# POLLEN STRATIGRAPHY AND AGE OF AN EARLY POSTGLACIAL BEAVER SITE NEAR COLUMBUS, OHIO[1]

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ABSTRACT

A former bog, buried under urban debris, was exposed during foundation excavation at Refugee Road, southeast Columbus, Ohio. Pollen samples were collected at two-inch intervals from 2 to 7½ feet below the present surface.

The uppermost 3 feet of peat, overlying 2½ feet of detritus gyttja, contained numerous pieces of spruce (*Picea*), willow (*Salix*), and juniper (*Juniperus*). Many pieces showed beaver toothmarks and were presumably a part of a beaver dam or lodge. Because of their small width, the beaver toothmarks are interpreted as representing those of the common beaver, *Castor canadensis*. Pollen analyses indicate that beaver occupied the site more than 12,000 years ago, and that the site was abandoned prior to the increase in oak and other hardwood pollen which marks the beginning of the hypsithermal interval.

## INTRODUCTION

Published evidence of the presence of the common beaver, *Castor canadensis* in Ohio during early post-glacial time is virtually non-existent. A giant beaver, *Castoroides ohioensis*, is described by Prufer and Baby (1963) from the Northern Lights shopping center excavations in north Columbus, Ohio. Wood fragments associated with this giant beaver were radiocarbon dated at 11,480 ± 160 years, B.P. (Y–526). These wood fragments showed toothmarks of both *Castor* and *Castoroides* (J. L. Forsyth, personal communication). Additional, earlier reports of *Castoroides* in Ohio are summarized by Hay (1923).

*Castor canadensis* today is known to exist as far north as 47°N latitude, where annual temperatures average less than 20°F. The species subsists primarily on a diet of willow (*Salix*) and aspen (*Populus*) (McNeel, 1964). This raises the question of whether the conditions under which the common beaver existed in early post-glacial time in central Ohio were similar.

The material recovered at the Refugee Road site contained beaver-gnawed willow (*Salix*) and spruce (*Picea*). Samples of both peat and wood from this site have been dated by radiocarbon analysis. From pollen analyses and correlations with surface pollen samples from elsewhere in northeastern North America, the general climatic conditions under which *Castor canadensis* probably existed here may be inferred.

The vegetational history of North America, as determined from pollen analyses, has been described by Sears (1930, 1933) and more recently by Ogden (1966) for Ohio, and by Deevey for New England (1939, 1951, 1957, Deevey and Flint, 1957). This sequence is divided into three major zones and includes: 1) a basal spruce and fir pollen zone, overlain by 2) an intermediate pine pollen zone, and 3) an upper oak pollen zone, subdivided into oak-hemlock, oak-hickory, and oak-chestnut (Deevey, 1943).

## POLLEN STRATIGRAPHY OF THE REFUGEE ROAD BEAVER SITE

The organic sediments (fig. 1) were uncovered in October, 1965, during foundation excavation at Refugee Road, southeast Columbus, Ohio (Franklin Co., Montgomery Twp., SW ¼, SW ¼, Sect 25, T5N, R22W). The deposit is in a former kettle north and west of the Johnstown-Reesville Moraine complex (B, fig. 2).

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FIGURE 1. Bog face from which pollen and radiocarbon samples were recovered. Small stakes mark stratigraphic units. Beaver-gnawed wood in center of section.

*Methods and Materials:* Samples were collected at 2-inch intervals throughout the 68-inch exposure and were placed in stoppered vials in the field. Samples (1.0 cc) were first sieved (screen mesh, 150 $\mu$), deflocculated in 10% KOH, and demineralized in cold, then hot 10% HCl. Silica was removed in a steam bath with 48% HF for 6–48 hours. The samples were acetolyzed (modified from Faegri and Iversen, 1964) and then washed in 10% KOH, stained with safranin, and mounted in silicon oil (2000 csk.). Pollen grains were counted at 320× magnification using apochromatic objectives; critical identifications were made at 800× and 1250× (oil immersion). The number of grains counted at each level ranged from 100 to 200, exclusive of spores and aquatic pollen.

