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Interdisciplinary Research in Historic Landscape Management

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The principles and techniques for identifying, evaluating, and preserving the vegetation of historic landscapes are evolving. Unfortunately, vegetation assemblages are not naturally stable, and plants respond sensitively to the frequent changes that are normal in human land-use practices. As a result, the flora on many National Park Service properties little resembles that of the historic period of significance.

The first step in vegetation restoration in a cultural landscape is to find out what the vegetation was like

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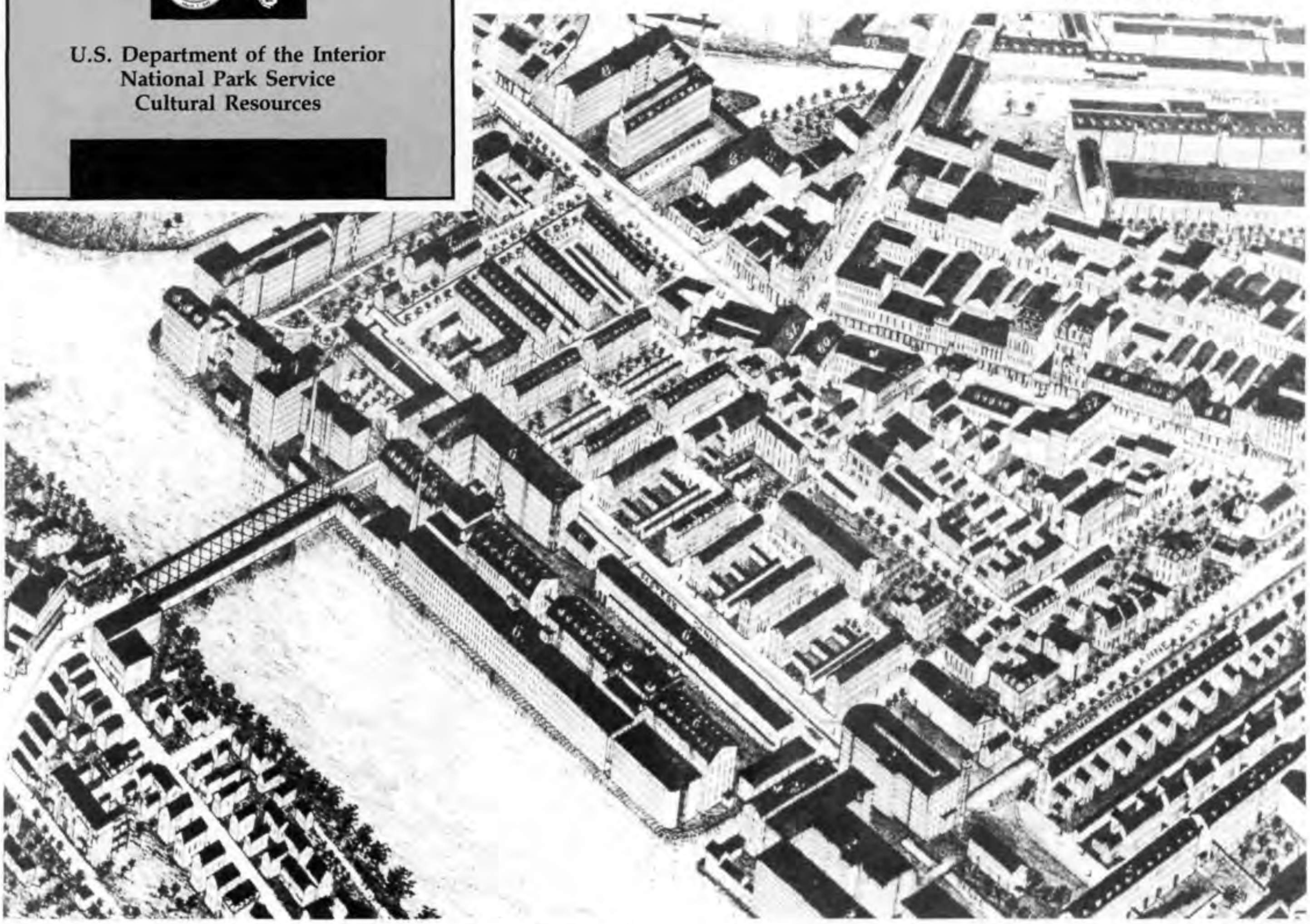


Lowell, Massachusetts, 1876.

during the period of significance. Standard Service historic landscape research procedures may not be well enough developed to do this. National Park Service historic landscape research primarily is organized around the "Cultural Landscape Report" described in *Cultural Resource Management Guidelines, NPS-28* and *National Register Bulletin 18: How To Evaluate and Nominate Designed Historic Landscapes* and *National Register Bulletin 30: Guidelines for Evaluating and Documenting Rural Historic Landscapes*. These are documentary, field survey, and archeological investigations that work best where the recent association of a site with famous persons or newsworthy events has generated an extensive photographic and literary record. For most 17th-, 18th- and 19th-century sites, especially for those inhabited or used by relatively humble folk, these studies produce little more than geographic features, evidence for present and former structures, and surviving specimens of long-lived plant taxa.

Recent investigations by North Atlantic Cultural Resource Center personnel and affiliates at a number of sites in the northeastern United States indicate that an approach integrating archeological, archival, and paleobotanical (fossil plant) data is highly effective in reconstructing the self-created environments of historical societies. Most landscape specialists are familiar with documentary research and many have dealt with archeological data. Few cultural landscape managers have been introduced to methods for recovering or interpreting paleobotanical data.

The Theoretical Basis of Historic Landscape Pollen Analysis

Seeds, phytoliths, and pollen grains are the three kinds of plant fossils most frequently employed in paleobotanical studies. Seeds and other relatively large plant parts are referred to in the literature as "macrofossils." It is easiest to tell exactly what plant you are dealing with from macrofossils, but they are not preserved as frequently as phytoliths or pollen grains. Phytoliths are glass bodies formed in plant cells from soluble silica taken in with ground water. They take on the form of the cell and are preserved in large quantities after the plants rot. Phytoliths have been used to distinguish a number of food plants, but they are primarily diagnostic of grasses. Phytoliths are most used in landscape and climatic studies to define broad vegetation patterns, such as the forest/prairie border. Pollen grains are the male component in the reproduction of flowering plants. They are more diagnostic of plant taxa than phytoliths, and are amenable to statistical manipulation because they are preserved in much larger numbers than plant macrofossils. The contribution of pollen analysis to historic landscape studies is the primary topic of this presentation.

Pollen Grain Composition

The three main parts of a pollen grain — cytoplast, intine, and exine — are depicted in the schematic drawing in Figure 1. The most important part, from a reproductive point of view, is the "cytoplast." This living tissue at the center of the grain carries the sperm, which is transferred to the megaspore (female component) via a pollen tube that grows after the pollen grain lands on the stigma of the right kind of flower. The intine is merely a protective balloon around the cytoplast that keeps it from drying out during transport from flower to flower. The exine is a hard protective cover around the cytoplast and intine. Both the cytoplast and the intine decay rapidly in soil, but the exine is made of very durable material. It will persist millions of years in an anaerobic environment, and it is the exine that is recovered and identified in pollen analysis.

