

Exploratory Pollen Analysis of Two Cores
from the
British Old Woods, Saratoga National Historical Park

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Objectives

If NPS interpreters are to accurately present the culmination of Burgoyne's campaign during the maneuvering and battles in the vicinity of Stillwater, they must understand the battle era landscape. The ground cover portion of that landscape consists of the native vegetation, the pre-battle modifications of the natural flora by resident Euroamericans, and the modification of the vegetation during the campaign by combatants on both sides. The original historical ground cover report and Base Map for Saratoga National Historical Park (Snell 1949, 1950) are 40 years old. A much larger quantity of data is now available and recent evaluations of the battlefield vegetation by non-NPS observers (Gordon 1987, Russell 1989, Schrepper 1989) suggest that some modification to the base map may be appropriate. The issues raised are mostly matters of the location and size of clearances, roads and structures.

Recent archeological excavations in the British Woods (Starbuck et al. 1986) recovered no evidence of the British presence, and plans for further archeological investigations will depend upon the outcome of this pollen study. There is some question whether the area has been disrupted by sand mining or other post-campaign activities. Observations by the North Atlantic Regional Archeologist (D.P. Hsu, personal communication 1989) suggest that the linear mound and ditch that Snow (1977) interpreted as a British earthwork may be of later construction.

This pollen investigation constitutes a feasibility study for the palynological investigation of historical vegetation in the park in general and an evaluation of the archeological potential of the British Old Woods in particular. Four specific technical objectives will be addressed:

- 1) To ascertain whether a palynological vegetation record can be obtained from terrestrial deposits in the British Woods.

- 2) To ascertain whether the vegetation of the British Woods has been perceptibly altered during the Euroamerican era.
- 3) To ascertain whether the matrices themselves have been disrupted during the Euroamerican era.
- 4) To establish a relative date for the surface under Snow's (1977) linear mound in comparison to the pollen spectra of soil profiles in the area.

Methods

Techniques.

Four pollen cores were collected from the British Woods on 16 April 1990. Core number 1 was taken in the ditch immediately south of Snow's linear mound. Core number 2 was driven through the mound. Core number 3 was taken from an apparently undisturbed spot 27.5 meters due south (180 degrees magnetic) from core number 1 in what should have been the field of fire which the British cleared in front of their lines (Russell 1989: Figure 1). Core number 4 was collected 27.5 meters due north (000 magnetic) of the core number 1 location in or near what should have been the British campsite in 1777.

The cores were taken by driving a sharpened section of 1.5" PVC pipe into the ground with a 20 pound sledgehammer and then twisting the PVC with a pipe wrench to break the core loose at the bottom. The PVC was manually removed from the ground using the pipe wrench as a handle. Normally the friction between the PVC wall and the sediment serves to hold the matrix in the tube, and a core the full length to which the PVC penetrates will be obtained. The British Woods samples were taken during a short break in a two week rainy period. The water table was 2" below the ground surface. The fine sand constituting the bulk of the matrix was saturated and slippery. Some sediment broke off and slid back into the hole at each core location. The empty portions of the PVC tubes packed and the ends were sealed to prevent further loss during transport.

Only core no. 2 (linear mound/earthwork) and core no. 4 were examined in this feasibility study. The core tubes were split on a table saw, and the split coring tube functioned as a sampling tray. Drawings of the cores are presented in Figures 2 and 5. Two centimeter samples were taken in most cases. One centimeter samples were taken where layers were thin or where the analyst thought finer chronological resolution might be required. All sample surfaces were cleaned to reduce the possibility of contamination. Mehringer's (1967) mechanical/chemical pollen extraction method was employed, but was modified by eliminating the HNO₃ step and reducing the NaOH strength to 1% to minimize oxidization of the already somewhat degraded and fragile pollen characteristic of the deeper portion of temperate zone soil profiles. Pollen residues were mounted in glycerol for viewing. Counting was done at 400 x, with problematical pollen grains

examined under oil immersion at 1000 x. In this feasibility study we were looking for gross vegetation and pollen record formation patterns at an acceptable cost and only 100 pollen grains were tabulated per sample. |

Benninghoff's (1962) exotic pollen addition method was employed in computing pollen concentrations per gram of sample. Pollen concentration figures were not calculated for individual taxa. These would not be meaningful in the absence of chronological control over sedimentation and pollen leaching rates and might be mistaken for pollen influx data. All pollen grains too degraded to be identified were tabulated to provide further control over corrosion factors. Unidentifiable pollen grains were not incorporated in any sum from which the frequencies of other types were computed, but the data for this pollen group, as a percentage of total identifiable and unidentifiable pollen, are presented for each profile. Corroded oak pollen grains, a prominent type that retains its identity while readily degrading (van Zeist 1967:49), were also tabulated. The terms "corroded" and "degraded" are used interchangeably and refer to any kind of pollen deterioration other than tearing. They are not intended as references to the specific classes of deterioration defined under these terms by Cushing (1964) and Havinga (1984). #.cdg? 6 Same with 5th

Methodological considerations.

