

POLLEN STRATIGRAPHY OF THE WETHERILL MESA REGION

by

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ABSTRACT

One hundred fifteen sediment samples from the Wetherill Mesa area have been examined for their pollen content. Those from site 1205 reveal a record of past environmental events. The samples from site 1200 (Long House) contain good time-horizon markers and a record of cultural activity of importance. Other samples were collected in order to explore the possibility that ancient cornfields could be recognized by their microfossil floras. The majority of these samples proved unproductive; it is thought that one was located through the presence of corn pollen in the soil samples.

The fossil pollen record indicates that no major climatic changes have taken place since prehistoric occupation. Although evidence of changes in the vegetation can be recognized, these are possibly due only to man's influence upon the local scene. Such cultural activities as corn agriculture, land clearance by burning, and trade seem manifest in the pollen record.

INTRODUCTION

Palynological investigations have two major purposes: chronological and ecological. The first purpose is served by the construction of recognizable pollen horizons in a sedimentary sequence which may be dated from some absolute or relative standard at one locality and can then be used as dating mechanisms at other localities. The second purpose is the reconstruction of the environment of a locality during the period of pollen deposition.

Within geographic region one can expect many plant communities adapted to different local conditions, so record of the prior vegetation of one locality will not necessarily indicate the record of all. Also, pollen horizons at such locality may not reflect changes occurring at the same time to other portions of the regional flora,

the utilization of the pollen profile as chronological scale may be limited. With these provisions in mind, and recognizing other limitations in palynological methodology and technique (Faegri, 1956; Faegri and Iversen, 1950; Eiseley, 1939; and others) the author undertook to extract, analyze, and interpret fossil pollen from the sediments associated with archaeological excavations at Wetherill Mesa, Mesa Verde National Park, Colorado. In addition, attempted to evaluate the fossil record in terms of the prehistoric inhabitants of the area; their environment and their utilization of this environment.

PROCEDURES

The extraction of pollen from the sediment samples was primarily by the method described by Arms (MS) which employs quebracho as silicate desiccant. This accomplishes an initial concentration of the organic fraction of the sample prior to digestion with hydrofluoric acid, acetolysis, and flotation by specific gravity differences. As the initial step this process is quite lengthy. I utilized quicker method on some of the samples. The second method is modification of that described by Frey (1955) for siliceous samples which also includes HF digestion and acetolysis.

If they are polliniferous, pollen could be extracted in quantity from sediments by both techniques, but the longer Arms method proved more efficient, as it could produce a greater percentage of material that needed further processing. Of the samples processed, 71 were considered countable.

The residue of the extraction process was placed in labeled vial to which glycerin and basic fuchsin stain were added. The mixture was smeared on a microslide and covered with a cover slip. Unused portions of the sediment samples and the vial and the slides are stored at the Geochronology Laboratories.

Counting of the pollen grains was done at 563 magnifications. A Leitz research microscope equipped with wide field oculars. In checking for accuracy and for making some identifications, 1250 magnifications (oil immersion) were used. Approximately 200 pollen grains, exclusive of unknowns were tabulated for each sample, except in two where the frequency of unknowns was over 60%. Counts of this size were considered adequate (Martin, et al. MS) for determining dominant pollen components in Southwestern sediments.

Pollen diagrams were constructed on the basis of absolute percentage of the various elements rather than by selecting one group (e.g. arboreal pollen) as standard. The arboreal-non arboreal relationships are indicated and based from the absolute percentage curves. Two scales were used in the pollen diagrams one for common taxa and an expanded scale for uncommon taxa. Because of its relevance in the pollen record, Unknown has been segregated from the other unknown pollen types.

