

## The Woodrat in Indiana: Recent Fossils

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### Abstract

Skeletal remains of *Neotoma*, presumably *N. floridana magister*, have been recovered in relative abundance from caves throughout Indiana's karst area associated with bones of such locally extinct fauna as black bear, porcupine, elk, and spotted skunk. Presently rare in Indiana, a few woodrats have been historically recorded and recently observed marginal to the Ohio River. The ancient depopulation may have been associated with some indirect effect of climatic change.

One species and several races of woodrat are present in the Eastern United States (4). Only a few woodrats, *Neotoma floridana magister*, have been recorded in Indiana (7), along and near the bluffs of the Ohio



FIGURE 1. Locations of *Neotoma* observations (circles) and "recent fossil" sites (squares).

1 Freeman's Pit, Hidden Pit Cave; 2 Beetre Cave, Brinegar's Cave; 3 Anderson Pit Cave; 4 Sullivan's Cave (1); 5 Carcass Crypt Cave; 6 Stroud Cave (6); 7 N. Jim Cave; 8 Cave 3 miles S.S.W. of North Vernon; 1 Wyandotte Cave (2, 8); 2 Small bluff-top cave (5); 3 Rat Cave (5).

River (5), and in Wyandotte cave (2, 8). The author has recently noted woodrats in the two caves near the Ohio River where Hickie and Harrison first recorded them in 1930 (5).

Kirkpatrick and Conaway found woodrat nests, though no rats, in Stroud cave, Orange County (6). Bader and Hall (1) found remains of woodrat in Sullivan's cave, Lawrence County, associated with bones of *Didelphis marsupialis*, *Blarina brevicauda*, *Erethizon dorsatum*, *Sylvilagus floridanus*, *Spilogale putorius*, *Procyon lotor*, *Urocyon cinereoargenteus*, *Odocoileus virginianus*, *Cervus canadensis*, and *Myotis sp.*, again indicating an ancient distribution farther north than at present.

TABLE 1. Location and occurrence of *Neotoma* remains.

Cave	Quadrangle, County	Occurrence and Important Associations
Freeman's Pit	Whitehall, Monroe	A dozen <i>Neotoma</i> with <i>Ursus</i> , <i>Spilogale</i> , and <i>Erethizon</i> in the explored top 17 inches of an osteiferous, laminated silt-clay deposit.
Hidden Pit Cave	Whitehall, Owen	One <i>Neotoma</i> in the top 4 inches of the silt floor of a dome.
Brinegar's Cave	Stanford, Monroe	Two <i>Neotoma</i> , one in a small nest with 2 <i>Ursus</i> .
Beetree Cave	Stanford, Monroe	One <i>Neotoma</i> in a nest, and another in a silt with <i>Erethizon</i> near an old entrance.
Trap Door Cave	Stanford, Monroe	A large nest with few bones.
Anderson Pit Cave	Clear Creek, Monroe	A large nest with 8 <i>Neotoma</i> and a human parietal fragment. Another nest was largely of vegetal material.
Sullivan's Cave	Owensburg, Lawrence	A large nest with 7 <i>Neotoma</i> , <i>Ursus</i> , <i>Erethizon</i> , and <i>Cervus</i> . Possibly the nest of Bader and Hall (1). Several other nests in the cave.
Carcass Crypt Cave	Bedford West, Lawrence	A nest with large <i>Ursus</i> bones and one <i>Neotoma</i> . Five <i>Neotoma</i> were contemporaneously associated with <i>Ursus</i> , <i>Spilogale</i> , and <i>Didelphis</i> in a carbon-rich area overlain by a sterile silt-clay layer.
Stroud Cave	Valeene, Orange	One <i>Neotoma</i> with <i>Erethizon</i> , among several nests.
N. Jim Cave	Mauckport, Harrison	One <i>Neotoma</i> in an osteiferous, fissure in-washed silt deposit. A <i>Spilogale</i> dentary nearby was not necessarily associated.
Cave near North Vernon	Hayden, Jennings	<i>Neotoma</i> skull and <i>Ursus</i> tooth on surface near the entrance.

From Indiana's caves have recently come numerous "Recent fossils" of *Neotoma* (Table 1), some as far north as western Monroe county (Fig. 1), and many with extensive associated faunas (Tables 2 and 3).