Natural and cultural processes affecting the pollen after it has been deposited on the ground are as important as the composition of the vegetation itself in forming the palynological ground cover record in terrestrial matrices. The most readily apparent of these post-deposition pollen record formation processes are downward pollen transport by percolating groundwater (Dimbleby 1985:5), and destruction of the transported pollen by oxygen in the groundwater (Tschudy 1969) and by aerobic fungi (Goldstein 1960).

27 edg Pollen percolation is significant because it serves to separate the pollen records of successive ground covers deposited on a ground surface when the soil profile is very slowly aggrading or not aggrading at all. The characteristic product of pollen percolation is a sequence in which most of the oldest pollen is at the bottom of the profile, most of the youngest pollen is at the top and most pollen of intermediate age is in the middle. An example from the literature (Kelso, Stone and Karish 1989) is presented in Figure 1. The illustrated profile is from Fort Necessity, Pennsylvania. At that site primordial forest was cut off ca. 1856-1880 and put to pasture. The forest is recorded in the oak frequencies at the bottom of the sequence. The clearance period is reflected in the ragweed counts in the center of the profile. The final product, pasture, is evident in the grass pollen at the top of the diagram.

Pollen destruction during leaching is continuous. The process produces a sequence in which pollen concentrations per gram of matrix fall off progressively toward the bottom of the profile while the proportion of the surviving pollen grains that are visibly degraded increase toward the bottom. This sequence is

illustrated at the bottom of Figure 1. These pollen preservation measures are important in the interpretation of pollen spectra because the presence of these characteristic concentration and degradation patterns indicate that the profile has developed naturally (i.e., soil processes have not been disrupted). Variations on these pollen concentration and degradation patterns record different kinds of human activities (Kelso n.d.).

Results

Core 4

Stratigraphy Core no. 4 in the postulated British campsite core was taken for control purposes. It should contain a natural pollen formation process sequence that will serve as the comparative basis for interpreting the linear mound core (no. 2). Core no. 4 (Figure 2) is 38 cm long, but the core hole was 46 cm deep. The core has been compressed 8 cm (17.39%), and any leaching rates calculated from this core will have to be increased by that amount if they are to be compared to leaching in other sites.

The Core 4 stratigraphy is easiest understood if discussed from top to bottom. The core 4 profile is capped by a 3 cm litter zone of compacted oak leaves. A 1.5 cm dark brown humus layer occurred below the litter. This brown humus zone faded into yellowish brown sand in the deeper core. This appears to indicate a normally developed soil profile, with A-horizon (humus) minerals leaching down into underlying parent material (C-horizon) to create an intermediate B-horizon. Pollen from the surface should fade out in the same way as the humic stain.

Palynology Countable quantities of pollen were recovered from all samples of core number 4. This means that the core did not reach the bottom of the preserved pollen record at the sample locus. Both the hazel (Corylus) pollen frequencies and the pollen concentrations are abnormally high in the deepest two samples of the core, and there were fewer pollen grains which were too degraded to recognize in sample 1. These counts appear to be part of the record of some land-use event. Hazel suggests clearance, but this hypothesis cannot be tested without more data. A deeper core needs to be taken at the locus.

Within the portion of the record that was recovered there are clear indications of major changes in the composition of the vegetation on the plot, and there is some evidence that the matrix itself has been manipulated. In the pollen spectra we are dealing with successive vegetational events. Each event can only be understood in terms of preceding events. The core will be discussed from the bottom up, and samples will be numbered in that order. Number 1 is at the bottom of the core and Number 21 is at the top.

Oak is the major pollen type in the deeper half of the profile and is accompanied by minor amounts of grass, Aster-type (insect-

Amelun?

pollinated Compositae) and dandelion-relatives (Liguliflorae) pollen. This appears to register a relatively stable oak dominated forest penetrated by enough light for a few herbs. Pollen preservation and concentration figures imply a normal pollen leaching situation and, consequently, an undisturbed soil profile.

