muscle to be studied. This device may also prove useful for local topical application or injection of small amounts of solutions into a cell by means of a micropipet.

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References and Notes

1. W. L. Nastuk and A. L. Hodgkin, *J. Cellular Comp. Physiol.* **35**, 39 (1950).
2. J. W. Woodbury and A. J. Brady, *Science* **123**, 100 (1956).
3. W. E. Garrey, *J. Cellular Comp. Physiol.* **1**, 209 (1932).
4. F. V. McCann, *Science* **137**, 340 (1962).
5. Supported by U.S. Public Health Service grant H 4747(C2) to Jane Sands Robb.
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Early Postglacial Beavers in Southeastern New England

Abstract. Wood cut by *Castor canadensis*(?) has been found at or near the base of five peat deposits studied in open exposure. Beavers apparently entered the region about 12,000 years ago and rapidly occupied most low-lying places. Many existing bogs may be the result of early dams. The disturbance of pond sediments by beavers probably affects pollen stratigraphy. Charred wood in early beaver structures indicates forest fires and the possibility that the climate was drier than it is today.

Beaver-cut wood is turning up with surprising regularity in the basal or lower parts of peat deposits in southeastern New England. I have examined five deposits in open exposure in recent years and all were rich in beaver-gnawed wood at or near the base of the postglacial organic sediments. These exposures have afforded a rare opportunity to examine the coarser features of peat deposits that are not seen in the usual method of study, by coring. Because of the scarcity of peat bodies exposed in cross section, the importance of beaver activity in the lower parts of peat deposits has been overlooked by palynologists and students of postglacial organic sedimentation. Three of the exposures that I examined were along the shore and were produced by marine erosion; two were in man-made excavations.

The characteristic signs of beaver are faceted and teeth-marked ends of logs, branches, and twigs; logs from which the small side branchlets have been neatly trimmed; and the absence of bark from many pieces of wood. At first glance the faceted ends and neatly severed branchlets resemble the work of a hatchet. Indeed, I am indebted to Douglas Byers, of the Robert S. Peabody Foundation for Archeology, Phillips Andover Academy, Andover, Massachusetts, who first pointed out to me the marks of the beavers' incisors on the cut surfaces and thereby prevented me from making an erroneous deduction as to the origin of the faceting. These teeth marks are generally delicate and show up only if the surface is washed and cleaned of peat adhering to it and viewed in raking light. In all five peat deposits that were studied, well over 50 percent of the wood found in the lower part of the peat showed signs of beaver work.

Squibnocket bog, on Martha's Vineyard, Massachusetts, is exposed in the upper part of the sea cliff at Squibnocket Point, on the southwestern part of the island, a few miles southeast of Gay Head. At this point the cliff is about 35 feet high and the bog is exposed for about 125 feet along the cliff, attaining a maximum thickness of 10 feet. The organic sediments rest on very compact till. The sediments are divisible into the following units, from the base up: (i) diatomaceous gyttja, 5 inches; (ii) brown fibrous peat with beaver-cut wood in the lower part, 48 inches maximum; (iii) black gyttja, 16 inches maximum; (iv) dark-brown fibrous peat, 40 inches maximum; (v) windblown sand, up to about 24 inches maximum. The pollen stratigraphy of this exposure has been studied independently by Gail A. Boyan and by J. Gordon Ogden III, but their findings have not yet been published. Leaves of small arctic-type willows and the cones of black(?) spruce occur in the lower part of unit ii. The pollen of unit i is predominantly nonarboreal.

The beaver-cut wood consists mostly of saplings lying parallel to the beds and flattened to various degrees. It forms a dense mat of interlaced branches about 30 inches thick at the western end of the exposure. This probably represents a collapsed beaver lodge rather than a dam, for the topography of the site suggests that most of the bog, and the original beaver dam with it, has long since gone out to sea because of cliff erosion. An age determination of 11,650 ± 250 years for one beaver-cut pine sampling (*1*) was made by the radiocarbon method (*2*). A determination of 12,700 ± 300 years was made for a thin sample from the base of unit i (*3*). It is interesting to note that some logs in the beaver structure are partly charred, undoubtedly as a result of forest fires.

