(25% available moisture) (Sexsmith, 1969). Thus, the results from our work and from the two previously mentioned studies suggest that seed dormancy increases as the amount of available soil moisture during the maturation period increases.

Although seeds of *A. patula* var. *robusta* are dispersed in late spring, they do not germinate until late summer and early autumn. During the 3 years of the study reported here, dense populations of *A. patula* var. *robusta* germinated and became established in September and October at the site where the seeds were collected. In all likelihood, the differences in dormancy and germination characteristics of freshly-matured seeds disappeared during the summer after-ripening period, and by September and October of the respective years seeds produced in 1971, 1972 and 1973 gave similar germination percentages. Thus, in the case of *A. patula* var. *robusta* preconditioning has no real ecological significance in the population dynamics of the species. This study does suggest, however, that differences in the environment during seed maturation can cause differences in dormancy and germination of freshly-matured seeds and cautions against assigning ecotypic status to plants producing seeds in different environments.

ACKNOWLEDGEMENT

The temperature data used in this study were provided by Jerry Hill, Advisory Agricultural Meterologist, National Weather Service. Campus Farm. Lexington, Kentucky. Unpublished data.

LITERATURE CITED

Baskin, J. M. and C. C. Baskin. 1973. Plant population differences in dormancy and germination characteristics of seeds: Heredity or environment? Amer. Midl. Natur. 90:493-498.

Carver, W. A. 1936. The effect of certain environmental factors on the development of cotton seed, germinating ability, and resultant yield of cotton. Proc. Fla. Acad. Sci. 1:150.

Fowler, D. P. and T. W. Dwight. 1964. Provenance differences in the stratification requirements of white pine. Can. J. Bot. 42:669-675.

Gleason, H. A. 1952. The New Britton and Brown Illustrated Flora of the Northeastern United States and Adjacent Canada. The New York Botanical Garden. Lancaster Press, Inc., Lancaster, Penn.

Habeck, J. R. 1958. White cedar ecotypes in Wisconsin. Ecology 39:457-463.

McKell, C. M., J. P. Robinson and J. Major. 1962. Ecotypic variation in medusahead, an introduced annual grass. Ecology 43:686-698.

McNaughton, S. J. 1966. Ecotype function in the *Typha* community-type. Ecol. Monogr. 36:297-325.

Mergen, F. 1963. Ecotypic variation in *Pinus strobus* L. Ecology 44:716-727.

Pegtel, D. M. 1972. Effects of temperature and moisture on the germination of two ecotypes of *Sonchus arvensis* L. Acta Bot. Neerl. 21:48-53.

Rowe, J. S. 1964. Environmental preconditioning, with special reference to forestry. Ecology 45:399-403.

Sexsmith, J. J. 1969. Dormancy of wild oat seed produced under various temperature and moisture conditions. Weed Sci. 17: 405-07.

Stearns, F. and J. Olson. 1958. Interactions of photoperiod and temperature affecting seed germination in *Tsuga canadensis*. Amer. J. Bot. 45:53-58.

United States Department of Commerce, Weather Bureau. 1971. Climatological Data. Kentucky. Vol. 66.

———. 1972. Climatological Data. Kentucky. Vol. 67.

———. 1973. Climatological Data. Kentucky. Vol. 68.

Wilcox, J. R. 1968. Sweetgum seed stratification requirements related to winter climate at seed source. Forest Sci. 14:16-19.

Winstead, J. E. 1971. Populational differences in seed germination and stratification requirements of sweetgum. Forest Sci. 17: 34-36.

JOURNAL OF THE TENNESSEE ACADEMY OF SCIENCE

VOLUME 50, NUMBER 3, JULY, 1975

CARIBOU (*RANGIFER TARANDUS* L.) FROM THE PLEISTOCENE OF TENNESSEE

JOHN E. GUILDAY, HAROLD W. HAMILTON
Carnegie Museum of Natural History, Pittsburgh, Pennsylvania

and

PAUL W. PARMALEE
University of Tennessee, Knoxville, Tennessee

ABSTRACT

Caribou (*Rangifer tarandus* L.) are reported from three caves in Northeastern Tennessee (36½ °N. lat.). This documents the southernmost known range extension of the caribou in Eastern North America.

