

Late Pleistocene Remains of Boreal Voles (Genera *Phenacomys* and *Clethrionomys*) from Southern Indiana Caves

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Introduction

The cool, moist and sometimes more equable climates (42) of the Late Pleistocene created environments that supported many now extinct animals, as well as a number of existing animals that once occurred in areas that they presently do not occupy (extralimital = extralocal, 55). Sometimes abundant in the fossil record are the shrews and microtine rodents, which, often with restricted modern distributions, are particularly sensitive to climatic change, and are thought to be good paleoecological indicators. This paper records the fossil occurrence of *Phenacomys intermedius*, the heather vole and *Clethrionomys gapperi*, the boreal red-backed vole in Indiana.

The heather vole is presently distributed over much of Canada, south through the Rocky Mountains (Figure 1), where dry, open forest with a coniferous component and understory of heaths (dwarf birch, willow and blueberry) is prime habitat (58), though it can also be found in a wide variety of coniferous situations from wet to dry in times of abundance (30). The boreal red-backed vole presently ranges throughout Canada, the Rocky and Appalachian Mountains and into Wisconsin and Michigan in the midwest (Figure 2), where it is most common in mixed conifer/deciduous forests, especially where the floor is littered with logs and stumps. It can be found in the brushy understory of forest edge situations (58). The red-backed vole appears to be less restricted than the heather vole, because it can supplement its diet by grazing (58). The distribution of the red-backed vole led Evermann and Butler in 1894 to suggest that it might possibly be found in the bogs and tamarak swamps of northern Indiana (8), though no evidence of this has ever been found.

Leslie Fay has identified teeth of *Phenacomys*, recovered from pre-Wisconsinan (perhaps pre-Illinoian) sediments at the Green Creek locality, Parke County, Indiana (Fay, personal communication, 1984), the first boreal vole fossils to be found in Indiana. This discovery prompted the author to identify in detail the microtine rodent material previously recovered from several southern Indiana caves, thereby identifying *Phenacomys* as well as *Clethrionomys*. Floatation material from the Prairie Creek Site, Daviess County, Indiana, was also scanned for boreal microtines. Preliminary results were published in 1984 (55). Further investigation at the cave localities has led to the present report.

Descriptive Paleozoology

In all, deposits from four caves in Lawrence, Harrison and Jennings counties, Indiana have produced 130 teeth (22 minimum individuals) of *C. gapperi* and 18 teeth (8 minimum individuals) of *Phenacomys* cf. *P. intermedius*. The Prairie Creek Site produced 5 teeth (4 minimum individuals) of *C. gapperi*. Only molar teeth were identified, using the criteria of Guilday and Parmalee (30) and Semken (58). The Prairie Creek materials are deposited in the Glenn A. Black Laboratory of Archaeology, Bloomington, Indiana. The cave materials, largely from undescribed faunas, are on file with the author.

Abbreviations: L, R, left, right; M1, M2, M3, upper molars; m1, m2, m3, lower molars; MNI, minimum number of individuals; cm, centimeters; m, meters.

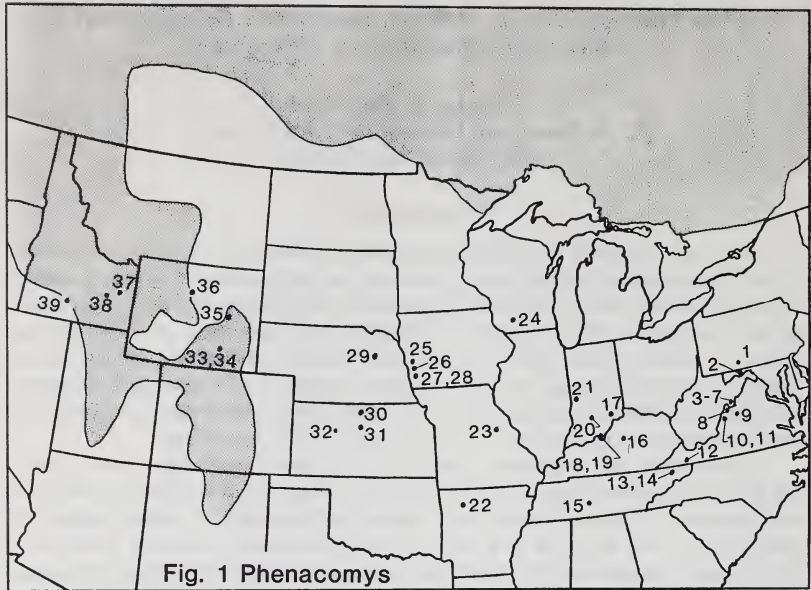


FIGURE 1. Modern distribution and fossil occurrence of *Phenacomys intermedius* (modern range after Hall, (32); citation of fossil occurrence after each locality; *Pre-Wisconsinan localities, all others Wisconsinan/early Holocene in age).