The pollen/vegetational sequence from earliest to latest (i.e. bottom to top of the core) is as follows:

- 1) Oak frequencies decline slightly above sample 7 and Aster-type (insect-pollinated Compositae) and dandelion-type (Liguliflorae) pollen virtually disappear in the sample 7-9 core segment.
- 2) Birch (Betula) percentages rise above sample 7 as oak declines. They and remain high to the top of the profile. Rose family (Rosaceae) pollen appears in the record as oak declines and birch rises.
- 3) Rose family pollen abruptly peaks in samples 11 and 12 and then drops off and virtually disappears above sample 13.
- 4) Ragweed (Ambrosia-type/wind-pollinated Compositae) and grass (Gramineae) pollen percentages increase abruptly in sample 13. They subsequently decline slightly but remain relatively high to the top of the profile.
- 5) Oak pollen decline abruptly in samples 17, 18 and 19 while hazel percentages increase proportionately.
- 6) Hazel pollen frequencies increase abruptly in samples 20 and 21 (top of profile) as oak pollen percentages rise appropriately.

*but Compositae is not
- flowering?*

Birch is a recognized pioneer on abandoned farmland in the Northeast (Braun 1950:429) and hazel is a very important element in European secondary forest succession (Iversen 1949:12). The oak-birch-hazel-oak dominance sequence among the core 4 arboreal pollen types strongly suggests that British Woods spectra record tree cutting and secondary succession. Clearance on the Saratoga site does not, however, appear to be agricultural in origin. Raspberry and blackberries (Rubus spp.), prominent native members of the rose family, take over and persist for 10 to 25 years in forest stands where more than 50% of the basal area has been cut (Barrett 1980:4). The increase in this type indicates that a significant portion of the canopy was removed during deposition of the samples 7-12 spectra. The soil, however, was not seriously disturbed at this time because the pollen of ragweed, the premier North American colonizer of the harsh environments of cleared ground (Bazzaz 1974:112), does not increase until sometime after oak frequencies drop off. Total arboreal pollen rebounds above sample 13 when the statistical pressure from the over-representation of rose pollen in samples 11 and 12 is released, but it does not reach pre-rose peak proportions. Clearance was nothing like the stripping recorded in the arboreal sums at Fort Necessity (Figure 1), but the tall forest canopy did not completely

regenerate either.

7. | Abrupt drops in the quantities of both "corroded oak" and pollen "too degraded to recognize" and a sharp increase in pollen concentrations occur in sample 11. Overlain on these abrupt changes are normal rising pollen concentrations and improving pollen preservation patterns. This brief shift in pollen preservation and concentration suggests that the soil may have been turned over, mixing new pollen down into the old about the time of the rose pollen peak. Normal pollen leaching and degradation processes then resumed. Such soil disturbance would also explain the destruction of the local populations of asters and dandelion relatives.

Rose pollen does not decline, it disappears abruptly. This suggests that the parent raspberries/blackberries were probably not shaded out. They were removed. As rose family pollen disappears, ragweed increases moderately, and it appears that continuous, low level soil disturbance was characteristic of the interval after this understory clearance. A few grains of European cereal pollen (wheat, barley, rye or oats) were observed in samples 16 and 17, and there more grass pollen in this part of the profile than in any other. If the cereal pollen was deposited with the manure the soil disturbance may have been caused by cattle turned out to graze in the woods.

The massive decline in oak pollen percentages and parallel rise in hazel frequencies in samples 16-19 can be interpreted two ways. Hazels are shade tolerant. These small trees or shrubs may persist for a considerable interval under a forest canopy after other pioneer species are shaded out. The oak-birch-hazel-oak sequence in core 4 resembles Iversen's (1956) diagram (Figure 4) of a typical European forest clearance and regeneration cycle. It is possible that the proliferation of hazel pollen in the upper profile is a stage of the land-use cycle that began with the oak decline and appearance of roses in sample 7. The hazel peak is quite shallow, -3 to -6 cm, and may reflect a decline in human pressure on the local vegetation with the establishment of the New York State Park in the 1920's. The problem with this interpretation is that the proportion of arboreal pollen in the total sum should have increased if the hazel population had gotten larger without any decrease in the local oak population. It does not do so. It is also possible that the oak/hazel oscillation in samples 16-19 reflects a new clearance episode. Birch frequencies are more regular and, perhaps, a little higher on the average above sample 14. These could be a response to a new opening in the canopy.