INTRODUCTION

Caribou remains have been recovered from three caves in Sullivan County, Northeastern Tennessee, about 9 miles south of the Virginia/Tennessee border, approximately 36½° North Latitude. The caves lie in the Upper Tennessee River drainage (North and South Fork Holston River Valleys) within 25 miles of one another, in the Ridge and Valley section of the Appalachian Mountains physiographc province (set map, locality 5). The Ridge and Valley section, lying in Tennessee between the Cumberland Plateau to the west and the Unaka Range of the Great Smoky Mountains to the east, is a continuum of long, even-crested mountain ridges and confined intermontane valleys, all parallel, trending northeast to southwest, some 800 miles from Pennsylvania to Northern Alabama. This provided a minimum of topographic obstacles for southern range extensions of periglacial large mammals, such as the caribou, during glacial episodes.

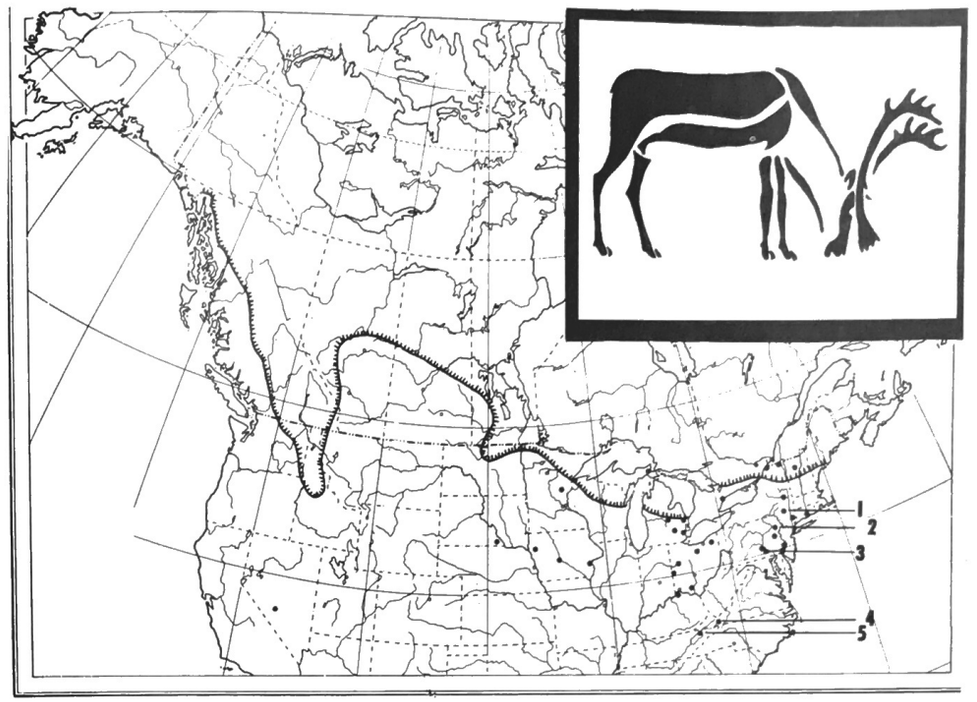

FIG. 1: Hachured line = Recent southern border of range of caribou (Rangifer tarandus), after Hall and Kelson, 1959; dots = Pleistocene paleontological finds: 1. Dutchess Quarry Cave, Orange Co., N.Y. 2. Hartman's Cave, Monroe Co., Pa. 3. Bootlegger Sink, York Co., Pa. 4. Saltville, Smyth Co., Va. 5. Guy Wilson Cave, Baker Bluff Cave, Beartown Cave, Sullivan Co., Tenn.[1]

LOCALITIES

Guy Wilson Cave, Sullivan County, Tennessee

Material. One right fused metacarpal III and IV, cracked but complete. University of Tennessee no. 2550 (Figure 2, lower). Found in association with a partial skeleton of dire wolf, *Canis dirus*, and isolated elements of *Mammuthus, Megalonyx, Tapirus, Erethizon*, in 1972 by Mr. Charles C. Coney, and donated by him to the University of Tennessee. Excavations in 1969 by Carnegie Museum produced remains of at least 12 peccaries, *Platygonus compressus*, and the boreal rodents *Phenacomys intermedius* and *Synaptomys borealis*. The cave matrix has been dug extensively and the contemporaneity of all collections is not clear. C^{14} dating of peccary bone (Table 2) indicates a late Wisconsinan age for at least part of the deposit.