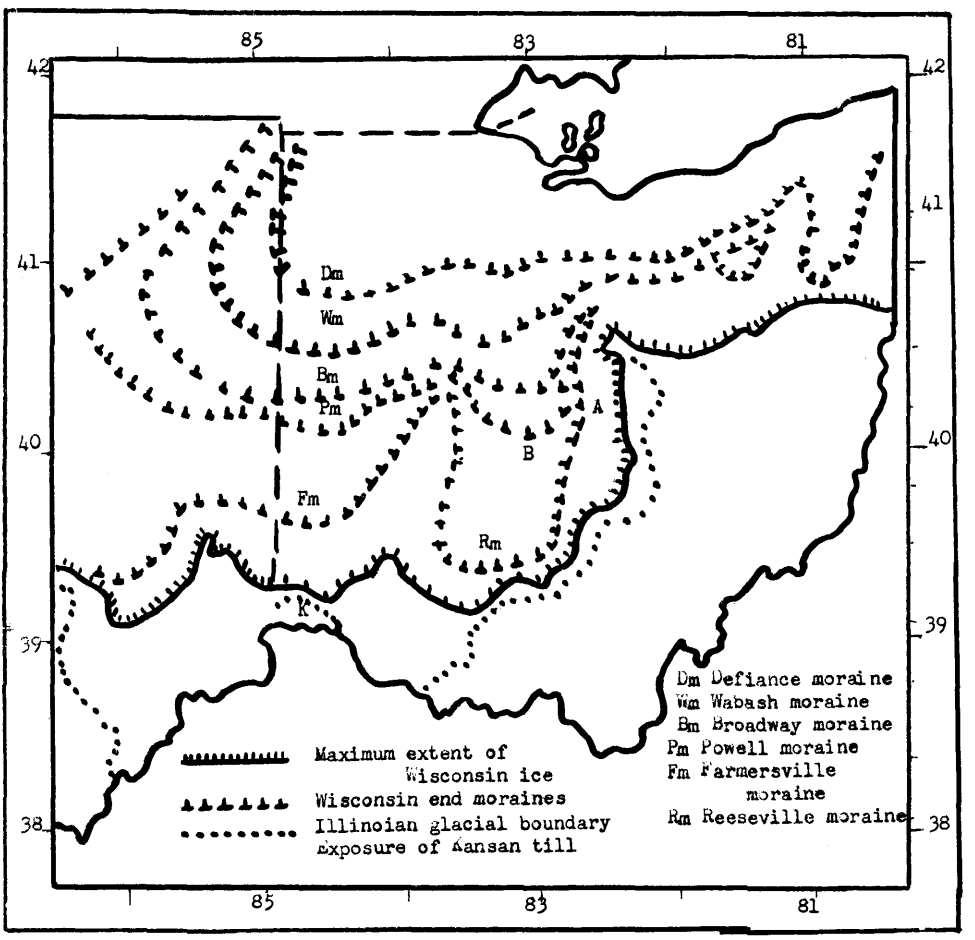


FIGURE 2. Glacial features of Ohio showing glacial boundaries and principal Wisconsin moraines. Point B marks the location of the Refugee Road site; point A is Torren's Bog.

Figure 3 shows the major pollen components of the sequence, plotted as percentage of total pollen. Sediment units are shown by symbols identified below the diagram. Pollen frequency was determined as the number of pollen grains per square centimeter of sample.

