1

THE SUBWAY TREE

(Bald cypress, *Taxodium distichum*)

A tree stump over 36,000 years old unearthed in downtown Philadelphia provided clues to the city's geologic past and future.

Figure 1.1 Fragment of the Subway Tree, unearthed in 1931 at 8th and Locust Streets. Carbon-14 dating puts its age at greater than 36,600 years. This specimen is on exhibit at the Wagner Free Institute of Science of Philadelphia. (Courtesy of the Wagner Free Institute of Science of Philadelphia. Specimen accession number 15868.)

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In 1931 construction workers in Philadelphia discovered well-preserved tree stumps underground at a depth of 12 meters—3 meters below sea level. They were digging a subway tunnel at 8th and Locust Streets, one block west of the Tomb of the Unknown Soldier in Independence National Historical Park. The stumps were positioned upright in swamp sod buried in clay. One stump, referred to as "the Subway Tree," had a circumference of over 5 meters.[1]

Investigation of the Subway Tree

The consulting engineer of the project immediately notified the Academy of Natural Sciences, and a team of six scientists investigated. They identified the Subway Tree as bald cypress, *Taxodium distichum,* a southern wetland species whose current natural range begins almost two hundred kilometers to the south of Philadelphia and extends to Florida and the Gulf Coast. They examined the clay around the stump for diatoms; that they found none was evidence that the sediment that buried the swamp was not from the sea.[2]

Horace G. Richards, a member of the team, had earlier discovered marine fossils indicating that climate in this region before the last glaciation had been warmer than it is currently. He had also found fossil evidence that the sea level off the New Jersey coast had once been 91 meters (300 feet) lower than it is today. Richards hypothesized that the Subway Tree grew in a warm interglacial period before the last (Wisconsin) glaciation and that meltwater flowing down the Delaware River from distant glacial ice had inundated the swamp, buried it in sediment, and contributed to a rise in sea level. Richards acknowledged that against his hypothesis was the well-preserved state of the wood of the Subway Tree. In this location, preservation of wood older than the last ice age seemed implausible but possible.[3]

In 1960, almost three decades after Richards published his hypothesis, carbon-14 dating of the Subway Tree confirmed its antiquity—older than 36,600 years.[4] The Subway Tree was indeed older than Pennsylvania's last glacial ice, which existed north of Philadelphia 17,000 to 22,000 years ago.[5] Richards wrote, "After twenty-eight years, I have achieved vindication!"[6]

Pieces of the Subway Tree are on display at the Wagner Free Institute of Science of Philadelphia. Accompanying the wood is a chunk of clay from the excavation. Lynn Dorwaldt, librarian at the Wagner, told me that the Wagner accessioned these objects at the time of the excavation. The wood feels light in weight, not stony like petrified wood and not blackened like coal. Its grain is visible and smooth, with splintered ends in cross section. Nothing about the wood's general appearance gives a clue to its age, or to the glacial sediment that buried it.

Floods

Glacial meltwater had long been recognized as the source of extensive sedimentary deposits in the region of what is now Center City, Philadelphia. In two papers published in the early 1880s Henry Carvill Lewis, geologist at the Academy, described how receding glaciers produced these deposits:

> During the melting of the great Northern Glacier, whose southern terminus crossed the river probably near Belvidere, the flooded Delaware, then a great torrent five or ten miles wide and at least 150 feet deeper than it is now, deposited at first gravels and afterwards, when quieter, clays; while floating ice carried down already rounded boulders and dropped them upon its bed.…It thus appears that during the Glacial epoch the waters of the Schuylkill emptied into those of the Delaware at Falls of Schuylkill, the city proper being entirely submerged.[7]

> The great glacier which covered the whole northeastern portion of our continent, and which, as a great sea of ice, flowed in a continuous stream across Labrador, the Laurentian highlands of Canada, the Adirondacks, the Catskills and the Alleghenies, was proved to have finally stopped within sixty miles of our city. At the extreme edge of the glacier it heaped up a terminal moraine, composed of rock fragments brought from more northern regions, which moraine was shown to stretch in a continuous line completely across our State.[8]

Figure 1.2 Rock fragments mark the surface of the terminal moraine of the Wisconsin glaciation at its southern limit in the Delaware River basin. Photographed near Belvidere, New Jersey, 100 kilometers north of Philadelphia in 1916. (U.S. Geological Survey photo # 871-awc00871, by W. C. Alden)

Philadelphia brick clay

A recent geologic map shows glacial sediments distributed as Lewis described them in Philadelphia, although some of these deposits preceded the last glaciation.[9] The glacial deposits left bountiful brick clay close to the surface. Called Philadelphia brick clay, it was still in place when Lewis explored Center City's geology:

> THE PHILADELPHIA BRICK CLAY. The built-up portion of the city stands upon an extensive deposit of brick clay and gravel, sections of which are exposed in every cutting. The brick clay invariably overlies the gravel.[10]

Philadelphia brick clay supported the city's early building boom. During the eighteenth and nineteenth centuries, it was quarried in brickyards within the city, and Philadelphia produced more bricks than did any other city in America.[11] A map of the city in 1794 identifies fourteen brick kilns, including one in the area that currently is Rittenhouse Square.[12] By 1857, the city had fifty brickyards, each of which produced on average a million bricks per year and employed about thirty men and boys. By the end of the nineteenth century, Philadelphia's brickyards were producing more than 200 million bricks per year, mostly by hand.[13]

Philadelphia's sprawling inventory of eighteenth- and nineteenth-century red brick buildings showcases its geologic and industrial past. Once substrate for the region's plants and animals, Philadelphia brick clay became the principal raw material for kilometers of row houses. James Stoops, whose brickyard and kiln were between 9th and 10th and Race and Vine Streets, produced bricks for the construction of the Pennsylvania State House, now called Independence Hall.[14] He molded and fired them from Philadelphia brick clay, a legacy of glacial meltwater and climate warming.

Figure 1.3 Independence Hall, constructed with bricks made from clay deposited a few blocks away by glacial meltwater.

Rising rivers

Glaciers no longer threaten to inundate the Delaware Valley with torrents of meltwater, but melting ice threatens to raise sea levels and flood low-lying areas within Philadelphia.[15] Center City and neighborhoods east and south are surrounded on three sides by tidal water that rises and falls with lunar cycles and also with interglacial cycles.[16] Climate warming will continue to produce meltwater, raising the level of Philadelphia's tidal rivers, creeks and marshes, and submerging wetland trees,[17] reminiscent of what happened to the Subway Tree.

Ann Fowler Rhoads and Timothy A. Block, in *Trees of Pennsylvania,* describe a kind of tree peculiar to cities. It grows on urban riverbanks and floodplains. It is a backcross between American sycamores (*Platanus occidentalis*) and London plane trees (*Platanus* × *acerifolia*), which themselves are sycamore hybrids.[18] These trees have the bark of the stately London plane trees lining old streets downtown, but they grow in wet habitats typical of American sycamores. Today these backcrossed hybrids thrive along a narrow intertidal zone on the east bank of the Schuylkill River, just downstream from the Philadelphia Museum of Art. The rising sea is slowly submerging them.

Figure 1.4 Plane trees (*Platanus* hybrids) at high tide on the east bank of the Schuylkill River downstream from the Philadelphia Museum of Art, looking south toward Center City, October 27, 2012. Rising sea level is submerging the bases of these trees.