### Discussion

*Neotoma* distribution in the past was most likely concurrent with the limits of both of Indiana's karst areas, according with its cave and

TABLE 2. *Fauna recovered from the various Neotoma nests.*

Species	Beetree Cave <sup>1</sup>	Anderson Pit Cave <sup>2</sup>	Sullivan's Cave <sup>3</sup>	Stroud Cave <sup>4</sup>
<i>Myotis sp.</i>	27	61	95	3
<i>Pipistrellus subflavus</i>	3	3	23	1
<i>Peromyscus sp.</i>	8	47	28	5
<i>Microtus sp.</i>	3	25	12	6
<i>Neotoma floridana</i>	1	8	7	1
<i>Blarina brevicauda</i>	4	30	28	4
<i>Sciurus sp.</i>	2	3	2	1
Indet. mole	1	3	1	1
<i>Bufo sp.</i>	1	4	1	—
Indet. frogs	2	2	2	—
Plethodontidae	2	2	5	4
Colubridae	1	3	2	1
Indet. bird	—	3	2	1

<sup>1</sup>Also from Beetree Cave were: Indet. large bat, 1; Indet. bat, 13; *Synaptomys cooperi*, 2; *Tamias striatus*, 3; *Marmota monax*, 1; Indet. small carnivore, 1; *Sylvilagus floridanus*, 1; *Odocoileus virginianus*, 1; *Ambystoma sp.*, 1; Crotalidae, 2; Indet. fish, 1; and snails.

<sup>2</sup>Also from Anderson Pit Cave were: Indet. large bat, 1; *Synaptomys cooperi*, 3; *Tamias striatus*, 1; *Marmota monax*, 1; *Sorex sp.*, 3; *Procyon lotor*, 2; Indet. small carnivore, 1; *Didelphis marsupialis*, 1; *Sylvilagus floridanus*, 1; *Odocoileus virginianus*, 2; *Homo sapiens*, 1; *Ambystoma sp.*, 1; *Terrepene sp.*, 1; Crotalidae, 1; Indet. fish, 1-3(?); snails; crayfish; and small clams.

<sup>3</sup>Also from Sullivan's Cave were: *Eptesicus fuscus*, 1; Indet. bats, 6; *Synaptomys cooperi*, 1(?); *Tamias striatus*, 1; *Marmota monax*, 1; *Erethizon dorsatum*, 1; *Ursus americanus*, 1; *Procyon lotor*, 2; *Urocyon cinereoargenteus*, 1; Indet. small carnivore, 1; *Didelphis marsupialis*, 1; *Sylvilagus floridanus*, 1; *Odocoileus virginianus*, 1(?); *Cereus canadensis*, 1; *Ambystoma sp.*, 2; Crotalidae, 2; Indet. fish, 3-6(?); aquatic snails; crayfish; small clams; bird eggshell (?).

<sup>4</sup>Also from Stroud Cave were: Indet. large bat, 1; *Marmota monax*, 2; *Erethizon dorsatum*, 1; *Procyon lotor*, 1; *Didelphis marsupialis*, 1; *Sylvilagus floridanus*, 1; *Odocoileus virginianus*, 1(?); Indet. frog or toad, 3; *Terrepene sp.*, 1; Naticrinae, 1; Indet. fish, 1; snails; crayfish; small clams.

bluff crevice habitat. Nests were observed in the wall solution anastomoses, in fissures, crevices, on ledges, and in breakdown piles; *Neotoma* bones, however, occurred in many depositional situations. Nests seem to have been used over again by successive woodrats. With time, the vegetal materials of the nest disintegrate, concentrating the bones, rocks, snails, etc., emphasizing the faunal component, whereas in all actively inhabited nests observed by the author in Kentucky the floral component had hundreds of times more bulk. Thus, the older nests usually had the greater bone concentration. The floral contents of nests have yet to be studied. Of the faunal contents, only those bones actually chewed upon can be attributed to the woodrat's collecting behavior, these being most all of the larger than squirrel-sized forms, with deer bones often making up the bulk. The extensive microfaunal remains were predominantly those animals inhabiting the cave (*e.g.*,

TABLE 3. Faunal remains from the various cave deposits.

Species	Hidden Pit Cave <sup>1</sup>	Brinegar's Cave <sup>2</sup>	Beetree Cave <sup>3</sup>	Carcass Crypt Cave <sup>1</sup>	N. Jim Cave <sup>5</sup>	Cave, N. Vernon <sup>6</sup>
<i>Myotis sp.</i>	2	—	28	395	360	—
<i>Pipistrellus subflavus</i>	5	—	2	6	52	—
<i>Peromyscus sp.</i>	26	—	5	11	192	—
<i>Microtus sp.</i>	—	—	5	4	1	—
<i>Neotoma floridana</i>	1	2	1	5	1	1
<i>Tamias striatus</i>	3	—	3	4	4	1(?)
<i>Blarina brevicauda</i>	2	1	6	3	5	—
<i>Sorex sp.</i>	1	—	—	1	23	—
<i>Bufo sp.</i>	1	—	5	2	—	2
Plethodontidae	4	—	2	2	22	—
Colubridae	2	—	2	2	ca. 17	—
Indet. bird	—	1	2	2	1	3

<sup>1</sup>Also from Hidden Pit Cave were: Indet. bats, 2; *Sciurus sp.*, 1; *Marmota monax*, 1; *Ambystoma sp.*, 1; snails.