Unit 1 (basal 32 inches) consists of detritus clay gyttja, with small fragments

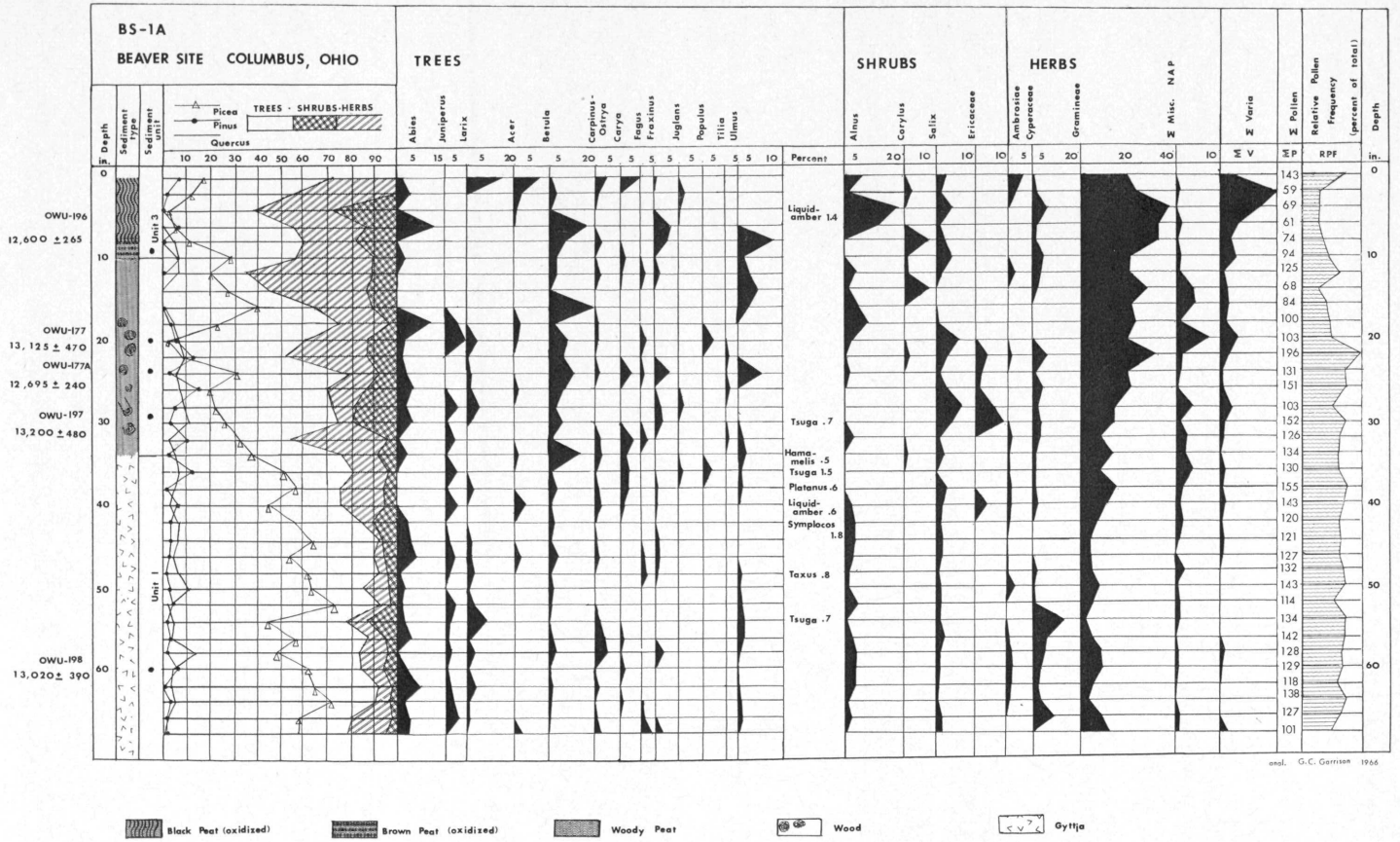


FIGURE 3. Diagram BS–1A. Summary pollen diagram of Refugee Road section. Pollen types are represented as percentage of total pollen. Relative frequency is calculated as the number of pollen grains/cm² of sample. Sediment units are identified by symbols below the diagram. Radiocarbon dates are indicated by solid circles in column 3 at the left of the diagram.

of wood and leaves near the upper part. A radiocarbon date from a sample 8 inches from the base of the unit was 13,020±390 years B.P. (OWU–198).