Location. 2½ miles south of Bluff City, Tennessee, on the south side of the South Fork Holston River valley, 36°27′N.lat., 82°13′W.long., 14 miles east (upstream) of Baker Bluff Cave, and 23 miles southeast of Beartown Cave. Collections of bones from this cave are housed at the University of Tennessee (Department of Anthropology, Knoxville), East Tennessee State University (Taylor collection), and Carnegie Museum of Natural History (Section of Vertebrate Fossils).

[1] For additional sites plotted see: O. P. Hay, 1923; Fisher, 1955; Forsyth, 1963; Guilday, 1966; Ray *et al.*, 1967. Insert: modern Baffin Island Eskimo print.

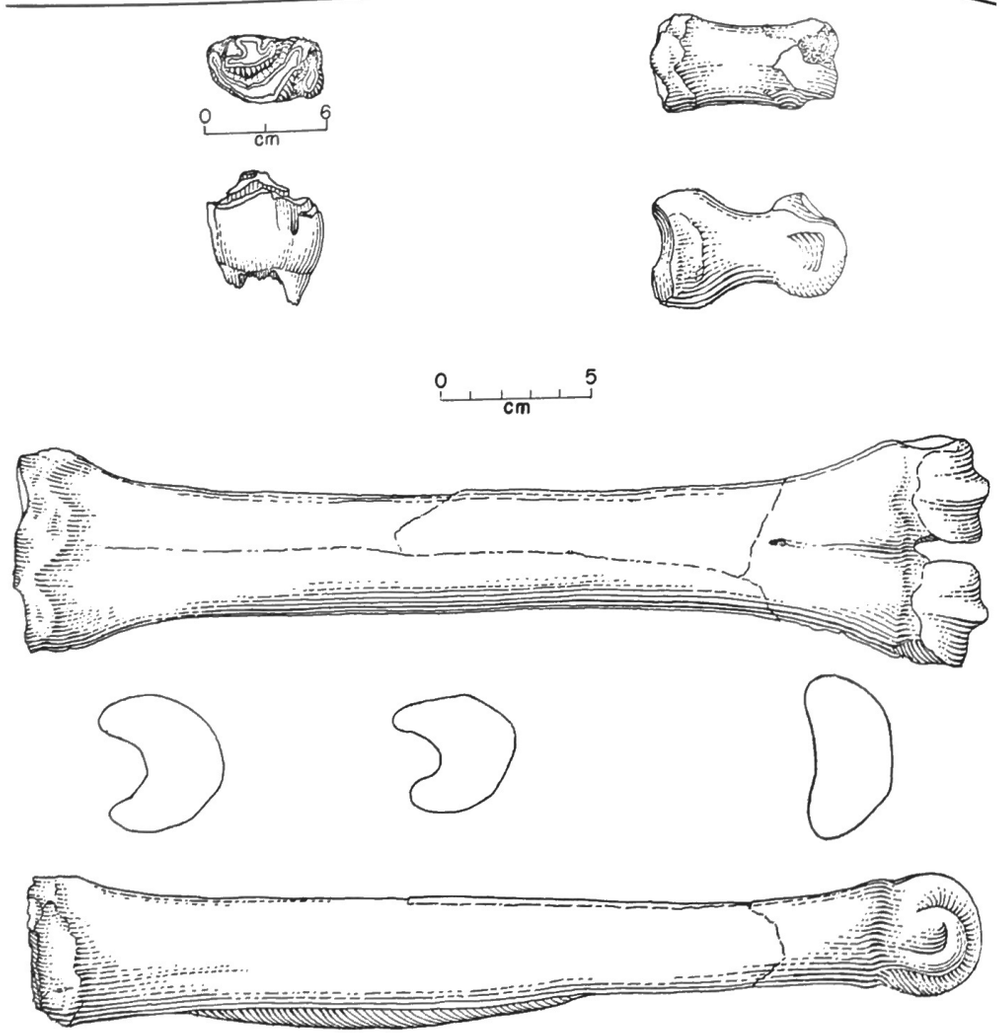

FIG. 2: Caribou (Rangifer tarandus) remains from Tennessee caves. Upper left: CM 24588, lower left fourth premolar, occlusal and labial views, Baker Bluff Cave, Sullivan Co. Upper right: CM 24308, second phalanx, dorsal and lateral views, Beartown Cave, Sullivan Co. Center and bottom: UT 2550, fused metacarpal III and IV, dorsal view, cross-sections, and lateral view, Guy Wilson Cave, Sullivan Co.

TABLE 1: Rangifer tarandus, right fused metatarsals III-IV, UT 2550, Measurements in mm, Guy Wilson Cave, Sullivan County, Tennessee.

Total length	200
Transverse width, distal end	45.7
Transverse width, proximal end	37.9
Transverse width, mid-shaft	23.7
Anteroposterior width, proximal end	26.9

Baker Bluff Cave, Sullivan County, Tennessee

Material: One lower left fourth premolar, CM 24588 (Figure 2, upper left), excavated from the 6-7 foot level of the cave by Harold W. Hamilton. Associated boreal mammals, including marten (*Martes americana*) and the voles (*Microtus xanthognathus, Phenacomys intermedius, Synaptomys borealis*), indicate a Wisconsin age. An additional tooth, a lower right fourth premolar, CM 24681, was found amidst Indian artifacts and food-bone fragments (Square #2, 0-1 foot) in the Holocene level by S. D. Dean, Jr. It probably had been displaced from the underlying boreal fauna

Location. 14 miles west (downstream) of Guy Wilson Cave, on the west bank of the South Fork Holston River, 36°27′30″N. lat., 82°28′W.long., alt. 1550 ft., 7 miles southeast of Kingsport, Tennessee.

Beartown Cave, Sullivan County, Tennessee

Material. One second phalanx, CM 24308 (Figure 2, upper right), recovered by S. D. Dean, Jr., in 1969. Mr. Dean states:

> "The material being sent was found approximately 40 feet from the cave entrance. The cave itself is hard to get to, being about 30 feet from the ground, in the face of a steep cliff. . . . In the tested area, hundreds of bones were present, and they seemed to be more numerous from five to eight inches under the cave floor. Below this area seemed sterile. Because the cave was so hard to get to, no matrix was taken out, so the material being sent was found on the cave site." (letter, Sept. 21, 1969).

In addition to the *Rangifer* phalanx, Dean's collection consisted of fragmentary teeth and bones (which may not be contemporaneous) of several other species of: Mammals: *Didelphis virginianus, Myotis,* sp., *Eptesicus fuscus,* leporid, sp., *Tamiasciurus hudsonicus, Neotoma floridana, Microtus* cf. *pennsylvanicus, Ondatra zibethicus, Mephitis mephitis, Mustela* cf. *frenata,* Birds: *Bonasa umbellus, Meleagris gallopavo, Ectopistes migratorius,* Fish: *Ictalurus,* sp., Reptile: *Chelydra serpentina,* Amphibians: *Rana,* sp., *Bufo,* sp., *Cryptobranchus allegheniensis.* A few freshwater gastropods and pelycypods were also encountered. All specimens are catalogued under CM 24308.

Location. On the south bank of the North Fork Holston River, 4 miles northwest of Kingsport, Tennessee, about .8 mile west of Bearton, 1.3 miles south of the Tennessee/Virginia border, 36°34′15″N.lat., 82°36′20″W.long.

DISCUSSION

Fossil caribou remains have been recorded from numerous bog and cave deposits in Eastern North America, including Ontario, Minnesota, Michigan, Wisconsin, Illinois, Kentucky, Ohio, Vermont, Connecticut, Pennsylvania, New Jersey, and Virginia (summarized in Ray *et al.*, 1967). The three Sullivan County records listed above are the first from the State of Tennessee and mark the southernmost range extension known to date of caribou in eastern North America, 50 miles south of Saltville, Virginia (Ray *et al.*, 1967), approximately 200 miles southeast of the Wisconsin terminal moraine in Ohio, 800 miles south of their known eastern historic range. A tentative identification by Guilday of *Rangifer?* from Robinson Cave, Overton County, Tennessee (McCrady & Schmidt 1963; Matthews, 1971) is invalid, since the questionable premolars were later determined as those of the deer *Sangamona* (Guilday, *et al.*, 1969).