The British Woods core 4 pollen sequence is capped by the resurgence of the oak pollen contribution as hazel drops off abruptly in samples 20 and 21. This oak zone corresponds to the litter layer, and it seems unlikely that oaks as large as those surrounding the sampling site could have grown up in less time than it would take a few leaves to decompose. The profile could have been truncated and the oak pollen in samples 20 and 21 could reflect the local pollen rain during the interval since the

truncation. Stratigraphy and pollen preservation argue against this interpretation.

A humus zone dominated by hazel directly underlies the oak dominated litter zone. This would have been removed in any truncation. A 5 cm zone of good total pollen preservation like that expected near any normal surface exists in the profile. It incorporates both the litter and the humus, and a zone of excellent oak pollen preservation extends 2 cm into the humus. These phenomena indicate that both the oak and the hazel pollen are of recent origin. The abrupt depression of hazel may mean that shrub hazels were physically removed by human agency rather than falling victim to the natural progression of secondary succession.

Pollen concentrations also unpredictably fall off in the litter zone. Oaks produce a lot of pollen (Faegri and Iversen 1964:33) and ca. 50,000 pollen grains of all kinds fall on each square centimeter of the Eastern United States every year (Davis 1969: Figure 3). Pollen concentrations in the litter should be high. A decline in pollen concentrations as oak pollen percentages increase suggests that the oak resurgence in samples 20 and 21 is at least partially the statistical product of the rather sudden decline in hazel. This would mean that there was actually an oak cutting incident in samples 17-19.

Core 2

Stratigraphy The stratigraphy of Core 2 (Figure 5), the profile through the embankment, is at least partially cultural in origin and is best understood if it is presented in chronological order of development. It will be discussed from bottom to top. Sixty one centimeters of core were recovered but the hole at core 2 was 76 cm deep. This means the recovered core was compressed by 19.7%. Compression may actually have been higher because the bottom 15 cm of the core as measured is slump. These bottom 15 cm were taken as a single sample. From 46 cm depth (sample 2) up to 23 cm depth (sample 12) we have a progressive darkening (Figure 5) of the matrix from brownish yellow (ca. sample 4) through yellowish brown (ca. sample 8) and dark gray (sample 11) to black (sample 12). The gradual nature of this shift was even more apparent when the samples were lined up in beakers of 5% HCL at the start of pollen extraction. The sequence appears to be a buried soil. A seed was recovered from ps 11, the brown stained area below the assumed buried A-horizon at ps. 12, supports such an interpretation.

The really dark humic zone in the embankment core (No. 2) was 2 cm thick and comparable to that in the campsite core (No. 4). No trace of a litter zone was, however, visible to the unaided eye in the buried profile. No optical instruments were available when I examined the humus, but no organics other than roots were caught on my 100 mesh screens either.

Three centimeters (-23 cm to -20 cm) of a light gray, almost white (5YR6/1), sand overlay the apparent buried humus horizon at ps 12. The lower centimeter of this white layer was mottled with black from the humus and was sampled separately (ps. 13). The white zone (ps 14) faded into gray sand (5YR5/1) above 20 cm. At

first I thought this white/gray zone might be the leached streak characteristic of podzols. This interpretation was discarded because the white/gray was on top, rather than under, the apparent humus zone. The white/gray deposit was also observed at approximately present ground surface in the profile of Starbuck's (1986) excavations through the linear mound.

When the residue from pollen extraction was screened, charcoal was found in the apparent humus zone, in the white zone and in the gray zone. The largest pieces were recovered from the apparent humus zone (ps 12), but the largest quantities came from the mottled (ps 13) and white (ps 14) zones just above the humus. A burned seed was found in ps 14. The quantities of charcoal declined steadily through the gray zone and disappeared from the record in ps 17 at the bottom of the overlying yellowish brown sand. The white/gray zone between 23 cm and 16 cm depth appears to be ash.

The white/gray zone was succeeded by yellowish brown sand (5YR5/4) above 14 cm depth. This yellowish brown sand is clearly an episodic cultural deposit, and it is responsible for the preservation of the buried soil profile in ps 12 (-25/23 cm) and below. There was a very minor black/brown mottling at the surface (-0 to .5 cm) of this yellowish sand, but no humus zone equivalent to that which capped the campsite area core (no. 4). This suggests that the embankment deposit has been truncated or is too recent to have developed a humus zone.