Unit 2 (10–36 inches) is a brown, fibrous, woody peat, containing beaver-gnawed willow (*Salix*), spruce (*Picea*) and juniper (*Juniperus*) wood. Single toothmarks range from ⅛″ to ½″ in width, characteristic of *Castor canadensis*, the modern Canadian beaver (fig. 4). Two wood samples from this section were

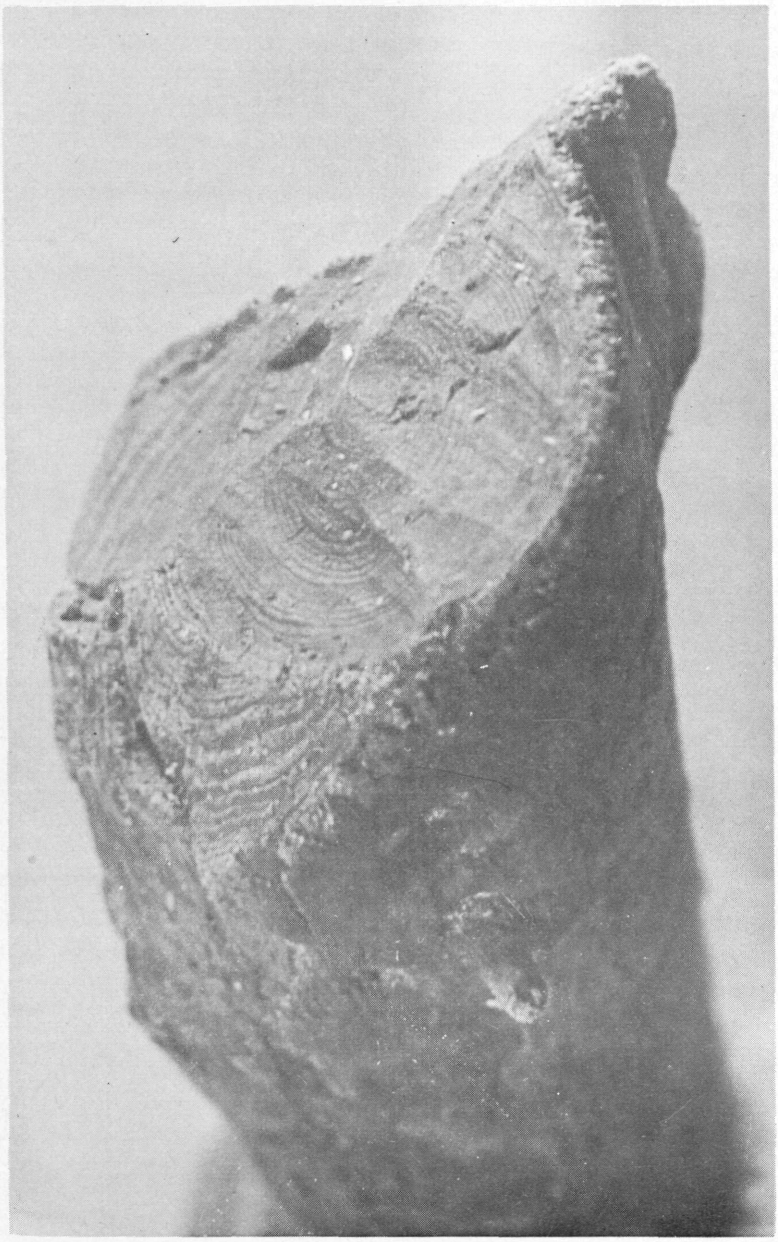

FIGURE 4. Juniper wood with ¼″-wide beaver toothmarks. Radiocarbon age of this wood is 13,000 years (OWU–177 and –177A).

dated at 13,125 ± 470 years B.P. (OWU–177) and 12,695 ± 240 years B.P. (OWU–177A), and a peat sample from this level was dated at 13,200 ± 480 years B.P. (OWU–197).