1. New Paris No. 4, Bedford Co., PA (29). 2*. Cumberland Cave, Allegany Co., MD (30). 3*. Trout Cave, Pendleton Co., WV (30) 4. New Trout Cave, Pendleton Co., WV (14). 5. Eagle (Eagle Rock) Cave, Pendleton Co., WV (21). 6. Hoffman School Cave, Pendleton Co., WV (22). 7. Mandy Walters Cave, Pendleton Co., WV (22). 8. Straight Canyon Fissure, Highland Co., VA (38). 9. Natural Chimneys, Augusta Co., VA (19). 10. Clark's Cave, Bath Co., VA (31). 11. Back Creek Cave No. 2, Bath Co., VA (31) 12. Meadowview Cave, Washington Co., VA (30). 13. Baker Bluff Cave, Sullivan Co., TN (24). 14. Guy Wilson Cave, Sullivan Co., TN (28). 15. Cheek Bend Cave, Maury Co., TN (46) 16. Welsh Cave, Woodford Co., KY (27). 17. Cave near North Vernon, Jennings Co., IN (Richards, this report). 18. N. Jim Cave, Harrison Co., IN (Richards, this report). 19. King Leo Cave, Harrison Co., IN (Richards, this report). 20. Sullivan's Cave, Lawrence Co., IN (Richards, this report). 21.* Green Creek Locality, Parke Co., IN (Fay, personal communication, 1984). 22. Peccary Cave, Newton Co., AR (58). 23. Graham Cave, Montgomery Co., MO (30). 24. Moscow Fissure, Iowa Co., WI (11; 51). 25*. Cudahy fauna, Little Sioux faunule, Harrison Co., IA (30). 26. Oakland local fauna, Pottawattamie Co., IA (3). 27. Craigmile local fauna, Mills Co., IA (52). 28. Waubonsie local fauna, Mills Co., IA (52). 29. Northeast NB (65). 30*. Hall Ash, Jewell Co., KS (7). 31*. Cudahy fauna, Wilson Valley faunule, Lincoln Co., KS (34;35). 32. Trapshoot local fauna, Rooks Co., KS (60). 33. Bell Cave, Albany Co., WY (67). 34. Horned Owl Cave, Albany Co., WY (23). 35. Little Box Elder Cave, Converse Co., WY (1). 36. Little Canyon Creek Cave, Washakie Co., WY (30). 37. Wasden (Owl) Cave, Bonneville Co., ID (*Phenacomys* sp: 20). 38. Moonshiner Cave, Bingham Co., ID (66). 39. Wilson Butte Cave, Jerome Co., ID (18).

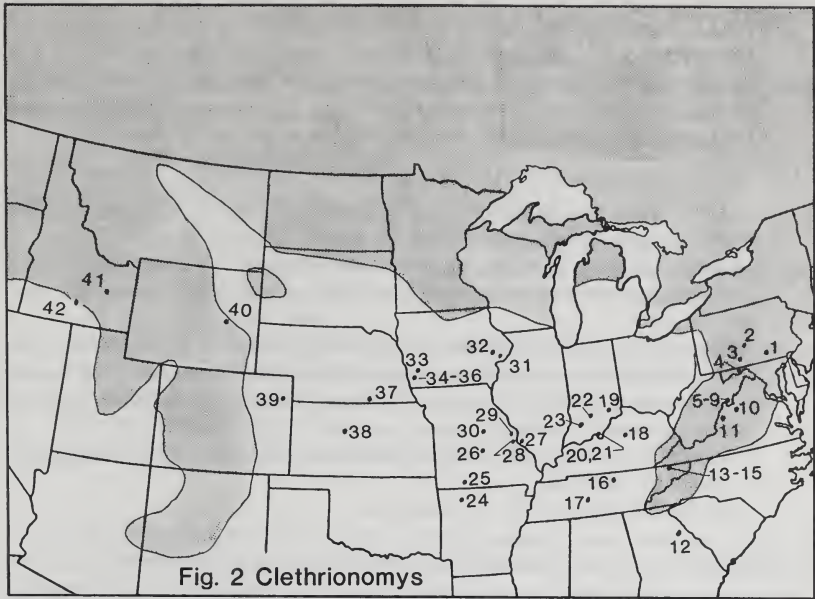


FIGURE 2. Modern distribution and fossil occurrence of *Clethrionomys gapperi* (modern range after Hall, (32); citation of fossil occurrence after each locality; *Pre-Wisconsinan localities, # Middle and Late Holocene localities, all others Wisconsinan/early Holocene in age).