These data are visual and largely qualitative. Quantities of organics and charcoal are only estimated. They do suggest that at one time the surface litter zone at the core 2 location ignited and that the fire was put out by digging sand from the ditch to the south of the embankment and tossing it on the surface fire. This would account for the buried soil, the absence of visible plant remains on top of the buried soil and the charcoal.

Palynology No pollen was recovered from sample 1 (-61/46 cm) in the British Old Woods core 2 (Figure 6) and only ca. 95 pollen grains per gram were found in sample 2 (-46/45 cm). Core 2 may be considered to have reached the bottom of the recoverable pollen record under the embankment. Three pollen zones are evident in this core. These are:

- 3) Sample 23 (-3 cm) to sample 24 (-1 cm)
- 2) Sample 15 (-19 cm) to sample 22 (-5 cm)
- 1) Sample 3 (-43 cm) to sample 14 (-21 cm)

Pollen zone 1 occupies the bottom 1/2 of the core. In this core segment, pollen concentrations rise steadily toward the top of the zone and both "too degraded to recognize" and "% corroded oak" indicate that pollen preservation got steadily worse toward the bottom of the core. This pattern duplicates the pattern for normal soil processes presented in Figure 1. Most of the pollen in a normal soil profile is to be found in the upper 4 cm (Dimbleby 1985:5) and in this core there is a strong peak of pollen

concentrations in samples 12 to 14 (-25 cm to 20 cm). This sample 12-14 peak must register a buried surface, and pollen zone 1 must record a buried soil. The buried surface coincides with heaviest charcoal concentrations in the core and supports the inference from stratigraphy that the soil was buried because of a litter zone fire.

Only one vegetation trend is registered in this pollen zone: oak pollen percentages decline while those of pine increase from the bottom of the zone to the top. Pines are prominent in secondary succession sequences in the Northeast (Braun:1950:429) and this sequence, which leached down from the surface in sample 14, appears to record reforestation. Such a reforestation stage cannot be correlated with any section of core 4 (campsite area) because the actual deforestation incident at the core 2 (linear mound) locus pre-dates the pollen record and because the pine frequencies in core 4 are too irregular to match up with the core 2 trend.

There are a number of historic references to pines in the Stillwater area, and Russell (1989:15-16) is interested in determining whether these were white pines (Pinus strobus) or pitch pines (Pinus rigida). White pines have gemmae on their ventral surfaces between their bladders (i.e., "belly warts"), but pitch pines do not. Unfortunately pine pollen is rather fragile and preservation in the British Old Woods cores was bad. I would not risk identification (see Figures 3 and 5) in most cases. Pollen preservation was best in the surface samples of zone 1 in core 2, and all of the pine pollen where I could get a ventral view was white pine. This should not be considered conclusive.

Pollen zone 2 of core 2 is incorporated in the gray sand and yellowish brown sand above the buried surface of zone 1. Zone 2 is characterized by lower pine pollen frequencies, higher oak pollen percentages, unpatterned pollen concentrations and generally worse pollen preservation. Most of these pollen percentages and pollen record formation measures are too irregular to have been formed by any of the normal cultural or natural deposition process recognized to date, and it is most probable that the pollen in this zone is old pollen dumped on top of zone 1 with the matrix dug from the adjacent ditch.

The top two samples (No. 23 and No. 24) of core 2 constitute pollen zone 3. Here oak, pine, total arboreal pollen, "too degraded to recognize" and "corroded oak" percentages drop off while ragweed-type, grass, rose and hazel pollen frequencies increase. Pollen concentrations are lower except for the uppermost sample. This zone is made up of modern pollen leached down into the surface of the mound and capped by last year's pollen rain. It has not penetrated far into the mound. This could mean either that the mound is very recent or that surface erosion has kept pace with percolation. I prefer the latter interpretation.

Summary and Discussion

appearance of the type at the Fort Necessity rate, however, dates the advent of Rubus to ca. A.D. 1730. Earthworms could have been involved in moving this pollen down and the percolation rate in sand, which constitutes most of the matrix at our sample locus, may be very rapid.