Unit 3 consists of 2 inches of oxidized brown peat overlain by 8 inches of

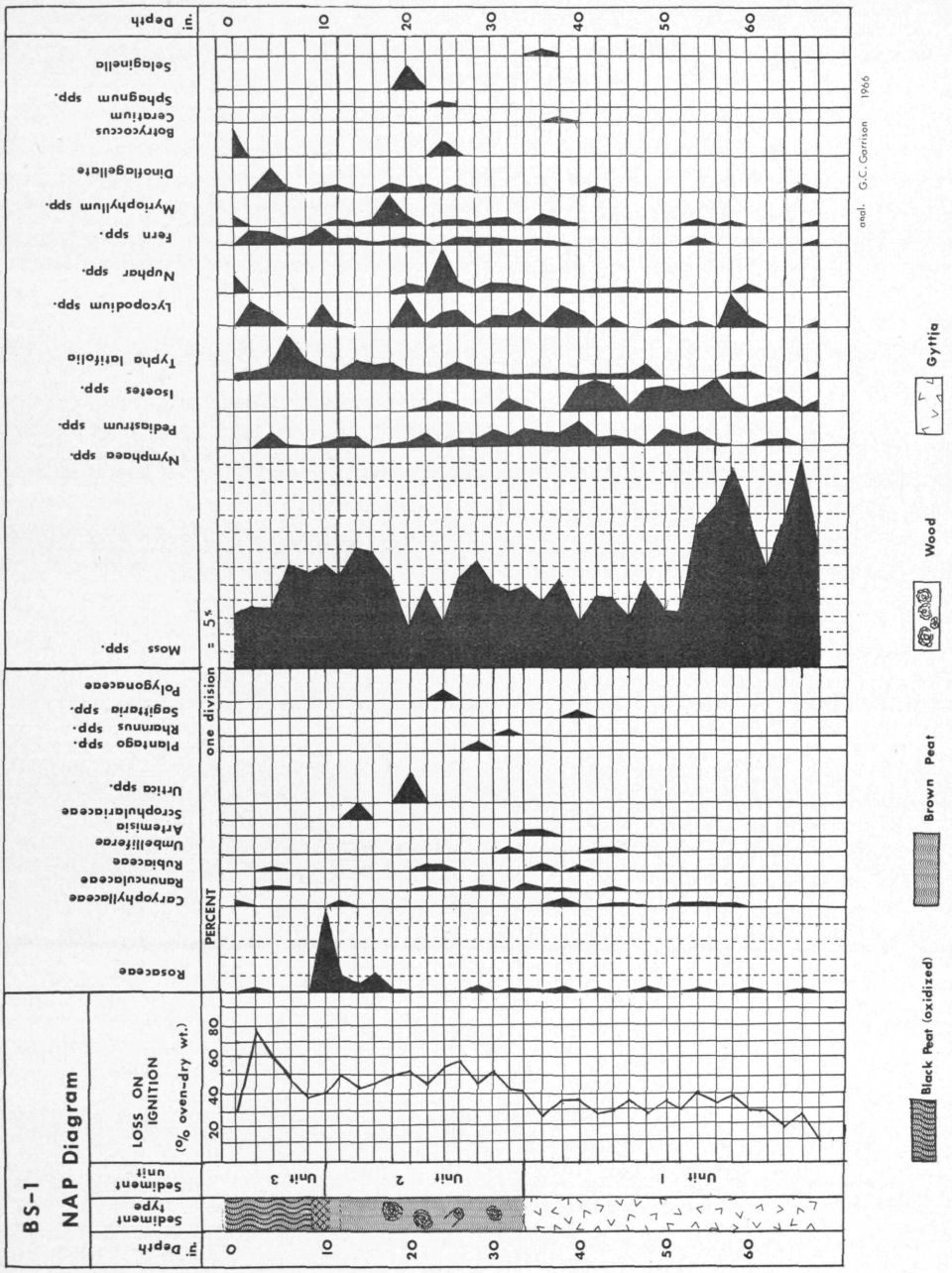


FIGURE 5. Diagram BS–1B. Nonarboreal pollen and spores are represented as per cent of total nonarboreal pollen. Loss on ignition is shown at left.

oxidized black peat. A radiocarbon sample from the brown peat gave a date of 12,600±265 years B.P. (OWU–196), indicating that the entire sequence spanned less than 1000 years of early post-glacial time.