The hurricanes of 1954 exposed a small bog in a low sea cliff on the east coast of Block Island, Rhode Island. The bog is about 0.4 mile south of The Harbor, at the place where the road takes a sharp turn and skirts the shore for a few hundred feet. The peat rests on light-gray silt with cobbles, possibly a postglacial solifluction deposit. From the bottom upward the bog contains (i) brown woody fibrous peat with logs, 10 inches; (ii) brown gyttja, 21 inches; (iii) reddish-brown gyttja with wood, 12 inches; (iv) black gyttja, 5 inches; (v) interlaminated fine sand and organic silt, 16 inches; (vi) brown sandy loam (buried soil), 17 inches; and (vii) windblown very fine sand, 12 inches. An age determination of 12,090 ± 200 years for small twigs from the base of unit i was made by the radiocarbon method (*4*).

In 1954, when I first studied this exposure, I was not aware of the beaver-wood problem and made no attempt to withdraw wood from the peat with sufficient care to preserve the ends. I returned to the site in 1960 to check the wood, with this problem in mind, and found that in the interim most of the exposure had been covered by large stone riprap. However, several pieces of wood were extracted from a small patch of the basal layer that was still uncovered by stone, and these showed beaver cutting. It is quite possible, therefore, that most of the wood in the lower part of this peat deposit is the result of beaver activity.

A small patch of peat was discovered by J. P. Schafer at intertidal level at the western end of the beach fronting Breakwater Village, a settlement of small summer cottages one-fourth mile west of Point Judith, Rhode Island. I examined the deposit and found beaver-cut wood embedded in brown gyttja overlying a thin, gray, medium-coarse sand. This in turn overlies compact, stratified dark-gray till (*5*). Several small spruce cones were found in the brown gyttja, along with the beaver-cut wood. This is a freshwater deposit formed when sea level was lower than it is at present. The small patch of peat is probably the remnant of a once larger and thicker deposit. This deposit has not been investigated further, but because of the close agreement of the brown gyttja and the beaver-cut wood with the gyttja and wood of other deposits that have been dated, and because of the presence of spruce cones, it is believed that the beaver wood probably is from 10,000 to 12,000 years old.

Two adjoining but apparently completely separate peat deposits were exposed in the summer of 1960 during the excavation of a large underground garage in the lower end of the Boston Common (*6*). One deposit, North peat, appeared to have been a freshwater body during the entire course of its existence (it was covered by fill in the 19th century). The South peat, though separated from the North peat by only 100 feet of gravel and till, began as a freshwater bog, but as sea level rose the bog was succeeded by a salt marsh, about 3800 years ago. This is clearly shown by an abrupt change from a deep red-brown leaf-bearing sedge peat to a light yellow-brown peat made up of *Spartina* debris. Both the North and the South peat bodies contain abundant beaver-cut wood in their freshwater section.

The North peat occupies a kettle and in the beginning was a pond about 20 feet deep. It appears that the small pond gradually filled with laminated clayey gyttja until it was sufficiently shallow to support a beaver colony. From the distribution of beaver wood throughout the peat it appears that beavers occupied the site more or less continuously until colonial times.

The South peat lacks the thick basal section of laminated lake clays of the North peat. Thin gyttja with a large amount of beaver wood, some partly charred, occurs at the base. An age determination of 11,000 ± 240 years for beaver wood and spruce cones from the layer has been made (*7*). This deposit may well be the result of construction of a beaver dam, perhaps built by the same beaver colony that occupied the kettle of the North peat. The original beaver dam probably lies to the west of the excavation, somewhere under the Boston Public Garden. Beaver-cut wood of the following types has been found in both peat deposits of the Boston Common: white pine, red pine, spruce, balsam fir, hemlock, red cedar, black birch, and oak.

Teeth marks on all the wood examined were of the size of teeth marks of *Castor canadensis,* our existing Canadian beaver. No teeth marks of *Castoroides,* the giant Pleistocene beaver, have been seen, nor have any bones yet been found. The cutting of conifer trees by beavers, though surprising at first sight, is not unknown among beavers today. Warren (*8*) noted that conifers are preferred by some present-day beavers even when aspen and other trees that are more common in beaver diet are handy.