Pollen grains are small, 5 to 250 millionths of a meter in diameter, and must be examined under a compound transmitted-light microscope at 400x or larger. Five basic characteristics are used to identify pollen grains. These criteria are size, shape, the kind and number of apertures (round pores or long furrows) provided for the emergence of the pollen tube, the texture (called sculpturing in Figure 1) of the outer surface of the exine, and the structure (arrangement of the columellae and tectum) of the inside of the exine wall. Generally speaking, about 50% of the pollen grains in a sample will be identifiable only to plant family. A further 49% will be identifiable to genus, and about 1% to species. These last are usually genera that are represented by only one species in the study area.

Pollen Grain Production and Dispersal

Most of the pollen studies published to date (arid-lands archeological sites excepted) have primarily employed tree (arboreal) pollen spectra from lake and marsh deposits. Tree pollen, which starts out high and gets carried up into the upper atmosphere, is transported long distances. The majority of these studies have been focused on defining prehistoric climatic change in broad regions, e.g., New England, the Great Plains, Sonoran Desert, over long time periods, e.g., Pleistocene, Holocene, Hypsithermal, by reconstructing

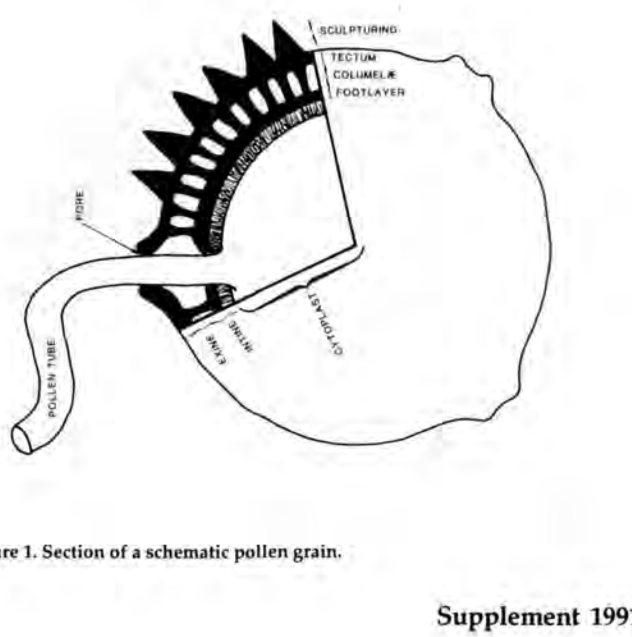


Figure 1. Section of a schematic pollen grain.

vegetation at the formation level, e.g., tundra, boreal forest, prairie. The vegetation patterns defined in these investigations are too broad to be used in restoring the flora of particular plots.

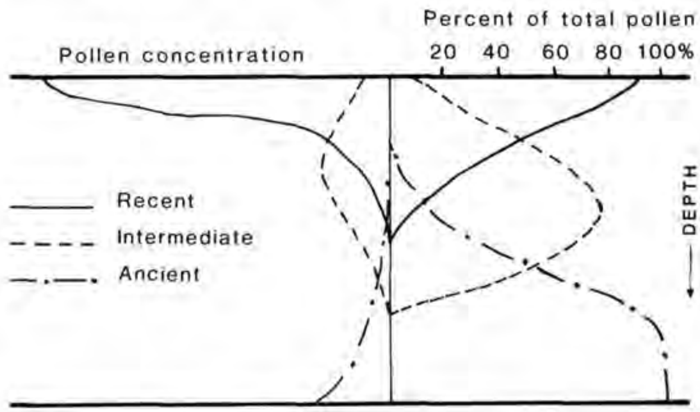
To produce an accurate historic landscape study the analyst must investigate the pollen records of the specific landscape, rather than that of some distant lake or marsh. This is done by analyzing a series of pollen samples taken down through the soil deposits directly under the landscape. In this sample series (profile) the oldest groundcover record will be at the bottom in the oldest soil, and changes in the pollen record up through the deposit will reflect successive changes in vegetation contributing pollen to the soil. It may, occasionally, be possible to isolate pollen evidence for local ornamental trees from the tree-dominated regional background pollen rain in soil profiles, but herb (non-arboreal) pollen will provide the most precise records of local groundcover and land use.

Herb pollen starts out closer to the ground, where wind velocities are lower and where the chance of loss through impact with vegetation is relatively high. It does not blow nearly as far as tree pollen and, therefore, reflects the vegetation of a relatively circumscribed area. It is not enough, however, to merely identify the kinds of plants that contributed pollen to the deposit being investigated. Some plant species produce much more pollen and disperse it more widely than others. Their pollen blows about, and there is no one-to-one correlation between the amount of a particular kind of pollen that fell on a given spot and the numbers of the plants producing that pollen type in the vegetation.

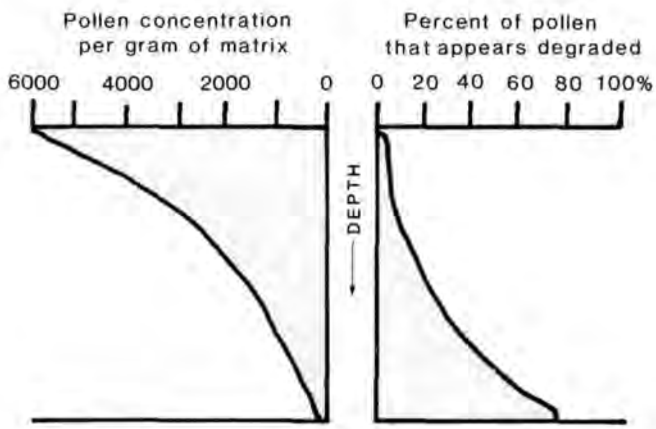
Three kinds of pollen transport and production must be considered. The first of these is wind pollination. Wind-pollinated (anaemophilous) plants produce large quantities of pollen and disperse it widely. Their reproductive strategy is to hit the stigma of another plant of the same species shotgun style. This dispersal mode does not preclude using wind-transported herb pollen in landscape studies, because the pollen of even the most notorious hayfever herbs travels much shorter distances than wind-transported tree pollen. The majority of ragweed pollen grains, for instance, come to earth within three meters of a one-meter high plant, and 95% of such pollen is lost from the air within nine meters. Wind-pollinated herbs are used to define general land-use patterns across the local landscape. If ragweed pollen goes up in the profile in proportion to grass, for instance, we can say that local soils are being disturbed, while an increase in grass pollen relative to that of ragweed can be interpreted as evidence for soil stabilization and a decline in the intensity of human activity.

Insect or animal-pollinated (zoogamous) plants need to produce much less pollen than wind-pollinated taxa because the pollen is carried directly to other flowers by the transporting creature. The pollen is securely held in the flower by the same sticky oils and resins through which it is transferred to the insect or animal vector, and any pollen not carried away falls to the ground with the flower in the immediate vicinity of the parent plant. Zoogamous pollen in the soil indicates that the source plant was growing close by. Such pollen is a primary source of very local environmental data, such as changes in relative soil moisture or shade through time. Because zoogamous pollen is deposited in such small quantities relative to that of the wind-pollinated taxa, the pollen analyst must make significantly larger counts (400 grains +) than are normal in paleoecological studies to get reliable patterns.