IDENTIFICATIONS

Subgeneric identification of pine (Pinus) is desirable in this area, as both pinyon and yellow pines are native to the region and inhabit different ecological niches. In Arizona (Martin, et al MS) pollen of the nut pines is smaller than that of other species. Assuming that this would also be the case in Southern Colorado, I made a series of measurements of pine pollen bladders from certain localities (figs. 3 and 4). Statistically significant fluctuations in mean size of pine pollen bladders from different localities and different depths were observed, but these fluctuations do not seem to reveal consistent trends or indicate changes from pinyon to yellow pine forest conditions. Because of the presence of juniper and oak in the pollen diagrams, I have assumed that the pine represented is primarily that of P. edulis, the local pinyon.

The accurate identification of oak (Quercus) is often dependent upon its state of preservation. In checking the pollen tabulations for accuracy (Table 2), I found that significant differences in the percentage count of oak pollen depended on whether the samples were counted under oil immersion or if counts were made by different observers. On the whole, I tended to over-represent the percentage of oak slightly in my original tabulation. The probability ($P=0.95$) that the original estimate and the estimate made under improved conditions of observation differed by a factor exceeding that of chance was exceeded in two cases out of the six observed. It is unlikely that the percentage of oak in stratigraphic sequence are in error relative to each other but placing great confidence in the absolute frequency of oak in any sample would be unwise.

Accurate identification of juniper (Juniperus) a fragile pollen type, is dependent to a great degree upon the preservation of pollen in the sample. The samples from site 1205 were retabulated because it was felt that misidentification of juniper had occurred in the original count. Those samples from site 1200 which contain appreciable amounts of juniper pollen were well preserved and their identification is reasonably secure.

Pollen grains of the cactus family (Cactaceae) are very rare in floodplain fossil pollen records, even in areas in which cacti dominate the vegetation. Those found at Long House are referable to the prickly-pear group (cholla). Since the cacti are zoogamous the persistent occurrence of the type at site 1200 is likely to represent pollen from plants fruits collected by man and brought into the dwelling.

E. B. Kurts, Department of Botany, University of Arizona, Tucson, a specialist on the pollen of the Cactaceae, confirmed my identification.

At first the pollen type designated as Unknown B was thought to be referable to Cleome serrulata, Rocky Mountain bee-plant. Subsequent observation by myself and others did not confirm the identification, and it remains an unknown type at this time. The pollen grain is small (ca. 20 μ) reticulate, and tricolporate, with transverse colpi; it is highly variable in shape and in the form of the aperture.

As the wind-pollinated pollen types to be found in the Southwest are relatively well known, it is unlikely that Unknown B is from such a plant. Since plants which pollinated with the aid of animals rarely contribute appreciable percentages of pollen to the fossil record,

it may be presumed that man was responsible for the presence of great quantities of pollen of this type to be found in the sediments from Long House. The plant may have been cultivated, allowed to grow as a useful weed in the cultivated fields, or gathered for some economic purpose.

Upon recounting certain levels under oil immersion I found that I had tended to underestimate the absolute frequency of Unknown B (Table 2). In the tabulations on which the pollen diagram from Long House was constructed the absolute percentages of Unknown B may be too low at any given sample; on the other hand, the relative percentages are likely to be correct.

The identification of Zea (corn) from Euchlaena (teosinte) and Tripsacum is somewhat uncertain; I have selected the definition of Martin and Schoenwetter (1960), i.e. graminoid pollen larger than 60 μ . E. B. Kurtz has also observed some of the pollen and believes that in the majority of cases, at least, it is referable to Zea.

The large thin-walled, periporate, echinate pollen type which I am calling Cucurbita could possibly represent some other genus in the squash family. Erdtman (1952:137) mentions that related genera have a similar pollen type. Because of the presence of microfossils of Cucurbita (O'Bryan, 1950:102) this pollen identification seems probable.

The Cheno-Am category is composed of periporate pollen grains referable either to members of the Chenopodiaceae (goose-foot family) and/or the genus Amaranthus (pigweed), as the pollen of these large groups is not distinguishable at the present time. Most of these plants favor disturbed soils, sandy ground, and waste places.

As sagebrush (Artemisia) is a member of the Compositae (sunflower family) the pollen curve has been plotted within that of the Compositae as a whole in the pollen diagram from site 1200.