<sup>2</sup>Also from Brinegar's Cave were: *Sciurus sp.*, 1; *Ondatra zibethicus*, 1; Indet. mole, 1; *Ursus americanus*, 2; *Mephitis mephitis*, 1; *Odocoileus virginianus*, 1; *Terrepene sp.*, 1.

<sup>3</sup>Also from Beetree Cave were: Indet. bats, 9; *Sciurus sp.*, 1(?); *Erethizon dorsatum*, 1; *Scalopus aquaticus*, 1; Indet. canidae, 1; Indet. small carnivore, 1; *Sylvilagus floridanus*, 1; *Odocoileus virginianus*, 1; *Ambystoma sp.*, 1; Crotalidae, 2; Indet. lizard, 1; Indet. fish, 1; snails.

<sup>4</sup>Also from Carcass Crypt Cave were: Indet. large bat, 1; Indet. bats, 7; *Sciurus sp.*, 2; *Erethizon dorsatum*, 1(?); Indet. shrew, 3; Indet. mole, 1; *Ursus americanus*, 2; *Procyon lotor*, 1; *Spilogale putorius*, 1-2; *Mephitis mephitis*, 1; *Didelphis marsupialis*, 1; Indet. frog, 4; *Ambystoma sp.*, 1; *Terrepene sp.*, 1; Crotalidae, 1; snails.

<sup>5</sup>Also from N. Jim Cave were: *Eptesicus fuscus*, 5; Indet. bats, 24; Indet. frogs, 2; *Ambystoma sp.*, 1; Crotalidae, 2; Indet. lizard, 1; snails.

<sup>6</sup>Also from the Cave near North Vernon were: *Lasiurus sp(?)* 1; *Sciurus sp.*, 1; *Marmota monax*, 1; Indet. mole, 1; *Ursus americanus*, 1; *Procyon lotor*, 2; *Didelphis marsupialis*, 1; *Sylvilagus floridanus*, 3; *Odocoileus virginianus*, 2; Indet. frog, 1; Indet. turtle, 2; Indet. snake, 1; Indet. fish, 1; large clams.

mice, shrews, bats, salamanders) or trapped in it (e.g., toads, frogs, snakes) and attracted to the nest, as indicated by the completeness of their skeletons, lured by the numerous invertebrates infesting its organic contents. Dying bats probably fell into the nests from their roosts. The minute clams and crayfish remains seem to be unique to the nests, perhaps collected by the woodrats, though along with the fish, could also been in the stomachs of raccoons, snakes, etc. Thus, many of the forms from the nests probably post-date the *Neotoma*, being only pene-contemporaneous. Animals associated in the sedimentary deposits, however, were most likely contemporaneous. Excepting *Spilogale*, *Ursus*, *Erethizon*, and *Cervus* the associated fauna seems to be similar to that at present, the latter three exterminated from southern Indiana by the mid-1800's, and *Spilogale* with an ancient northerly distribution, much as *Neotoma*. This *Neotoma-Ursus-*

*Erethizon-Spilogale* component commonly occurs together, and can be used locally to recognize a Prehistoric fauna. From faunal evidence the *Neotoma* archaeo-range seems to have been presettlement at minimum, and post-Pleistocene by the lack of true fossil fauna. The presence of *Didelphis*, known to be a late arrival in the Eastern United States (3), sealed in the Carcass Crypt sediments confirms a maximum of at least a few thousand years for at least that deposit.

Illinois and Missouri also have "Recent fossil" finds. Jerry Long cave, Ralls County, Missouri, included a large percentage of *Neotoma*, *Marmota monax*, *Ursus americanus*, *Sylvilagus floridanus*, and *Spilogale* sp., among others. The bones were thought to have accumulated "a few hundred years prior to about 1850". *Neotoma* may inhabit that same area presently, but in less abundance (10). In Meyer cave, Monroe County, Illinois, bones of 535 *Neotoma* were associated with one of the most extensive Recent age faunas ever recovered in the United States, and included *Spilogale* and *Erethizon* where they do not presently occur. *Neotoma* was there 50 miles northwest of its living population (11). *Spilogale* has been recorded from the Modoc Rock Shelter, Randolph County, Illinois, where it does not presently occur, from a level radiocarbon dated at between 4,500 and 2,500 years B.D. (9). Other than the "Recent fossil" finds of Bader and Hall (1) and the author, *Spilogale* has not been definitely recorded in Indiana, paralleling the Illinois situation.