The pollen of self-fertilized plants (autogamaous) is also significant in the interpretation of historic landscapes, but the patterns recovered by this kind of pollen are more likely to reflect human activity than groundcover. The only autogamous pollen regularly encountered in cultural sites is that of the Eurasian domesticated cereals — wheat *(Triticum)*, oats *(Avena)* and barley *(Hordeum)*. The pollen grains of these plants are hard to tell apart and are normally lumped under the term "Cerealia." In these cereals, the seed head incorporating both the anther and stigma does not open until the grain is threshed, and, even then, much of the pollen is securely bound to the seed by entwining pollen tubes. Such pollen travels with the grain and even survives baking in bread. It is more likely to be found where grain is lost or garbage is disposed of than where the grain was grown. In inner urban sites Cerealia normally accounts for 2-5% of the pollen, but larger quantities are



THEORETICAL DISTRIBUTION IN SOIL OF
POLLENS OF DIFFERENT AGES
(after Dimbleby 1985)



THEORETICAL POLLEN CONCENTRATION
AND DEGRADATION IN A SOIL PROFILE

Figure 2. Theoretical pollen concentration, degradation, and differential age distribution patterns in soils.

found in commercial sites where grain was processed or stored. Such pollen is, consequently, useful in distinguishing mercantile landscapes from those around habitations.

Post-Deposition Pollen Transport and Preservation

When fossil pollen assemblages are used to reconstruct historic landscapes it is necessary to take into account what happens to the pollen grains after they are incorporated into the soil profile. The arrangement of pollen grains in a soil profile is altered by natural processes that destroy pollen and move it downward in the profile. This downward movement separates older pollen from younger soils that accumulate slowly. The oldest pollen is concentrated at the bottom of the soil profile, intermediate age pollen is concentrated in the center of the profile and younger pollen is concentrated at the top. A model of this phenomenon from the literature is presented in Figure 2a. The pollen is attacked by oxygen and aerobic fungi as it moves downward, producing a sequence with larger relatively fresh pollen concentrations at the top of the profile and more worn and deteriorated pollen at the bottom. A model of such pollen concentration and degradation as they appear in natural pollen profiles is presented in Figure 2b.

These are empirical models. Examples from a core taken at Great Meadows, Pennsylvania, are presented in Figure 3. Great Meadows was the site of George Washington's Fort Necessity in 1754. The dense forest on the hillsides around the fort was cleared during the last half of the 19th century, and the hillsides turned into pasture. This clearance is recorded in a succession of oak pollen (the original forest) at the bottom of the profile, ragweed pollen (soil disturbance at forest clearance) in the middle of the profile, and grass pollen (the created pasture) at the top of a pollen profile collected on one of these hillsides (Figure 3a). This sequence exactly replicates the ideal model of old, intermediate, and recent pollen in Figure 2a. Soil erosion and wind deflation are the characteristic soil processes of exposed hillsides on Euroamerican farms. The Great Meadows pollen sequence does not reflect soil accumulation. The variation in pollen in the soil profile developed because the pollen percolated down into the soil, becoming worn down and degraded as it moved. The degradation produced a sequence in which the pollen concentrations, the pollen too degraded to

Figure 3. Fort Necessity, PA. Core 2 pollen percentages based on combined arboreal and non-arboreal pollen sums.

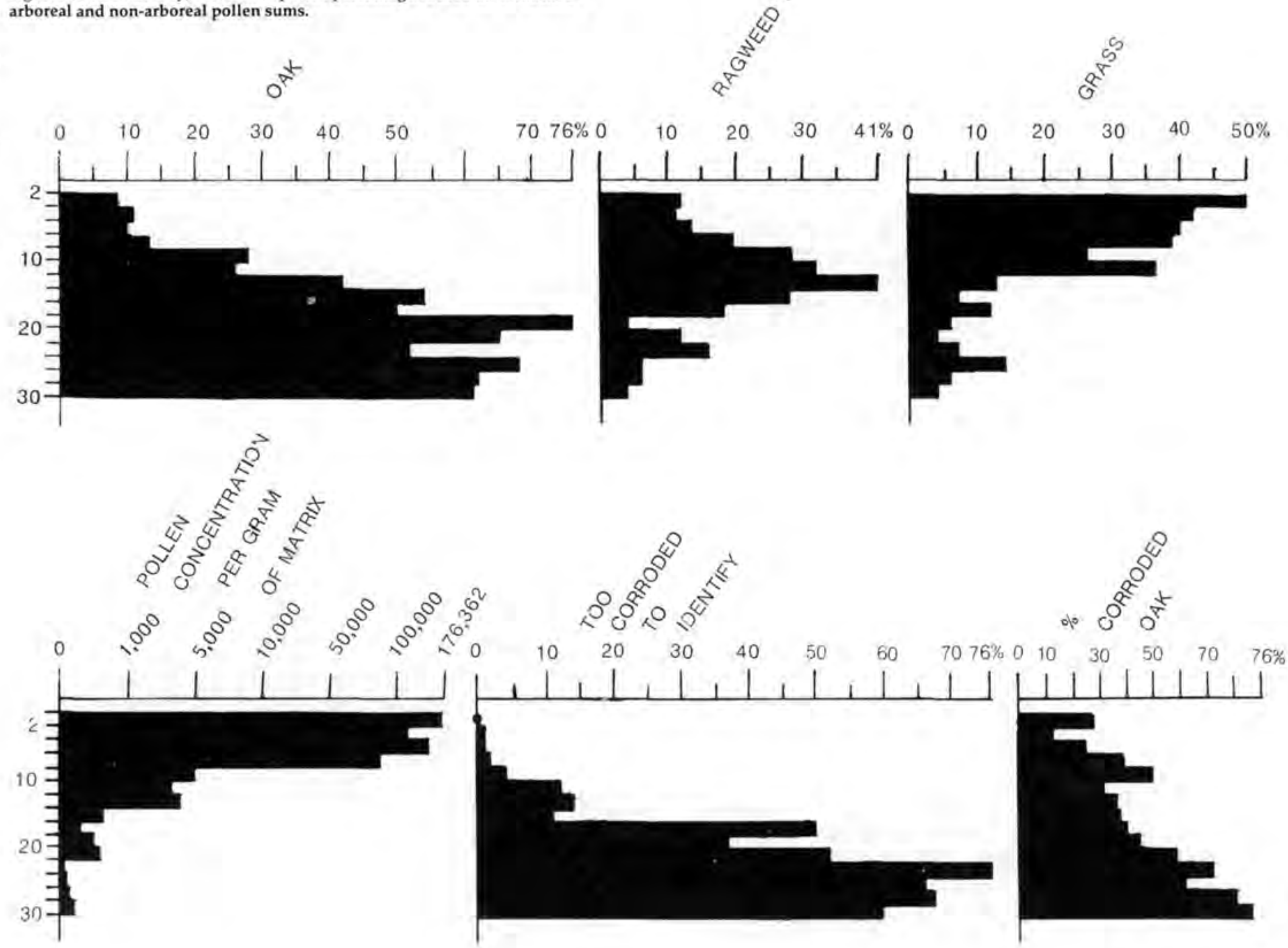


Figure 4. A former Boott Mills boardinghouse restored by the Lowell Historic Preservation Commission to its original exterior appearance. Courtesy of Mary C. Beaudry.

identify, and the proportion of corroded oak pollen grains (a type that corrodes readily while remaining recognizable), are identical (Figure 3b) to the predicted pollen concentration degradation patterns of Figure 2b.