The finding of beaver-cut wood at, or close to, the base of four of these peat deposits points to the possibility that beaver dams were responsible for the bodies of water in which the organic sediments were deposited. That is, there is presumptive evidence that beaver dams, built across shallow valleys, created beaver ponds which then persisted through thousands of years, slowly accumulating vegetational debris. The original beaver dams have been obliterated with time, perhaps in part engulfed by the peat fill of the ponds in back of them. Where the dams had been built in series up and down valleys, the positions of the dams are additionally obscured by the continuous chain of peat-filled beaver ponds. The small sample of this study therefore suggests that in early postglacial time the landscape of southern New England may have been much less swampy and poorly drained than it is today.

Castor canadensis, or a very close precursor, must have entered southeastern New England about 12,000 years ago, soon after the retreat of the last ice sheet. The beavers rapidly multiplied and, if this small sample is typical, colonized almost all small valleys, ponds, and poorly drained depressions.

For the student of the late Pleistocene the facts cited in this report (*9*) raise two important questions. (i) What has been the effect of beavers on pollen stratigraphy? Considerable stirring up of bottom sediments in the shallow ponds in which these animals lived must have occurred. This may account for the fact that the early postglacial pollen stratigraphy of eastern North America is somewhat less regular than that of Europe. (ii) What is the significance of the charred wood? The charring in all likelihood is the product of naturally set forest fires—that is, we must assume this until such time as the presence of early postglacial man in the region has been demonstrated. Lightning-set forest fires are very rare in the present humid climate of New England. Is it not possible, then, that the charred wood is an indication of a drier climate in early postglacial time?

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References and Notes

1. The wood was identified by Elso S. Barghoorn, Harvard University.
2. The sample was Humble, O-766. I am indebted to the Geochemical Research Laboratory, Humble Oil and Refining Company, Houston, Texas, and to Mr. Milton Williams and Prof. Barghoorn for the two radiocarbon determinations discussed here.
3. M. Rubin and C. Alexander, *Am. J. Sci. Radiocarbon Suppl.* **2**, 129 (1960). The age determination for the sample (W-710) was made in the Washington Laboratory of the U.S. Geological Survey. See also Stuiver *et al., Am. J. Sci. Radiocarbon Suppl.* **2**, 51 (1960), for data on three basal samples (Y-647-1, 2, 3) dated at the Yale radiocarbon laboratory.
4. M. Rubin and H. E. Suess, *Science* **123**, 442 (1956). The age determination for sample W-255 was made in the Washington Laboratory of the U.S. Geological Survey.
5. J. P. Schafer, *U.S. Geol. Surv. Geol. Quad. Map No. GQ-140* (1961); C. A. Kaye, *U.S. Geol. Surv. Bull. No. 1071-I* (1960).
6. C. A. Kaye, *U.S. Geol. Surv. Profess. Papers No. 424-B* (1961), pp. 73–76.
7. The sample was Humble, O-1256.
8. E. R. Warren, *American Society of Mammalogists Monographs, No. 2* (Williams and Wilkins, Baltimore, 1927).
9. Publication of this report was authorized by the Director of the U.S. Geological Survey.

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High-Energy Sound Associated with Fright in the Dolphin

Abstract. A sound produced by the Atlantic bottlenose dolphin (*Tursiops truncatus*) under conditions of fright is described and illustrated. It is suggested that a similar sound may be the basis of the long-distance alarm signal reported in other cetaceans.

During recent behavioral studies of captive *Tursiops truncatus* (Montagu), in which behavior and concurrent sound production (especially whistles) were being investigated, an apparently context-specific sound produced under fright conditions has been discovered. The sound is apparently inaudible out of water, but it was heard clearly on underwater listening equipment. The equipment used was a Clevite (oyster type O modified) hydrophone and a Tandberg (model 6) tape recorder. The frequency response of such a system is flat from 50 cy to 10 kcy/sec, which is not adequate for studying the full range of broad-band pulses such as echolocation clicks. The sound we report on here was recorded several times, and a sonagram of one of these recordings was prepared (Fig. 1). The sound consists of a loud, sharp "crack" with a jarring impact on the listener's ear. Recent reviews of the sound production of cetaceans make no reference to it (*1*).

The sound was elicited several times from either one or both of two tame adult female *T. truncatus* on an occasion in daylight when a life-size plastic model of a young dolphin was dragged toward them. Their behavior at this