1. Bootlegger Sink, York Co., PA (25).
2. Frankstown Cave, Blair Co., PA (50).
3. New Paris No. 4, Bedford Co., PA (29).
- 4*. Cumberland Cave, Allegany Co., MD (41).
- 5*. Trout Cave, Pendleton Co., WV (38;41).
6. New Trout Cave, Pendleton Co., WV (14).
7. Eagle (Eagle Rock) Cave, Pendleton Co., WV (21).
8. Hoffman School Cave, Pendleton Co., WV (22).
9. Mandy Walters Cave, Pendleton Co., WV (22).
10. Natural Chimneys, Augusta Co., VA (19).
11. Clark's Cave, Bath Co., VA (31).
12. Little Kettle Creek, Wilkes Co., GA (64).
13. Baker Bluff Cave, Sullivan Co., TN (24).
14. Carrier Quarry Cave, Sullivan Co., TN (58).
15. Riverside Cave, Sullivan Co., TN (38).
16. Robinson Cave, Overton Co., TN (26).
17. Cheek Bend Cave, Maury Co., TN (46).
18. Welsh Cave, Woodford Co., KY (27).
19. Cave near North Vernon, Jennings Co., IN (Richards, this report).
20. N. Jim Cave, Harrison Co., IN (Richards, this report).
21. King Leo Cave, Harrison Co., IN (Richards, this report).
22. Sullivan Cave, Lawrence Co., IN (Richards, this report).
23. Prairie Creek site, Daviess Co., IN (Richards, this report).
24. Peccary Cave, Newton Co., AR (58).
25. Zoo Cave, Taney Co., MO (37).
26. Bat Cave, Pulaski Co., MO (33).
- 27#. Meyer Cave, Monroe Co., IL (44).
28. Crankshaft Cave, Jefferson Co., MO. (49).
- 29#. Barnhart Site, MO (57).
30. Brynjulfson Caves, Boone Co., MO (48).
- 31#. Mud Creek fauna, Cedar & Scott Cos., IA (40).
- 32#. Rock Run Shelter, Cedar Co., IA (57).
- 33#. Site 13 ML 124 (12).
- 34#. Garrett Farm local fauna, Mills Co., IA (9).
35. Craigmile local fauna, Mills Co., IA (52).
36. Waubonsie local fauna, Mills Co., IA (52).
- 37*. Angus, Nuckolls Co., NB (38;41).
38. Duck Creek, Ellis Co., KS (41).
39. Jones-Miller, Yuma Co., CO (59).
40. Little Box Elder Cave, Converse Co., WY (1).
41. Moonshiner Cave, Bingham Co., ID (66).
42. Wilson Butte Cave, Jerome Co., ID (18).

LOCALITY 1: Green Creek Locality, Parke Co., Indiana

MATERIALS: *Phenacomys*: ca. 30 teeth.

OCCURRENCE: Fluvial silts of pre-Wisconsin (perhaps pre-Illinoian) age.

PUBLISHED RECORDS: Unpublished (L.P. Fay, personal communication, November, 1985).

LOCALITY 2: Sullivan Cave (Owensburg Quad.), Lawrence Co., Indiana

MATERIALS: *Phenacomys*: 4 teeth (L,RM1; LM3; molar fragment), 3 MNI.

Clethrionomys: 2 teeth (Lm1; Rm3), 2 MNI.

OCCURRENCE: Remains recovered from within a 23 cm deep mixed silt/sand/gravel deposit in an abandoned floor stream channel, some 600 m inside the cave.

IMPORTANT ASSOCIATIONS: Extinct: *Dasyurus bellus*, beautiful armadillo. Extralimital: *Spermophilus tridecemlineatus*, thirteen-lined ground squirrel; *Geomys* cf. *G. bursarius*, plains pocket gopher; *Spilogale putorius*, spotted skunk; *Neotoma floridana*, eastern woodrat.

COMMENTS: Boreal voles occurred from below the organic top 5 cm of deposit downward to bedrock.

PUBLISHED RECORDS: (55;56).

LOCALITY 3: King Leo Cave (Depauw Quad.), Harrison Co., Indiana

MATERIALS: *Phenacomys*: 9 teeth (L,RM1; RM2 + RM3; L,Rm1; 2L, 1Rm3), 2 MNI. *Clethrionomys*: 16 teeth (L,RM1; RM1 (or M2); L,RM2; 1L,2RM3; 2L, 1Rm1; Lm2; 1L,2Rm3), 2 MNI.