The way in which a historic cultural deposit formed affects the nature of the pollen record and must be accounted for when reconstructing historic vegetation from that pollen record. Such soil deposit formation processes may be evaluated by comparison with the natural pollen-record formation pattern just described. When this natural pattern appears in the soil profile of an archeological site, cultural deposition has been slow or insubstantial. In places where there was more human activity, soil compression and faster sediment deposition preclude pollen percolation. These factors produce shifts in the pattern of plant pollen deposits that correlate with stratigraphic levels, irregular pollen degradation patterns, and pollen concentrations that correlate with shifts in pollen types, thus reflecting the relative density of the vegetation. When the natural pollen concentration and degradation patterns are reversed or when pollen concentration figures shift abruptly without clear stratigraphic boundaries in the soil, it is probable that the deposit consists of episodic fill or disturbed soil.

Each of these pollen-record formation patterns, in conjunction with groundcover data contributed by conventional pollen counts, can be used to define the nature and intensity of land use. The examples included in this presentation illustrate the use of this paleobotanical data in determining the residential land use by mill workers living in the Boott Mills boardinghouse and mill managers occupying the Kirk Street Agents' House in 19th-century Lowell, Massachusetts.

Included in each example are pollen diagrams (Figures 9, 11, 14) which provide a graphic representation of the quantity and relative age of the pollen recovered from an archeological excavation. Relative age is represented by the vertical axis of each histogram. The oldest pollen is at the bottom, the youngest is at the top. Quantities of pollen are represented by the horizontal axis. These quantities are percentages, and the longer the bar to the right of the vertical line for each pollen type, the greater the percentage of that kind of pollen at the particular depth. Two kinds of percentages are presented. The solid black portion of each histogram reflects percentages calculated from the total pollen sum

Figure 5. Front elevation of the Kirk Street Agents' House. The door on the left opened into the home for the agents of the Boott Mills, that on the right for agents of the Massachusetts Mills. Courtesy of Mary C. Beaudry.

of each sample, and the hollow-line portion of each histogram reflects percentages calculated from only arboreal or non-arboreal (trees vs. non-trees) pollen counts, as appropriate. Separate arboreal and non-arboreal percentages clarify land-use history by eliminating distortion of the groundcover record by the pollen contributions of ornamental trees and the additional pollen contributed by trees in the region around the sampling site.

The Boott Mills Boardinghouses

The plot investigated is located along the Eastern Canal in Lowell (Figure 6). It was part of a farmstead, ca. 1821, and was occupied successively by the mansion of the industrialist Kirk Boott (ca. 1825-1835) and two of the eight Boott Mills boardinghouses (1835-1942). The backlot between the boardinghouses was the focus of the recent archeological investigation (Figure 7). The original 1830s-1840s inhabitants of the central boardinghouse section of each unit were largely New England-born single women. Life in the boardinghouses and the external appearances of the structures were strictly controlled as part of a corporation policy of maintaining an image of order and propriety. Late 19th century photographs of the boardinghouses show tree lined streets, vine covered walls, and what appear to be rather barren utilitarian backlots.

The numbers of both families and unattached males increased in the 1850s though the 1860s, although the families in the tenements were largely American born, and the women in the boardinghouse greatly outnumbered the men. The numbers of foreign workers were rising rapidly during this era, but the immigrants were not living in the boardinghouses. After 1880 this began to change, and by 1900 males equaled females in number, and immigrants exceeded the native born among the boarders. During this immigrant interval, both living conditions and corporate control of the labor force deteriorated markedly. Boardinghouse keepers were more frequently censured by mill management for the condition of the exterior spaces, and complaints about employee off-duty behavior increased. Two-thirds of the recorded reprimands to employees were concerned with alcohol abuse and three quarters of these went to persons with Irish surnames.

The archeological deposits of the boardinghouse backlot (figure 8) agrees closely with the documentary record. The soil stratigraphic sequence was capped with a thin, relatively continuous layer of broken window glass from the 1934/1942 dismantling of the boardinghouses. In parts of the former backlot, where the archeological record is undisturbed, three soil layers are evident in the stratigraphy. The oldest of these is the artifact-sterile, inorganic glacial sand (level 1) at the base of the profile. Above this sterile layer is level 2, which spanned the last three-quarters of the 19th century, making it the major occupation layer at the site. Relatively few artifacts and faunal remains were recovered from the lower three-quarters of this deposit. Weed seeds were rare compared to later deposits, while food-plant seeds and phytoliths (plant silica bodies) were found only in cultural features. A well maintained backlot free of weeds, trash, and organic waste is indicated. Most of the artifacts and other cultural material in level 2 was recovered from the upper few centimeters of the layer. This material appears to have been deposited after 1880, and the

Figure 6. Detail of an 1876 bird's-eye view of Lowell, MA showing the area of Boott Corporation mills and housing.

Figure 7. The layout of Kirk Boott's estate and the subsequent boardinghouses over "plan of the Land and Building belonging to the Merrimack Manufacturing Company" made in 1825 by Geo. R. Baldwin, Courtesy Lowell National Historical Park. The black square labeled EU 21N/8W is the pollen-sampled archeological excavation unit.

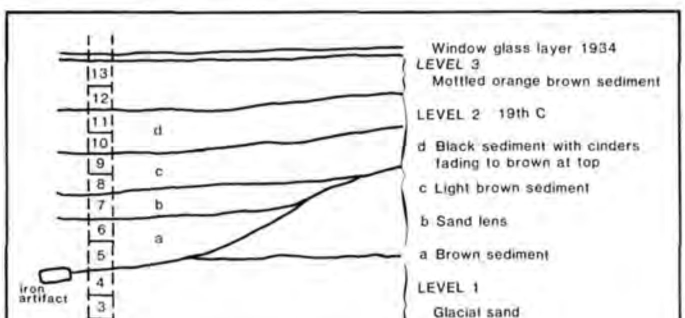


Figure 8. Palynologist's field sketch: soil stratigraphy and pollen column location, 21N/8W, northwest corner profile (the natural pollen percolation profile).

