis):			770
Greatest anteroposterior length of glenoid cavity:	217		219
Greatest transverse width across glenoid cavity:	138		143
Humerus			
Distal end, transverse width:			289
Distal end, anteroposterior depth (of medial condyle):			207
Femur			
Least transverse diameter of shaft:			169
Anteroposterior diameter of shaft at above position:			83
Greatest transverse width of distal end (normal to articular surface):			260
Least circumference of shaft:			413

The recovered fauna indicates a marshy wetland with emergent vegetation and probably nearby permanent water at the time of mastodon deposition. Aquatic vertebrates such as fish and salamanders were apparently sparse in the marsh, due perhaps to periodic drying. There was little evidence for turtles, and none for snakes, mink, or even the meadow vole (*Microtus pennsylvanicus*), usually common in marshes, meadows and around lake shores (18).

The lower, greenish peat level was C-14 dated at 12,650 ± 120 ybp (Beta-17594), and wood from immediately below the skull at 12,240 ± 80 ybp (Beta-20143). The possibility of sediment disturbance by the living mastodon (7), and tendency of bones to settle downward through the peat (5), suggest that the 12,240 ybp date is a maximum for mastodon deposition.

Some pieces of burned wood were recovered in Units 2 and 8 spanned by, though not necessarily contemporaneous with, the mastodon bones.

A set of 9 pollen samples spanning 95 cm of an exposed peat face in which one tusk was embedded has been counted. The pollen spectra indicate that the bones were depostied in a marshy peat-forming fen in which there was standing water for much of the year. This setting is suggested by high percentages of grass and sedge, the occurrence of many aquatic macrophytes (*Myriophyllum, Typha latifolia, Brasenia, Sagittaria, Utricularia, Nuphar*, and *Potamogeton*) and remains of several algae (*Botryococcus, Pediastrum boryanum, P. araneosum, P. integrum*).

The tree pollen types are clearly dominated by spruce with some larch and fir. These taxa are indicative of boreal conditions. Some hardwoods also occurred. The most common hardwoods were ash, ironwood-hornbeam, elm, and oak. Pollen spectra similar to these are found from a number of late-glacial sites on the till plains of Indiana and adjacent Ohio (1; 25; 32; 33). At most sites the late glacial transition from spruce dominance to spruce and some hardwoods occurs between 13,500 and 12,000 ybp. This is consistent with the available radiocarbon dates from the Dollens site.

At many midwestern mastodon localities the forests were apparently open, spruce-dominated boreal woodlands (13; 32). This may be true for the Dollens site also, as *Ambrosia, Artemisia*, and Tubuliflorae grains occur. However, the evidence is less conclusive, as the high percentages of grass and sedge are probably from wetland taxa.

Discussion

Fauna, flora and sediments indicate the Dollens mastodon was deposited in a vegetation-choked marshy basin some 12,240 ybp or less, during the terminal infilling of a kettle lake. Seasonally dry, the area of bone deposition lacked true aquatic fauna such as fishes and mollusks, though permanent water was in the immediate area. Just prior to and perhaps during mastodon deposition the marsh was occupied by muskrat and active beaver lodges. Beaver gnawed wood, sometimes burned, and collapsed lodges have also been regularily found in the lower Late Pleistocene, levels of southeastern New England peat deposits (14).

The recovered fauna consists of current resident species, and without the presence of mastodon and conifer pollen, would not suggest an environment any different from that of the area today. Open spruce woodlands, predominant during the early late glacial in much of the Midwest (2), is the predominant environment associated with Midwestern mastodon remains (3; 13; 32).

The low faunal diversity noted in this study is also apparent in Michigan muck and peat deposits (12). Localities where mastodon bones occur in marl and sand, such as the Kolarik locality, Starke Co., IN, however, can be quite productive for mollusks, fishes and other vertebrates (20). These kettle lake and bog faunas do not

approach the abundance and diversity of taxa recovered from the more terrestrial cave deposits (19; 20; 21).

Although the right scapula and humerus were semi-articulated, the remainder of the bones, consisting mainly of larger elements, was dispersed. Major skeletal areas, such as the vertebral column, ribs, lower legs (tibiae, fibulae, ulnae, radii), pelvis and most of the foot bones were missing. Major portions of mastodon skeletons are often not found in marl (lake) and bog/marsh (peat) deposits, even where other portions are articulated (Kolarik locality, IN, Ellis and Richards, in prep.; 8; 12), perhaps because of natural processes (8). The lack of any vertebrae or ribs (over 75 elements) suggests a non-random process of bone dispersion. The Dollens bone pattern characterizes two different modes of dispersion. First, the presence of such large bones as the skull, mandible, humeri and femur (Class III and II) and lack of ribs, vertebrae and most of the podials (Class I) is typical of bones that have moved slowly (by traction) in running water (29). Except for an occasional pebble or seam of sand, there was, however, little indication of moving water in the deposit. Second, the bones present are those which, on dry land, might disarticulate early (scapulae, mandible), or later (femur, humeri, podials) from the skeleton; vertebrae, ribs and pelvis (those "missing" from the deposit) can be the last to disarticulate (10; 11). Hill (10) further suggested that units composed of more than one bone (e.g. vertebral column) do not readily scatter, and that in the absence of running water the vertebrae should be the bones remaining longest at the death site. Peat removed by crane from the deeper basin immediately to the south and west of the bones was spread by heavy machinery and failed to produce any of the missing parts. Perhaps the vertebrae, pelvis and ribs are closely associated, buried in the shallow peat to the north or east of the bones.

Fisher (4; 5) describes several Michigan mastodon sites that suggest butchery by Paleo-Indians using bone wedges to separate articulated elements. Use of the scanning electron microscope detailed differences between rodent, digger/preparator markings and those produced by proposed bone wedges and cutting instruments (26). The Dollens mastodon R humerus head does have several gouge-like marks, but lacks any matching marks on the articulating R scapula glenoid cavity. Other bones with similar marks lack conarticulating elements. We suggest that these marks were made by rodents, scavengers, and during the excavation process, including probing. The SEM was not used. Concentrate from the several cubic meters of washed sediment did produce one chert microflake with a platform (71.3.40.22, 2.8 mm × 2.0 mm × 0.8 mm) from the top 10 cm of Unit 3 (NW corner balk). Although chert microflakes would be expected at a mastodon butcher site as a result of tool resharpening or use (17), it is difficult to directly relate this microflake to the mastodon skeleton.

Acknowledgments

We thank Randy and Cindy Dollens for the opportunity to recover and study the site materials, which they donated to the Indiana State Museum. Dave Rieger produced Figure 3. John Wyatt, Indiana State Museum, produced Figure 2, Dave McLary, same institution, molded and painted the R tusk cast and Kim Bone typed the manuscript. We also thank the numerous Ball State University archaeology students, Indiana State Musuem (including Vern Swanson, who recovered the R m1 from the spread peat) and local volunteers who made the field recovery possible.

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