A buried soil whose surface coincided with the charcoal bearing ash-like deposit 22 to 27 cm down in core 2 was found immediately under Snow's linear mound. This strongly suggests that the mound was thrown up to smother a surface litter fire. A reforestation incident in which pine replaces oak was registered in the pollen sequence of this soil, but the clearance incident itself pre-dates the surviving pollen record. Neither pitch pine nor white pine shed much pollen before they are 10 or 12 years old (Fowells 1965:405,450), and pine succession in reforestation was well underway when the litter fire was smothered. Gordon (1987), Russell (1989) and Schrepfer (1989) all emphasize the density of the forest in the Stillwater area prior to the arrival of the combatants in 1777. Wilkinson's map (Russell 1989:Figure 1) does show several pre-campaign Euroamerican fields in the line area, but these are depicted as completely cleared rather than overgrown. Reforestation takes time and even if the pollen sequence under Snow's linear mound records secondary succession on British clearances, the mound must post-date the Burgoyne campaign by some years. The pollen spectra of this core cannot be dated relative to events in core 2 (campsite) because the pine pollen sequence of core 2 is too irregular.

In terms of pollen record formation processes, the pollen records of forest trees under the canopy proved to be more sensitive to changes in vegetation across short spaces and through time than had been assumed. The objective of the study was to date the linear mound interpreted as British earthworks relative to vegetation events in the area of the postulated British campsites. This did not prove to be possible because the cores from the two areas could not be correlated. Apparently the forest species composition was too complex, and the pollen shed by the forest trees fell too close to the parent plant to permit the correlations I was seeking. Questions about the abrupt rise and decline of hazel and the abrupt decline of the rose family type in core 4 also remain, and pollen leaching processes under the canopy in the British Woods may also differ from those in the rural pastures, urban backlots and formal lawn which I drew on for models.

Recommendations

1. Linear Mound/Fortification History: The data provided by this study indicate that Snow's linear mound was thrown up onto a surface that had been undergoing secondary forest succession for some time and very probably was not a 1777 British fortification. Unless the post-Burgoyne campaign history of the area is of interest, no further work need be done on the linear mound itself.

2. British Woods Land-Use History: Core 4 (campsite) did not reach

pollen-sterile deposits, and the pine taxon question has not been resolved and the nature of the oak-hazel-oak shift at the top of the profile has not been satisfactorily explained. If we want to pursue the clearance record of the British Woods, determine whether we can find a pollen record of the Burgoyne campaign period, and contribute to historic land-use/record formation theory, we should do three things:

- a) Pollen counts for the existing samples should be expanded to 400 grains.
- b) All pine pollen grains should be examined under oil emersion to see if the ventral surfaces are absent.
- c) Another core should be taken adjacent to core 4. It can be analyzed from the bottom up until the rose pollen peak is reached. Those counts can then be tacked onto core 4 to complete the record.

If the place of the mound in the post-battle history of the woods is of some interest, the missing portion of the core 4 (campsite) pollen record should be recovered and linked to the linear mound core (No. 2) by doing two things:

- a) A series of 3 cores should be taken along a transect between the mound at the core 2 locus and core 4 in the campsite area. One of these cores should be taken immediately adjacent to the mound and the others at 10 meter and 20 meters from the mound.
- b) The mound has been truncated, apparently by normal erosion, and the core through the fill of the ditch adjacent to the mound should also be investigated.

3. Professional Standards and Intellectual Satisfaction: Any incomplete pollen record is unsatisfying. This is especially true of core 4 (campsite) because the increase in hazel pollen and improvement in pollen preservation at the bottom of the recovered sequence suggests that older land-use data are preserved in the deeper sediments. We have not really tested the potential of pollen analysis in the British Woods.

- a) The bottom portion of a core should be taken adjacent to the core 4 locus. This should be analyzed and spliced onto the existing. This is the minimal professional thing which we can do. It should be done while we can still find the core 4 locus.
- b) Existing counts should be expanded to 400 grains. This can be done later. It should not be delayed too long as pollen expands and eventually dissolves in glycerol.

References Cited

BARRETT, J.W.