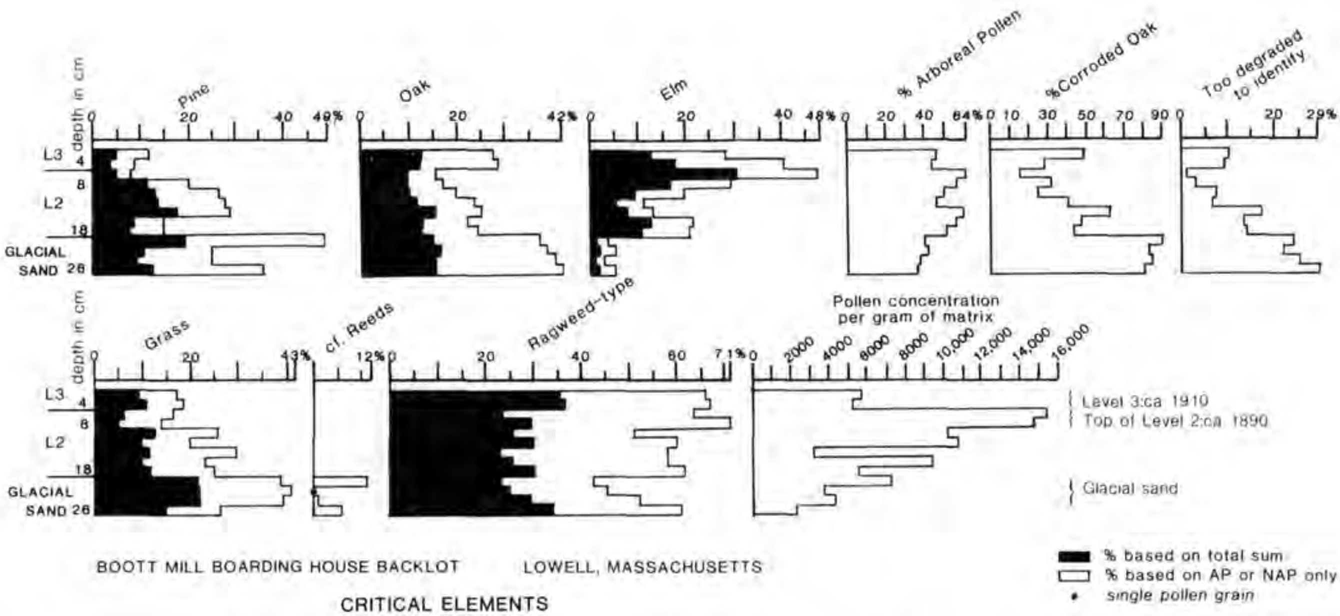


Figure 9. Pollen percentages of critical types, 21N/8W, northwest corner profile (the natural pollen profile). Solid bar histograms are based on total pollen sum. Hollow bar histograms are based on arboreal pollen or non-arboreal pollen sum only.

majority of the items post-date 1890. Some of this trash consisted of housewares that were originally the property of the boardinghouse keepers, but other items, pipe fragments marked with Irish slogans for instance, can be attributed to the immigrant boarders. All but 2 of the 72 alcoholic beverage bottles found in the backlot were recovered from this post-1890 portion of level 2. The cultural inventory of level 3, at the top of the profile, was dominated by artifacts dating to the first quarter of the 20th century, and post-dates the use of the buildings as residences.

The Natural Pollen Percolation Profile Reflecting Vegetation Changes

Artifact data indicate that a pollen profile taken at the northwest corner of excavation unit 21N/8W (Figure 7) includes archeological deposits from the entire 1830s to 1930s boardinghouse occupation period. Pollen concentrations generally decline from the top to the bottom of this profile, while measures of pollen corrosion are progressively larger in the deeper fill (Figure 9). This conforms to the natural site formation process pattern presented in Figures 1 and 2. It indicates that the profile is undisturbed.

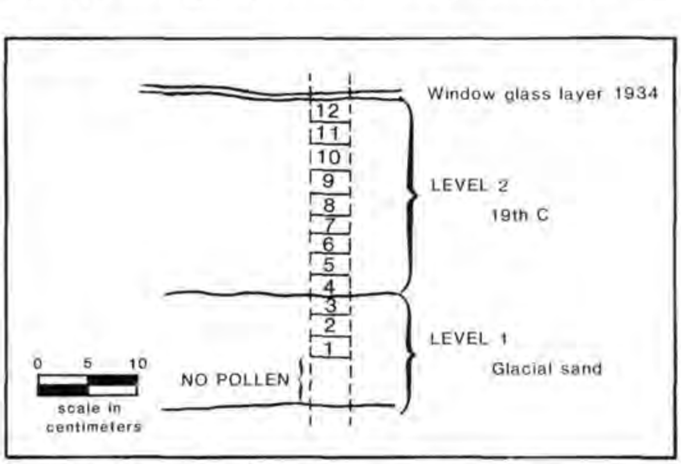


Figure 10. Palynologist's field sketch: soil stratigraphy and pollen column location, 21N/8W, northeast corner profile (the soil-disturbance pollen profile).

The sand of level 1 at the base of the boardinghouse stratigraphic sequence is glacial outwash. It supported no plants during its formative stages, and it contained no artifacts; it should, therefore, contain no pollen except for that which percolated down from higher layers. Contrary to expectations, pollen spectra reflecting several distinct plant populations were recovered from the glacial sand of level 1 in this boardinghouse profile. Sedge (Cyperaceae) pollen and grass pollen resembling that of reeds *(Phragmites)* are present only in the level 1 glacial sand (samples 1-4, Figure 9) and reflect the poor drainage of the terrace above the river before construction on the site. Ragweeds (*Ambrosia* spp.) tolerate the harsh temperature and moisture regimen of cleared ground better than most other weedy taxa, and the ragweed-type pollen dominating sample 1 reflects either agricultural fields or the construction period of the Boott mansion.

Grass (Gramineae) pollen frequencies increase abruptly, replacing ragweed-type as the dominant herb, in sample 2; and declined with equal suddenness in sample 5. Grass pollen percentages rise slowly on planted pastures or stabilizing ground. Kirk Boott had a well maintained grass lawn and the sudden changes is samples 2 and 5 can only reflect the sodding and destruction of that lawn.

Grass frequencies drop off as ragweed counts increase in samples 5-9 of level 2 (Figure 9). These samples span the 1836-1890 boardinghouse occupation. The abrupt shift in the pollen spectra reflects the sudden, planned change in land use from formal lawn to inner-urban backlot. There, during the 1839-1890 period represented in pollen samples 5-9, both grass and ragweed frequencies were relatively uniform, and groundcover was stable. The main occupation backlot was more weedy than Kirk Boott's lawn, but less weedy than the subsequent post-1890 interval. The quantities of European cereal pollen deposited during this interval were low when compared to other urban dwelling backlots, and little organic garbage was being spread around. Rising chestnut *(Castanea)*, elm *(Ulmus)*, and vine family (Vitaceae) frequencies in level 2 reflect the maturation of the trees still visible along the adjacent streets and the Boston ivy (*Parthenocissus*, a member of the vine family) decorating the boardinghouse in several 19th century photographs. The pollen spectra agree with the documents