Significantly, by Recent fossil evidence from three Midwest states *Neotoma* has had a distribution much farther north than at present, in Indiana almost 70 miles from the historically recorded Wayndotte *Neotoma*. The distance of the range delineation, age of the Illinois *Spilogale*, inferred ages of other *Neotoma*, and association with *Didelphis* permits a generalized age of a few thousand years, with a wide age span between northerly and southerly sites, to be inferred.

There is a general opinion that following the glaciations climate has changed from cool to warmer than present, and now cooler again. During this warm phase prairies are thought to have expanded easterly, and southern elements northerly (12). Parmalee (11), on the Meyer cave remains, regards *Erethizon* and several other northern forms as belonging to the cool-moist climate of approximately 9,500-7,500 B.C., and *Spilogale* and others as belonging to the warm-dry period of approximately 3,500-1,500 B.C. These forms, including the woodrat, were regarded as becoming expatriated, being unable to adjust to a replacement in vegetation type.

As *Neotoma floridana magister* ranges almost abruptly to the southern borders of Indiana at the Ohio River, yet also ranges up through the cooler Appalachian area, temperature would not seem to play a strong role locally in its distribution. South-central Indiana's vegetation is similar, if not identical, to that of adjacent Kentucky, where *Neotoma* is common. Except for the Ohio River the karst habitat is continuous. Thus, *Neotoma* could probably inhabit Indiana's karst area today. The author holds that there was a widespread, and

effective (*i.e.*, lack of disjunct colonies) depopulation of *Neotoma* in the northerly portion of its range, rather than just an ancient northerly extension, and that with time *Neotoma* would regain its former distribution were it not hampered by its slow immigration (*e.g.*, from cave system to cave system, the Ohio River crossing). The widespread nature of the depopulation would seem to point to climate as the cause; however, with the ecological plasticity of *Neotoma* only an extreme in climate would seem to displace it. The associated fauna indicates that climate was not then at an extreme. Thus, some other ecological factor, perhaps an indirect result of a mild climatic change, would seem to be the cause of the *Neotoma* depopulation.

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#### Literature Cited

1. BADER, ROBERT S., and JOHN S. HALL. 1960. Mammalian remains from an Indiana cave. *J. Mammal.* 41:111-112.
2. COPE, E. D. 1872. Observations on Wyandotte Cave and its fauna. *Amer. Natur.* 6:406-422.
3. GULDAY, JOHN E. 1958. The prehistoric distribution of the opossum. *J. Mammal.* 39:39-43.
4. HALL, E. RAYMOND, and KEITH R. KELSON. 1959. The mammals of North America. The Ronald Press, New York, N.Y. 819 p.
5. HICKIE, P. F., and THOMAS HARRISON. 1930. The Alleghany wood rat in Indiana. *Amer. Midland Natur.* 12:169-174.
6. KIRKPATRICK, CHARLES M., and CLINTON H. CONAWAY. 1948. Some notes on Indiana mammals. *Amer. Midland Natur.* 39:128-136.
7. MUMFORD, RUSSELL E. 1969. Distribution of the mammals of Indiana. Monogr. No. 1, Indiana Acad. Sci., Indianapolis, Ind. 114 p.
8. PACKARD, A. S. 1888. The cave fauna of North America, with remarks on the anatomy of the brain and origin of the blind species. *Mem. Nat. Acad. Sci.* 4:16.
9. PARMALEE, PAUL W., and DONALD F. HOFFMEISTER. 1957. Archaeozoological evidence of the spotted skunk in Illinois. *J. Mammal.* 38:261.
10. ———. and KARL W. JACOBSON. 1959. Vertebrate remains from a Missouri cave. *J. Mammal.* 40:401-405.
11. ———. 1967. A recent bone deposit in southwestern Illinois. *Nat. Speleol. Soc. Bull.* 29:119-147.
12. SMITH, PHILIP W. 1965. Recent adjustments in animal ranges, p. 633-642. In H. E. WRIGHT, JR., and DAVID G. FREY (eds.), *The Quaternary of the United States*. Princeton Univ. Press, Princeton, N.J. 922 p.