OCCURRENCE: Bones occurred within a 5-10 cm thick silt deposit on the bedrock floor of an abandoned stream channel deep within cave (probable old entrance, now closed, couple hundred meters away).

IMPORTANT ASSOCIATIONS: Extinct: Muskox Sp. (under study). Extralimital: *Martes pennanti*, fisher.

COMMENTS: Many of the small bones, including boreal vole teeth, were splintered and crusted with a white, chalky mass, probably representing the scat of a carnivore.

PUBLISHED RECORDS: (55)

LOCALITY 4: N. Jim Cave (Mauckport Quad.), Harrison Co., Indiana

MATERIALS: *Phenacomys*: 1 tooth (Lm3), 1 MNI. *Clethrionomys*: 110 teeth (9L, 11RM1; 7L, 9RM2; 10L,11RM3; 1oL,1oRm1; 1oL,9Rm2; 7L,7Rm3); 8L,6R dentaries; 16 MNI.

OCCURRENCE: Boreal voles occurred in lowermost levels I through levels IV (5 cm through 30 cm) of a 65 cm deep stratified silt, clay, and gravel deposit on bedrock in a small alcove, some 30 m inside the pit cave (10.7 m deep).

IMPORTANT ASSOCIATIONS: Extralimital: *Sorex arcticus*, arctic shrew; *Sorex dispar*, dusky shrew; large *Sorex fumeus*, smoky shrew; *G. bursarius*, plains pocket gopher.

COMMENTS: Plains pocket gopher occurred in level IV; extralimital shrews in level I (lower part). This is the first notation of *Sorex dispar* for Indiana.

PUBLISHED RECORDS: (53; 54; 55)

LOCALITY 5: Cave near North Vernon (Hayden Quad.), Jennings Co., Indiana.

MATERIALS: *Phenacomys*: 4 teeth (2LM1; 2Rm1), 2 MNI. *Clethrionomys*: 2 teeth (2Rm1), 2 MNI.

OCCURRENCE: Bone recovered from a partially indurated silt and gravel se-

quence at the 5 cm through 18 cm level in a 23 cm deep deposit on bedrock, in a short upper passage ca. 5 m from the entrance.

IMPORTANT ASSOCIATIONS: Extralimital: thirteen-lined ground squirrel; plains pocket gopher.

COMMENTS: Fish bone predominates in the riverine fauna.

PUBLISHED RECORDS: (53; 55)

LOCALITY 6: Prairie Creek Site, Daviess Co., Indiana.

MATERIALS: *Clethrionomys*: 5 teeth (LM3; 4Lm1), 4 MNI.

OCCURRENCE: All teeth recovered from Unit C, a mixture of Holocene and Pleistocene material, in an alluvial redeposit of sediments and bone flushed from a late Pleistocene lake basin.

IMPORTANT ASSOCIATIONS: Many extinct and extralimital forms in unit D (Pleistocene), but reworking with younger sediments above obscures the faunal unity of Unit C.

COMMENTS: No boreal voles recovered from Unit D floatation.

PUBLISHED RECORDS: (55;61;62)

Discussion

All of the Indiana boreal vole fossils are from extensive faunas consisting primarily of mammals, amphibians and reptiles (occasional fish and birds) that inhabit Indiana today. Association with other extralimital species and occasionally with extinct species suggests different climatic/ecologic conditions at the time of accumulation than exist in southern Indiana today. In Sullivan's Cave, Lawrence Co., and the cave near North Vernon, Jennings Co., the extralimital thirteen-lined ground squirrel, plains pocket gopher, and perhaps the extinct beautiful armadillo suggest open grassy areas or parkland, with well developed, perhaps sandy soils. The occurrence of *Clethrionomys* and *Phenacomys* in these faunas indicates that boreal forest environments also occurred in the vicinity.

The stratified sequence in N. Jim Cave, Harrison Co., however, provides the best biostratigraphic relationships. Level IV, with its extralimital plains pocket gopher and red-backed vole suggests mixed conifer/deciduous forests with open areas supporting well developed soils. Rhodes (52) has similar associations and he has referred to the environment as a "boreal grassland." Above this, through lower level I, the number of individuals expands enormously with *Clethrionomys* becoming abundant, *Phenacomys* scarcely represented, and an unusual concentration of *Sorex fumeus*. *Sorex fumeus*, like *Clethrionomys*, thrives best in moist woodlands where rocks and fallen trees provide good ground cover (2).