*Pollen Stratigraphy.* The abundance of spruce pollen throughout the sequence is indicative of a generally cool moist climate, an interpretation also reached by Sears (1933). The high percentage of both grass and spruce pollen in the upper layers could be interpreted to indicate a warming and drying trend, although, in this case, secondary ecological succession due to interference by *Castor canadensis* is the more probable cause.

The presence of *Pediastrum* (fig. 5) indicates a lake environment. A lake surface would also be a collecting site for wind-disseminated pollen from distant areas, which could account for the presence of some deciduous pollen, such as oak, throughout the sequence, an interpretation similar to that of Smith and Kapp (1964).

Oak pollen was found consistently throughout the section, although percentages were low. Because of the cool climate implied by the abundance of spruce pollen, it is unlikely that oak trees were growing in the vicinity of the site (Ogden, 1965a). Pine pollen is also present throughout the section, though it makes up only a small percentage of the total pollen content. This small amount is to be expected, in view of the lack of success of pine today on the clay soils of central Ohio (Ogden, 1966; Sears, 1930). The presence of both the pine and oak pollen in this sequence is probably due to wind transport from some distance, rather than actual growth of these trees near the site.

The increasing percentages of organic material from Unit 1 to Unit 3 (fig. 6) and a corresponding increase in percentages of birch (*Betula*) and alder (*Alnus*) pollen may indicate a shoaling of the lake similar to stratigraphic and pollen sequences at a beaver site in Squibnocket Cliff, Martha's Vineyard, described by Ogden (1963). At a depth of twenty inches, *Pediastrum* is replaced by the pollen of *Typha*, *Myriophyllum*, and *Nuphar*, which are characteristic of shallow lakes. An increase in fern spores near the top of the section supports the inference of progressive drying and formation of a bog mat.

## CORRELATION WITH SURFACE POLLEN IN EASTERN NORTH AMERICA

Twenty-three pollen types from depths of 4″, 10″, 36″, 52″, and 60″ were compared, by a modified Spearman's Rank Correlation method (Ogden, 1962), with surface samples representing various sites in northeastern North America (table I).

Samples from near the base of the section (at depths of 36″, 52″, and 60″) show a high correlation (Rs>0.95) with surface samples from Nichicun Lake in

TABLE I

*Correlations of Refugee Road pollen samples with surface samples from northeastern North America. Correlations of less than 0.900 (Rs>0.900) not shown*

| BS–1 | 4 | 10 | 26 | 34 | 36 | 52 | 60 | 68 |
|---|---|---|---|---|---|---|---|---|
| GL | | .900 | .908 | | | | | |
| QL | | | | .947 | .920 | | | |
| LRL | | | .922 | .915 | | | | |
| LL | | | | .904 | | | | |
| CL | | | .915 | .914 | .938 | | .906 | |
| NL | | | | .906 | .967 | .952 | .965 | .933 |
| IKL | .919 | | | | | | | |

GL—Gray's Lake 42°N 88°W
QL—Queechy Lake 43°N 71°W
LRL—Little Round Lake 44°N 76°W
LL—Leech Lake 47°N 80°W
CL—Cedar Lake 49°N 80°W
NL—Nichicun Lake 53°N 71°W
IKL—Lake Ikro-owick (drained) 72°N 156°W

Quebec, at a latitude of 53°N. This region is part of the boreal forest region of Canada, and has an annual average temperature of 23°F (Terasmae and Mott, 1964). Conifers such as fir (*Abies*), spruce (*Picea*), and some pine (*Pinus*) characterize the vegetation. Enclaves of deciduous forest trees (birch and alder) may occur, although the density of these species decreases with an increase in latitude.

Samples from Unit 2, including the beaver-gnawed wood, at 10″, 24″, 34″ and 36″, show high correlations with surface pollen samples from Cedar Lake, Ontario, at a latitude of 47°N. Cedar Lake is representative of the colder, drier climate of the Northern Clay Forest, with principal pollen types limited to spruce (*Picea*), pine (*Pinus*), and birch (*Betula*). A low amount of ragweed and grass pollen is also characteristic of the area (Ogden, 1962).

Because pollen samples from Unit 3 (above 10″) are highly oxidized, certain resistant grains, such as grass, alder, and spruce, may be overrepresented. If this is the case, the pollen representation of the upper levels at Refugee Road must be considered to be of little value in the reconstruction of the forest history of the region.