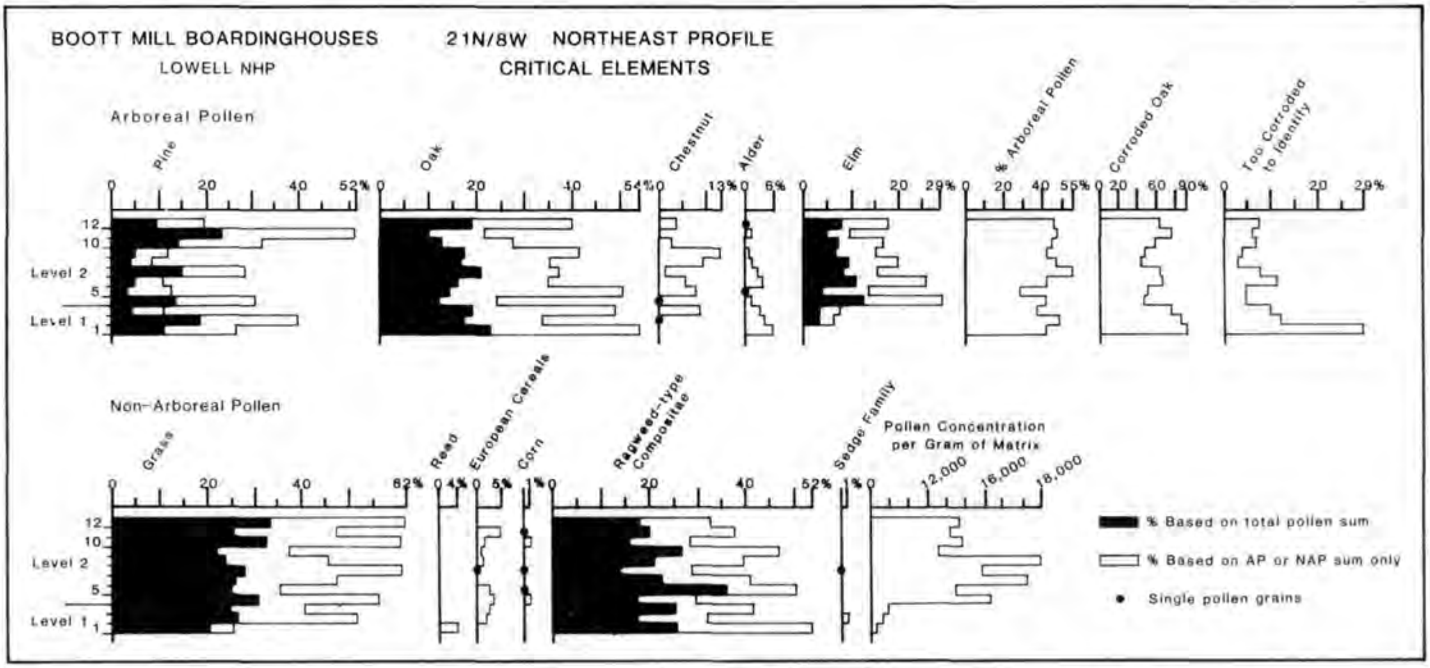


Figure 11. Pollen percentages of critical types, 21N/8W, northeast corner profile (the soil-disturbance pollen profile). Hollow bar histograms are based on arboreal pollen or non-arboreal pollen sum only.

and archeological data in describing the backlot as having been a well-maintained island of utilitarian space in a landscape that was managed to project a desirable corporate image.

Grass pollen frequencies decline further in samples 10 and 11 at the top of level 2 while those of ragweed increase. This is the post-1890 portion of the level, which was deposited during the immigrant labor period and from which the bulk of the artifacts were recovered. Pollen, as well as archeology and documents, indicate that landscape maintenance was slipping. Boardinghouse keepers helped the boardinghouse residents to create the mess, and mill administrators apparently lacked the will to impose their authority on the situation.

Pollen concentrations decline abruptly from almost 16,000 to less than 6,000 grains per gram of matrix in early-20th-century level 3, while both the percentage of corroded oaks and the percentage of pollen too corroded to identify increase abruptly. The same kinds of plants continued to contribute pollen to the backlot, but there were fewer of them. During this interval, one of the boardinghouses was frequently vacant while the other served as mill storage. The backlot was subjected to increased vehicular and foot traffic. This would suppress such flora as existed on the plot and would churn the upper portion of the soil, exposing the extant pollen to corrosive agents and further depressing concentrations. Compression of the soil under the churned layer might reduce soil permeability and divert destructive oxygen and aerobic fungi from the high pollen concentrations in the top of level 2.

The Soil-Disturbance Profile and Pollen Variation

Level 3 was absent in another soil sample column taken at the northeast corner of the same excavation unit. The level 2 matrix appeared to have been homogenized and the archeologists interpreted this area as a cultural feature (Figure 10). The normal leached pollen concentration and pollen corrosion patterns are evident only in the level 1 glacial sand at the bottom of the profile (Figure 11). Reed grass and sedge pollen were most prominent in the sand, as they were in the natural-process pollen profile (Figure 7). The zone is probably a remnant of a pre-boardinghouse pollen spectrum leached down into the sand. The pollen spectra of individual plant taxa are irregular in level 2, but pollen concentrations are higher in samples 4-8 and abruptly lower in samples 9-12. When compared to the previously discussed profile, these do not appear to be natural patterns. The contrast in pollen concentrations between the two zones suggests two different sources or two separate soil deposition episodes. Nine squash or pumpkin (*Cucurbita* spp.) phytoliths were found in sample 11, and 13 of this type were recovered from sample 12. Phytoliths resembling those of bananas *(Protium panamense)*, were found in samples 7, 8, and 9. The varied pollen concentrations in this profile record two episodes of garbage disposition.

The Kirk Street Agents' House

The Kirk Street Agents' House is an imposing 2 1/2 story brick duplex (Figure 5) erected between late 1845 and early 1847 at 63-67 Kirk Street to house the top local managers (i.e., agents) of the Massachusetts and Boott Mills corporations. Both the interior and exterior of the structure reflected the high status of the occupants in the corporate hierarchy. Early in the

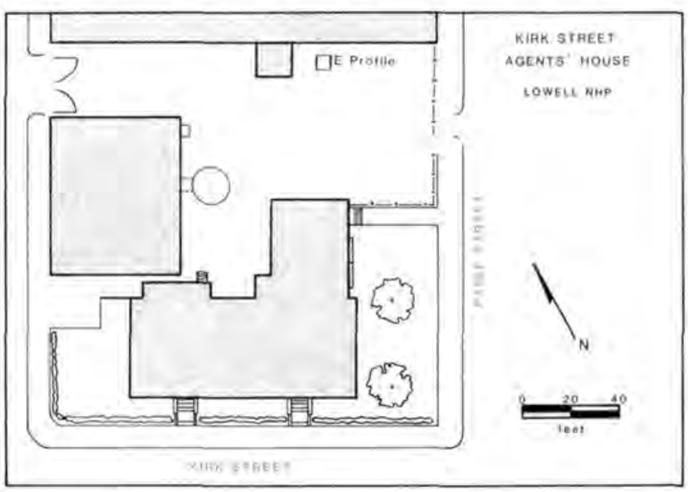
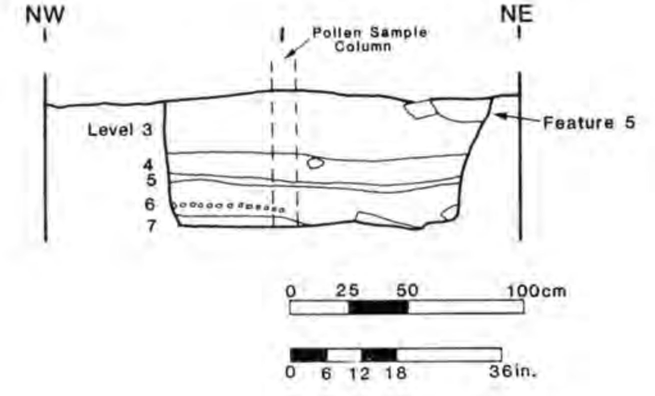


Figure 12. Plan view of the Kirk Street Agents' House showing location of the Square E pollen profile.