TABLE 2: C^{14} dates associated with Rangifer tarandus from Eastern North America.

Site	Date	Reference
Dutchess Quarry, New York	12,530±370 yrs. B.P. (I-4137)	Funk et al., 1970
Saltville, Virginia	13,460±420 yrs. B.P. (SI-461)	Ray *et al.*, 1967
Guy Wilson Cave, Tennessee	19,700±600 yrs. B.P. (I-4163)	this paper

All Appalachian records of Pleistocene caribou, to date, are Wisconsinan in age. The Dutchess Quarry date (Funk, et al., 1970), table 2, was run upon uncharred caribou bone astensibly in association with a Cumberland fluted point. The Saltville and Guy Wilson dates were run on uncharred bone of other species of mammals, and even if they do not directly date the caribou, they do indicate the order of magnitude of the age of the deposits. The apparent correlation between C^{14} dates and latitude is believed to be spurious at this time (Table 2). The chance of each of the three dates being a terminal one is remote.

Caribou ranged far to the south of the continental glacial margin in North America during at least Wisconsinan times. Eastern Tennessee is at the same latitude as the Great Smoky Mountains. The likelihood of certebrate fossils of any type from the higher altitudes of the Great Smokies is remote due to the lack of caves or bog sites in that high, well-drained, limestone-free area. Fossils have yet to be found in the caves of such low altitude areas as Tuckaleechee Cove, Cades Cove, and White Oak Sink, along the western rim of the mountain range, but in the light of the Sullivan County records it seems quite probable that caribou occurred in the Great Smokies during the Pleistocene.

ACKNOWLEDGEMENTS

We wish to thank Mr. Charles C. Coney and Mr. S. D. Dean, Jr. for donating caribou remains found by them to the University of Tennessee and Carnegie Museum of Natural History, thereby making this paper possible. Research was conducted under Naional Science grant no. GB42258, made to the senior author. Figure 2 drawn by Erica Hansen.

LITERATURE CITED

Fisher, D. W. 1955. Prehistoric mammals of New York. The New York State Conserv., Vol. 9, No. 4, pp. 18-22.

Forsyth, J. L. 1963. Ice Age census. The Ohio Conserv. Bull., Vol. 27, No. 9, pp. 16-19, 31, 33.

Funk, R. E., D. W. Fisher, and E. M. Reilly, Jr. 1970. Caribou and paleo-Indian in New York State: A presumed association. Amer. J. of Sci., Vol. 268, pp. 181-186.

Guilday, J. E. 1966. *Rangifer* antler from an Ohio bog. J. of Mammal., Vol. 47, No. 2, pp. 325-326.

Guilday, J. E., H. W. Hamilton, and A. D McCrady. 1969. The Pleistocene vertebrate fauna of Robinson Cave, Overton County, Tennessee. Palaeovertebrata (Montpellier), Vol. 2, pp. 25-75.

Hall, E. R., and K. R. Kelson. 1959. The mammals of North America, Vol. II, 1,083 pp., Ronald Press Co., N.Y.

Hay, O. P. 1923. The Pleistocene of North America and its vertebrated animals from the states east of the Mississippi River and from the Canadian provinces east of longitude 95°. Carnegie Institution of Washington, 499 pp.

Matthews, L. E. 1971. Descriptions of Tennessee caves. Tenn. Dept. of Conserv., Bull. 69, 150 pp. Nashville.

McCrady, A. D., and V. Schmidt. 1963. Second interim report—late Pleistocene fossils from Robinson Cave, Tennessee. The Netherworld News, Pittsburgh Grotto, Nat. Speleol. Soc., Vol. 11, No. 2, pp. 19-27.

Ray, C. E., B. N. Cooper, and W. S. Benninghoff. 1967. Fossil mammals and pollen in a late Pleistocene deposit at Saltville, Virginia. J. of Paleontol., Vol. 41, No. 3, pp. 608-622.