- 1980 The Northeastern Region. In Regional Silviculture of the United States. Edited by J. W. Barrett. pp. 25-65. Wiley International. New York.
- BAZZAZ, F.A.
1974 Ecophysiology of Ambrosia Artemisiifolia: A Successional Dominant. Ecology 55:112-119.
Journal of Biology. 11:678-685.
- BENNINGHOFF, W.S.
1962 Calculation of Pollen and Spores Density in Sediments by Addition of Exotic Pollen in Known Amounts. Pollen et Spores 6(2):332-333.
- BRAUN, E.L.
1950 Deciduous Forests of Eastern North America. The Blackstone Co. Philadelphia, PA.
- CUSHING, E.J.
1964 Redeposited Pollen in Late Wisconsin Pollen Spectra from East-Central Minnesota. American Journal of Science 262:1075-1088.
- DAVIS, M.B.
1969 Climatic Change in Southern Connecticut Recorded by Pollen Deposition at Rogers Lake. Ecology 50:409-422
- DIMBLEBY, G.W.
1985 The Palynology of Archaeological Sites. Academic Press. New York.
- FAEGRI, K. and J. IVERSEN
1964 Textbook of Pollen Analysis. Hafner Publishing Co. New York.
- FOWELLS, H.A.
1965 The Silvics of Forest Trees. USDA Handbooks No. 271. United States Department of Agriculture. Washington, DC.
- GOLDSTEIN, S.
1960 Degradation of Pollen by Phycomycetes. Ecology 41:543-545.
- GORDON, Nancy M.
1987 The Saratoga Battlefield: A Vegetative History. Report on file at National Park Service, North Atlantic Regional Office, Division of Cultural Resources, 15 State Street, Boston, Massachusetts.
- HAVINGA, A.J.

1984 A 20 Year Investigation into Differential Corrosion
Susceptibility of Pollen and Spores in Various Soil
Types. Pollen et Spores 26 (3-4):541-558.

IVERSEN, Johs.

1949 The influence of Prehistoric Man on Vegetation.
Danmarks Geologiske Udersogelse IV Raekke. Bd.3.
Nr.6:5-25.

1956 Forest Clearance in the Stone Age. Scientific
American 194:36-41.

KELSO, Gerald K. and Mary C. BEAUDRY

1990 Pollen Analysis and Historic Urban Land Use: The
environs of Scottow's Dock In 17th, 18th, and Early
19th-Century Boston. Historical Archaeology 24(1):
61-81.

KELSO, Gerald K., Rodger STONE and John F. KARISH

1990 Pollen Analysis in Historic Landscape Studies at Fort
Necessity National Battlefield. Park Science 10(2):10-
11.

MEHRINGER, Peter J. Jr.

1967 Pollen Analysis of the Tule Springs Area, Nevada.
In Pleistocene Studies in Southern Nevada. Ed. by H.M.
Wormington and D. Ellis, pp. 120-200. Nevada State
Museum Anthropological Papers 13. Carson City.

RUSSELL, Emily W.B.

1989 Saratoga National Historical Park. Critical Review of
Historical Base Map. Report on file at National Park
Service, North Atlantic Regional Office, Division of
Cultural Resources, 15 State Street, Boston,
Massachusetts.

SCHREPFER, Susan R.

1989 Analysis of Saratoga National Historical Base Map.
Report on file at National Park
Service, North Atlantic Regional Office, Division of
Cultural Resources, 15 State Street, Boston,
Massachusetts.

SNELL, C.

1949 A Report on the Ground Cover at Saratoga National
Historical Park, October 8, 1777. On file at National
Park Service, North Atlantic Regional Office, Division
of Cultural Resources, 15 State Street, Boston,
Massachusetts.

1950 Historical Base Map, Master Plan, Saratoga National
Historical Park. On file at National Park Service,

North Atlantic Regional Office, Division of Cultural
Resources, 15 State Street, Boston,
Massachusetts.

SNOW, Dean R.

- 1977 Archaeological Atlas of the Saratoga Battlefield.
Report on file at National Park Service, North Atlantic
Regional Office, Division of Cultural Resources, 15
State Street, Boston, Massachusetts.

STARBUCK, David R., Silvie C. BROWNE, Allyson BROOKS, Dennis HOWE
and Deborah SUCIU.

- 1986 Saratoga National Historical Park Archeology Progress
Report-1985. On file at National Park Service, North
Atlantic Regional Office, Division of Cultural
Resources, 15 State Street, Boston,
Massachusetts.

TSCHUDY, R.H.

- 1969 Relationship of Palynomorphs to Sedimentation. In
Aspects of Palynology, ed. by R.S. Tschudy and
R.S. Scott. pp, 79-96. John Wiley and Sons. New
York.

VAN ZEIST, W.

- 1967 Archaeology and Palynology in the Netherlands.
Review of Palaeobotany and Palynology 4:45-65.