Level 3 - Medium to dark brown silty sand/sandy loam
Level 4 - Dark to very dark grayish brown silty sand/sandy loam with mottling
Level 5 - Black to very dark brown fine silty sand
Level 6 - Brown to dark brown coarse sand with clastic gravel, silt, clay, and mortar
Level 7 - Yellowish-brown fine to coarse sand with silt, gravel, pebbles, cobbles, boulders
Feature 5 - Trench

Figure 13. South Face of Square E, Kirk Street Agents' House, showing location of pollen column.

20th century the Agents' House was sold and was used as a boardinghouse and lodginghouse until 1911. The vacant property was purchased by the city of Lowell in 1914, and a boiler plant for the school system was erected on the Boott Mills half in 1922.

The Intense Land-Use Profile

Seven levels were recognized in stratigraphic sequence in the Kirk Street Agents' House backlot. Level 1 consisted of modern blacktop and concrete. Level 2 appeared to be a mixed early-20th-century (pre-1925) fill that may be a byproduct of boiler plant construction and modifications in the 1920s, while the ceramics in the brown, silty sand of level 3 were mostly late 19th-century with a few possibly early-20th-century pieces. During this period, the house was occupied by middle aged, childless couples. Level 4 was a dark, uniform layer incorporating large quantities of fish bones and scale and domestic animal bones that suggest butchering in the backlot. Phytoliths indicated a high vegetal matter content, and many 19th-century ceramics were recovered from the level. This level was not a garden plot as originally hypothesized. It was only 6-10 cm thick, and there was no evidence of mixing with level 5 below, as would be expected if it had been cultivated. The dishes (deposited after ca. 1850) had been noticeably scratched and worn in active use but had suffered little post-deposition damage, again, the opposite of what would be expected if cultivation had occurred. The excavators suggest that the ceramics deposited in the backlot were either the result of increased breakage in the large household that occupied the structure in the late 1850s, childs' play refuse associated with the younger members of that household, or refuse from the departure of that family in 1861. Layer 5 below was thinner but even darker. It peeled away cleanly from level 6, and patches of mortar in a sand and gravel mix were noted on the interface. Level 6 was a brown sand mixed with clastic gravel, cobbles, fine silt, and lenses of mortar dating the deposit to the 1845-1847 construction period. Level 7 appears to be the culturally disturbed upper portion of the glacial sand underlying the area. Quantities of artifacts decreased progressively through levels 5, 6, and 7.

Five of the seven archeological levels analyzed for pollen in the backlot were found in Square E (Figure 12). Level 7, at the bottom of the deposit (Figure 13), was dominated by grass pollen that may reflect former pasture (Figure 14). This was

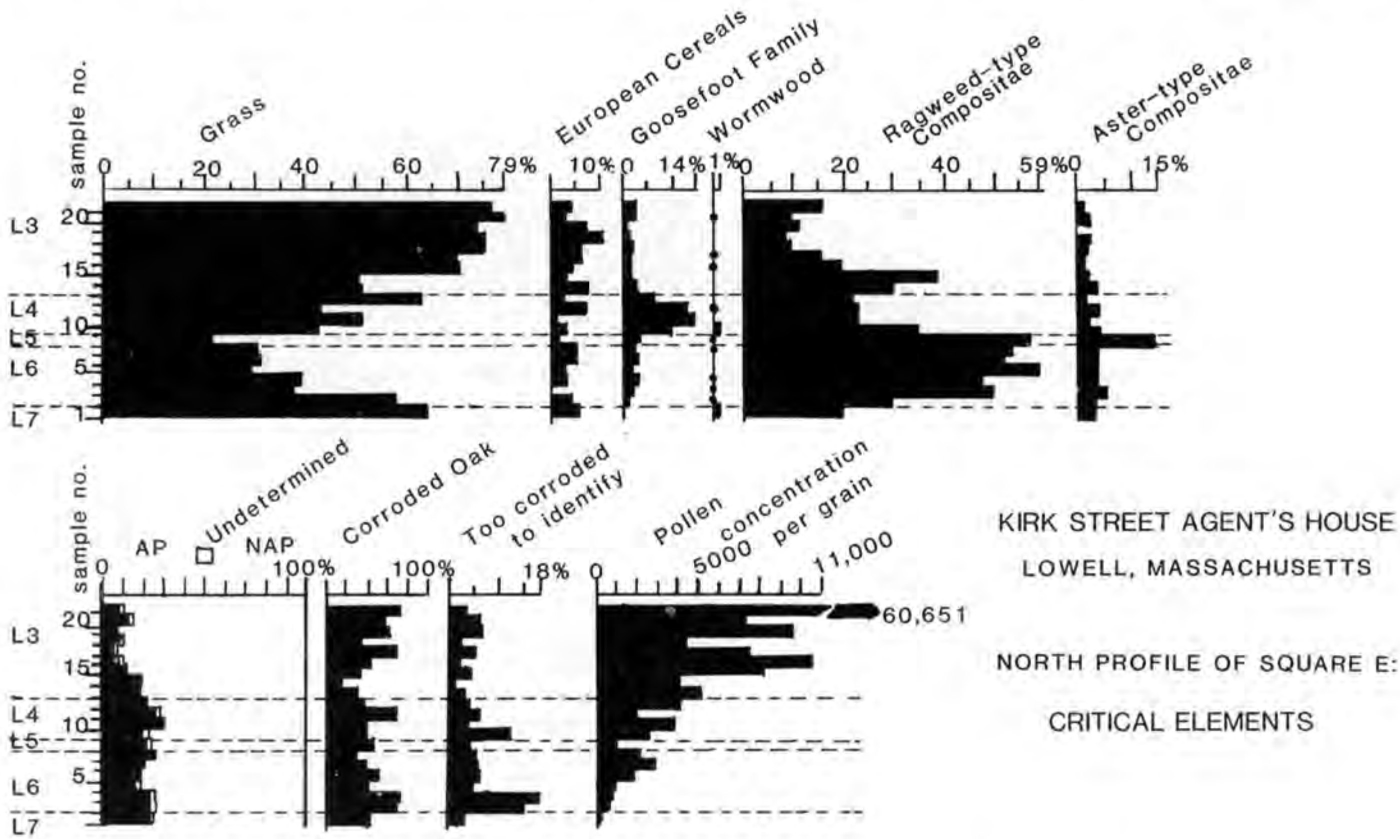


Figure 14. Pollen percentages of critical types in Square E, Kirk Street Agents' House (the intense land-use profile). Histograms are based on combined arboreal and non-arboreal pollen sums.

replaced by ragweed, reflecting the soil disturbance of the 1845-1847 construction period in mortar-laden level 6. Pollen concentrations increase toward the top of the layer, and pollen degradation measures increase toward the bottom, indicating that much of this pollen is leached down into the deposit from the surface. The ragweeds gave way to asters and related ruderal-ground indicator taxa (*Aster* -type) across the rear of the backlot during the brief interval of level 5 (Figure 14) when human activity declined between the end of construction-related soil disturbance and the beginning of intensive inhabitant activity. The goosefoot (Chenopodiaceae) family favors fertile soils, and the pollen contribution of these plants rose abruptly during deposition of organically enriched, trash-loaded level 4. Goosefoot pollen percentages drop off in late 19th-century level 3 while the grass pollen contribution increases at the expense of ragweed-type. Pollen concentrations rise parallel to grass percentages, suggesting that groundcover was thickening, and soils were stabilizing during deposition of level 3. The smaller, childless households of the late 19th century were apparently using, and disturbing, the backlot less.