## CORRELATION WITH TORREN'S BOG, OHIO

The pollen stratigraphy of the basal units at Torren's Bog, Licking County, Ohio (A, fig. 2), shows a high correlation with samples from Refugee Road (table II). Torren's Bog is located 40 miles northeast of the Refugee Road site, just within the Johnstown moraine (fig. 2).

Highest correlation occurs between the pollen spectrum at 26 inches at Refugee Road and the 710-to-730-cm region of the Torren's Bog core. Refugee Road samples from 52″ to 60″ correspond significantly to the materials from depths of from 760 to 865 cm at Torren's Bog, with the highest correlation at 760 cm. The high correlations ($Rs > 0.86$) of the Refugee Road samples with the 710-to-865-cm section of the Torren's Bog cores indicate the presence of a similar vegetation at the two locations at the time of accumulation of the deposits. Radiocarbon dates for the 710-to-865-cm region of the Torren's Bog core range from 12,000 to 14,000 years B.P. (Ogden, 1965b).

TABLE II

*Correlations of pollen samples from Refugee Road with Torren's Bog, Ohio (core TB–2)*

| Refugee Road—depth | 26″ | 52″ | 60″ |
|---|---|---|---|
| Torren's Bog—depth | | | |
| 0–600 cm | .600 | .500 | .300 |
| 620 cm | .787 | .706 | .742 |
| 640 cm | .653 | .000 | .318 |
| 660 cm | .688 | .000 | .311 |
| 680 cm | .819 | .533 | .616 |
| 710 cm | .876 | .676 | .745 |
| 730 cm | .859 | .879 | .909 |
| 740 cm | .859 | .824 | .862 |
| 745 cm | .815 | .870 | .893 |
| 760 cm | .665 | .991 | .976 |
| 770 cm | .580 | .983 | .955 |
| 780 cm | .000 | .964 | .921 |
| 790 cm | .830 | .910 | .934 |
| 810 cm | .725 | .961 | .960 |
| 820 cm | .808 | .910 | .926 |
| 830 cm | .694 | .959 | .962 |
| 840 cm | .752 | .979 | .945 |
| 860 cm | .848 | .829 | .867 |
| 865 cm | .797 | .928 | .935 |

The similarity of pollen stratigraphy at the two sites—high percentages of spruce followed by increasing percentages of birch and alder, and then an increase in the number of hardwoods—further represents evidence for the same climatic change, a transition from a cool, moist climate to a warmer, drier trend (Ogden, 1965b).

## COMPARISON WITH NEW ENGLAND SITES

The information gained at Refugee Road is very similar to results of studies by Kaye (1962) and Ogden (1963) of an eroded sea cliff at Squibnocket on the island of Martha's Vineyard, Massachusetts, an area also located within part of a Wisconsin terminal moraine. The sediment units at Squibnocket consist of a clay gyttja containing beaver-gnawed wood (spruce, willow, and pine), overlain by woody peat, black ooze, and sphagnum peat. Beaver toothmarks on the wood fragments are considered to be those of *Castor canadensis* (Kaye, 1962) and indicate the presence of a beaver lodge in the area. Wood samples from the lower forest bed within the gyttja are dated at 11,650 ± 250 years B.P. (W–710) and 11,352 ± 211 years B.P. (OWU–6), and wood from the upper forest bed was dated at 8820 ± 180 years B.P. (OWU–139). Basal-clay-gyttja samples associated with the lower forest bed gave dates whose average age is 12,000 years B.P. (Y–647–1, Y–647–2 and Y–647–3).

Wood from a similar pollen sequence at Point Judith, Rhode Island, gave a date of 10,906 ± 112 years B.P. (OWU–22) (Ogden and Hay, 1964), indicating beaver occupation of these eastern sites almost 1000 years later than the occupation at the Refugee Road site.

Thus, beaver in early post-glacial time is shown, by closely similar pollen and macrofossil evidence, to have been present in all three areas—Squibnocket Cliff in Massachusetts, Point Judith in Rhode Island, and Refugee Road in Ohio.