The large size of *S. fumeus* in lower level I agrees with, though are still larger than, those from the southern Appalachians today (54; Richards, in prep). The dusky and arctic shrews, which today do not overlap in distribution, occur together in lower level I. Upper level I appears to be represented by temperate deciduous woodland forms only. The entire sequence suggests that an open boreal forest/parkland (level IV) progressed to a closed boreal or mixed woodland (levels III through lower level I), being finally replaced by the deciduous forest of today (upper level I).

The N. Jim biostratigraphy suggest that most of the other cave localities with boreal voles and open area extralimital species (Sullivan, and cave near North Vernon) may be equivalent in age with the N. Jim level IV or earlier.

The Sangamon-aged Harrodsburg Crevice fauna, Monroe Co., Indiana also contained grassland/prairie species (eg. plains pocket gopher; spotted skunk; Pleistocene horse) but lacked diagnostic boreal microtines and shrews (43; 47; 63). The absence from Indiana faunas of the tundra-inhabiting collared lemming (*Dicrostonyx*), known

extraliminally from Pennsylvania (29), West Virginia (14) and southwestern Wisconsin (11) suggests that faunas from the Wisconsinan maximum (ca. 18,000 years ago) have not yet been recovered in Indiana, or that a tundra environment was poorly developed in the karst region of southern Indiana.

Guilday and Parmalee recorded 20 extralimital *Phenacomys* localities (30). At least 39 *Phenacomys* and 42 *C. gapperi* fossil localities are now known (Figures 1 and 2).

Many of the major late Pleistocene faunas surrounding Indiana such as Welsh Cave, Kentucky (27) Robinson (26) and Cheek Bend Caves (45;46), Tennessee, Crankshaft Pit (49) and Brynjulfson Caves (48), Missouri, also have a mixture of boreal woodland shrews and microtine rodents with such grassland species as thirteen-lined ground squirrel, plains pocket gopher, and extinct armadillo. Most of the report suggests that boreal woodlands with tracts of open grassy country or parkland were present during a somewhat cooler period of late Pleistocene/early Holocene accumulation.

Guilday, Martin and McCrady (29) noted a late Pleistocene movement of western forms into eastern woodlands in response to a greater variety of environments (eg. woodland and grassland). Foley (11) has also recorded the extension of western plains species into southwestern Wisconsin during the full Wisconsinan. *Geomys*, in particular, enjoyed a much greater distribution in the late Pleistocene (13;45).

Late Pleistocene faunas, in general, are characterized by extinct, extralimital and modern resident species. Most contain "disharmonious" elements, species that today are geographically separated and appear to have different ecological tolerances, occurring in the same deposit (15; 42; 58). These faunas are believed to result from individualistic responses of species to changing late Pleistocene environments (16; 39). The "Equable Climate" model suggests that reduced seasonal extremes (ie. higher winter low and lower summer high temperatures) resulted in a relaxing of range-limiting temperature and moisture constraints of the individual taxa, resulting in the "disharmonious" faunas (15; 42; 58). Rhodes (52) in interpreting average seasonal temperatures suggests that the equable glacial climate model did not apply to the northern midcontinent, where the Wisconsinan winters were cooler than at present. Holman (36) summarizes other alternatives for disharmonious faunas, and points out as does Fay (10) that most late Pleistocene herpetofaunas are represented by species that live in the area today.

Delcourt and Delcourt (6) suggest that disharmonious faunas reflect the response of animal communities to major climatic amelioration during the late glacial/early Holocene, as well as to an increase of habitat diversity resulting from vegetational and geomorphic instability. This concept is also in agreement with some faunal interpretations (17).

Considering *Phenacomys* and *Clethrionomys* apart from other extralimital species, the botanical evidence speaks clearly. Delcourt and Delcourt (4; 5) indicate that prior to about 12,000 years B.P. southern Indiana was covered with boreal forest. This forest was replaced over the next two thousand years by a mixed conifer/hardwood forest, and some 10,000 years B.P. by deciduous woodlands. With the replacement of boreal environments the habitats of boreal voles disappeared.

Phenacomys was more abundant in the lower and *Clethrionomys* more abundant in the upper levels of two well-documented, stratified localities (New Paris No. 4 (29) and Peccary Cave (58)). This suggests that *Phenacomys* is a better boreal indicator than *C. gapperi*. While *Phenacomys* does not presently occur in eastern North America, and does so only on late Pleistocene/ early Holocene sites, *Clethrionomys* is also known extraliminally from several Holocene localities and archaeological sites (57). This suggests that *Phenacomys* fossils in the Ohio valley can be good biostratigraphic markers for pre-Holocene faunas, as suggested by Guilday and Parmalee (30). *Clethrionomys* may extend into the early Holocene faunas in the region.

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