Summary and Conclusion

The Kirk Street Agents' House and the Boott Mills boardinghouse pollen counts were part of an interdisciplinary archeological investigation. At these sites pollen indicators of soil deposit formation processes were integrated with material culture, archival data, phytoliths, plant macrofossils, and pollen data reflecting groundcover to generate a systematic historical landscape description that could be applied to broader questions of social structure and differential land use.

The status of financier Kirk Boott and the prominent position of the mill agents in the local hierarchy were publicly asserted by the impressive facades of their dwellings and by the formal lawns that both pollen spectra and documents record around their respective dwellings. The Boott Mills Corporation carried this concern with appearances over to the boardinghouses. The elms and the vines photographically and palynologically recorded along the streets and on the boardinghouse walls projected an image of orderly, well-kept living conditions. The backlot was neat and had little cultural debris. Phytolith, seed, and pollen data indicate that the small amount of organic garbage that was deposited behind the boardinghouses was intentionally buried. The boardinghouse backlot was definitely more barren than Kirk Boott's preceding lawn, and the stability of the grass and weed pollen counts over the ca. 1836-1890 period suggests that it was intentionally maintained in that state. The pollen recovered probably reflects a few plants in inaccessible spaces. Pollen concentration and preservation measures fall into the natural pollen-record formation pattern, indicating a slow to non-existent accumulation of matrix during an interval of about 50 years. Slow deposition and stable vegetation imply that the backlot was little used as well as regularly maintained.

The corporation and its operatives were in control. The mill workers, who constituted the majority of the boardinghouse occupants, were little in evidence. They apparently did not spend much time in the backlot and had little influence on the palynological land-use record. Such data support the contention that the concerns of the labor force with the boardinghouses as "home" were focused on interior spaces.

After ca. 1890, the mill workers became more visible in the archeological record as trash attributable to both boardinghouse keepers and boarders began to accumulate and weeds sprouted in the backlot. Management reprimanded boardinghouse keepers about exterior maintenance with increasing frequency, but took little direct action. This was symptomatic of the attitudes of corporate managers, landlords, and boardinghouse keepers toward foreigners, and these attitudes resulted in a general deterioration of mill worker living conditions during the immigrant labor period in the boardinghouses. The liquor bottles among the weeds, in turn, record worker violation of the frequently reiterated corporation rule against drinking on the premises. These bottles may reflect workers' attitudes toward both their employer and the environment provided for them as they sought to exercise some control over their own lives.

A very different land-use regimen is recorded in the backlot of the Kirk Street Agents' House. Pollen concentration and preservation data from all three profiles indicate that the rapid accumulation of deposits that is characteristic of actively employed space occurred here. The pollen spectra of individual stratigraphic layers are distinctive. They reflect a local, rather weedy, flora that was adapting rapidly to land use as it changed with the occupation history and demography of the Agents' House. The soil-disturbance related ragweeds of the construction period gave way to the sunflowers and asters of a brief "settling in" period at the beginning of the occupation. The goosefoot interval that followed reflects the rich soils of a period in which butchering took place in the backlot, in which garbage was broadcast-deposited, and in which the agent's grandchildren played with, and abandoned, old housewares. The rising grass pollen frequencies and increasing pollen concentrations of the more shallow deposits reflect the stabilizing soils and thickening groundcover of the later mill agent occupation period when the house was inhabited by childless, older married couples with fewer servants. Unlike the mill workers in their boardinghouses, the managers who occupied the Kirk Street Agents' House controlled the backlot of their dwelling, and they used it. They apparently included their exterior as well as interior environment in their definition of "home," and the groundcover in the backlot reflects their personal attitudes as these changed through time rather than company policy.

The Boott Mills boardinghouse and Kirk Street Agents' House pollen investigations indicate that an interdisciplinary approach integrating archival resources, archeological data, and paleobotanical sediment analysis can be more productive than independent studies of these kinds in historic landscape reconstruction. The way in which these disciplines were applied in this study differs from the way such data sources are normally used in landscape research. In a typical landscape analysis, documents are searched for references to plantings and formal landscape features. Here the target of the literature search was the composition of social units and the attitudes of people toward their living conditions and toward each other. Landscape archeologists normally seek evidence of planting beds, paths, and other structural elements. In the Lowell study, trash, or the absence of it, was the most productive line of evidence. It told the excavators a great deal about the forces of social control and how people felt about their surroundings. Palynologists investigating landscapes customarily seek pollen evidence for the groundcover composition. Here pollen spectra reflecting the vegetation were used with palynological evidence for soil deposit formation processes to provide information about the nature and intensity of human activity on given plots. When these three data sources — documents, material culture, and pollen — are integrated it is possible to draw inferences about socio-cultural patterns and ideology beyond the capability of any single discipline.

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Technological Considerations

Pollen-record formation processes and subtle land-use patterns cannot be observed in widely spaced samples, in partial profiles, or in small pollen counts. Pollen profiles should consist of contiguous samples (no space between samples). Sampling should start deep in the pre-occupation deposits under the site and extend to the modern surface. At least 400 pollen grains should be counted for each sample.

The pollen in lakes and marshes is normally well preserved. Palynologists studying such matrices normally use harsh methods to clean up their samples. Pollen in soils has been weakened by oxidization and the attacks of aerobic fungi. Most of the pollen below the surface zone in a soil will be destroyed if the methods of Quaternary palynology are applied. The HNO^3 often used to break organic colloids, the NaOH used to remove humic acids, and the acetolyses mixture employed to eliminate plant tissue are especially destructive.

In this study, a modification of the method developed by Peter J. Mehringer of Washington State University, Pullman, for the analysis of arid-lands alluvium was employed. In this method carbonates are removed from ca. 25 grams of matrix by stirring the matrix in a 500-ml beaker while adding HCL until the reaction stops. The matrix, still in the HCL, is then swirled until a strong vortex develops and is then allowed to settle for about one minute. The fluid is then decanted into a 250-ml beaker before the swirling motion stops. This concentrates the pollen, leaving the heavy sediment behind. The fluid is then swirled into a 50-ml test tube and centrifuged for 3 minutes. This second swirl is repeated 3 to 6 times. The samples are then washed twice in distilled water and placed in 50% HF overnight to eliminate sand. The next day the samples, still in the HF, are placed in a boiling water bath for 30 minutes, centrifuged and given two distilled water washes. Concentrated HCL is then added (to break colloids caused by the HF) and the test tubes are placed in a hot water bath until a few bubbles appear. After centrifuging and two distilled water washes, .5% NaOH is added, and the test tubes are placed in a boiling water bath for 3 minutes. The samples are then washed in distilled water until they decant clear. It is preferable to mount the residue for viewing in glycerine (which expands pollen) rather than silicone oil (which tends to collapse weakened grains). If pollen mounted in glycerol is to be measured, it should be counted within a week or two after extracting.

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