## CONCLUSION

Beaver-gnawed logs indicate the presence of a beaver (*Castor canadensis*) community in a kettle lake near Columbus, Ohio, approximately 13,000 years ago, soon after the retreat of Wisconsin ice from this part of Ohio (Burns and Goldthwait, 1958). Pollen samples from the site show predominantly spruce and fir, with some pine and hardwoods. The amount of tree pollen, especially spruce, decreases from the bottom to the top of the section, due principally to an increase in grass and other herbaceous pollen types. The deposit is truncated at the top, presumably by dessication prior to the onset of the hypsithermal interval. From radiocarbon dates on peat and wood samples from the section, it appears that the entire sequence includes no more than 1000 years, and represents the setting at and just after approximately 13,000 years ago.

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## REFERENCES CITED

**Burns, G. W.,** and **R. P. Goldthwait.** 1958. Wisconsin age forests in western Ohio. Ohio Jour. Sci. 58: 209–230.

**Deevey, E. S., Jr.** 1939. Studies on Connecticut lake sediments. Amer. Jour. Sci. 237: 691–724.

———. 1943. Additional pollen analyses from southern New England. Amer. Jour. Bot. 241: 717–753.
———. 1951. Late glacial and postglacial pollen diagrams from Maine. Amer. Jour. Sci. 249: 177–207.
———. 1957. Radiocarbon-dated pollen sequences in eastern North America. Geobot. Inst. of Zurich. 34: 30–37.
——— and **R. F. Flint.** 1957. Postglacial hypsithermal interval. Science 125: 182–184.
**Faegri, K.,** and **J. Iversen.** 1964. A textbook of pollen analysis, 2nd ed. E. Munksgaard, Copenhagen.
**Hay, O. P.** 1923. The Pleistocene of North America and its vertebrate animals from the states east of the Mississippi River and from the Canadian Provinces east of longitude 95°. Carn. Inst. Wash. publ. 322, 499 p.
**Kaye, C. A.** 1962. Early postglacial beavers in southeastern New England. Science 138: 906–907.
**McNeel, W., Jr.** 1964. Beaver cuttings in aspen indirectly detrimental to white pine. Jour. Wildlife Manag. 28: 861–863.
**Ogden, J. G., III.** 1962. Problems in comparisons of surface pollen samples with pollen stratigraphy (Abstr.). International Pollen Conference, Tucson, Arizona.
———. 1963. The Squibnocket cliff peat: radiocarbon dates and pollen stratigraphy. Amer. Jour. Sci. 261: 344–353.
———. 1965a. Pleistocene pollen records from eastern North America. The Bot. Rev. 31: 481–504.
———. 1965b. Great Lakes-Ohio River Valley INQUA Guidebook G, Day 9, Stop 9.6. VIIth INQUA Congress Guidebooks, published by Nebraska Academy of Sciences, Lincoln, Neb.
———. 1966. Forest History of Ohio. I. Radiocarbon dates and pollen stratigraphy of Silver Lake, Logan County, Ohio. Ohio Jour. Sci. 66: 387–400.
**Ogden, J. G., III,** and **R. J. Hay.** 1964. Ohio Wesleyan University natural radio-carbon measurements I. Radiocarbon 6: 340–348.
**Prufer, O. H.,** and **R. S. Baby.** 1963. Palaeo-Indians of Ohio. Ohio Historical Soc., Columbus, Ohio.
**Sears, P. B.** 1930. A record of post-glacial climate in northern Ohio. Ohio Jour. Sci. 30: 205–217.
———. 1933. Climatic change as a factor in forest succession. Jour. of Forestry 31: 934–942.
**Smith, J. G.,** and **R. O. Kapp.** Pollen analysis of some Pleistocene sediments from Illinois. Transactions of the Illinois State Acad. of Sci. p. 158–162.
**Terasmae, J.,** and **R. J. Mott.** 1964. Pollen deposition in lakes and bogs near Ottawa, Canada. Canad. Jour. Bot. 42: 1355–1363.