The column marked OTHERS is reserved for pollen types of rare occurrence. The number after the identification refers to the number of grains observed, rather than the percentage: Juglans (walnut), Agave, Plantago (pleintain), Alnus (alder), Euphorbiaceae (spurge family).

The UNKNOWN category refers to rare pollen types that could not be otherwise identified (exclusive of Unknown B), and to pollen grains that were broken or otherwise damaged beyond recognition. This latter group is by far the majority.

POLLEN STATISTICS

The application of statistical methods to pollen analyses results in quantitative statements made in addition to qualitative ones, and measures the probability of an occurrence being caused by chance. In this study statistics were applied in two ways: to provide information on the use of certain pollen characters as horizon markers and to give quantitative determinations of accuracy.

Measurements were made of the length of the bladder of 20 pine pollen grains from each productive sample at site 1205 (fig. 3). The range of the measurements (black line), the mean (peak), one standard deviation on either side of the mean (white bar) and two standard errors of the mean on either side of the mean (black bar) were calculated and graphed according to the method of Hubbs and Hubbs (1953).

The white bar (twice standard deviation) encompasses measurements expectable of 95% of a population from which this sample might originate. The black bar (twice standard error) encompasses 95% of the means of hypothetical replicate samples of such population. Samples with standard errors which do not overlap are considered to originate in different populations with probable error by chance of only 5%. As an example, the standard error of the mean of samples from unit X at site 1205 overlap each other. Statistically, these samples show no significant difference from each other and may be considered as originating from the same source. The standard error of the mean of the sample from zone I, however, does not overlap those of unit X. There is 95% probability that this difference is not due to chance, so it is likely that the sample from zone I is representative of distinct population.

In unit Z significant differences can be observed, but differences occur between the samples from unit Y. There are significant differences between samples from unit Z and unit X, indicating that they originated from similar sources. Differences between the samples in unit Y are observed to be gradational in time. Assuming that the differences in size of pine pollen bladders are not artifacts of preservation, it appears that during the deposition of unit Z and X the source of pine pollen at site 1205 was similar but that changes occurred during the deposition of unit Y and zone I.

At site 1200 pine bladders were measured from those stratigraphic zones which contained quantities of pine (fig. 4). It was hoped that one might contain pine pollen significantly larger or smaller than that of the other zones. Figure 4 shows that the pine pollen from any one zone is variable in size, so cannot be used as stratigraphic marker

It was observed that the number of broken pine pollen grains was higher at site 1200 in zone II than zone I. Selecting Area IV as an example, the percentage of broken pine grains from zone I was compared with the percentage from zone II. There was found to be a significant difference (binomial system, $P = 0.95$), with more breakage occurring in zone II. Next, the percentage of breakage from all samples from zone IIc was examined. There was found to be significantly less breakage in zone IIc than in zones II a-b, but no significant difference in breakage between pine pollen in zone I and zone IIc.

Table 1.

<u>Zona</u>	<u>% Broken Pine Pollen</u>	<u>N</u>
I	13.33	150
IIa-b	26.66	150
IIc	9.09	176

This may be the result of increased cultural activity in zones IIa and IIb at the site and could be used as a stratigraphic marker. At site 1205 the percentage of broken pine pollen is significantly higher in units X and Y indicating less occupation in zone I and unit Z, or a possible time equivalence of zones IIa and b at Long House with units X and Y at site 1205.

Table 2 shows differences in the percentages of various pollen types observed from the same samples under different conditions. The samples from room 53 were first observed at 563 magnifications. A second tabulation

DEPTH	0.3'		1.0'			1.3'		1.7'		2.3'			3.0'	
	1st	2nd	1st	2nd	3rd	1st	2nd	1st	2nd	1st	2nd	3rd	1st	2nd
Pinus	1.26	1.61	1.37	0.9	1.23	0.5	0.4	4.08	3.82	12.82	8.08	15.12	14.7	9.02
Quercus	1.74	0.8	1.71 *	0.4 *	0.1	2.1	0.9	3.99	1.2	13.18*	2.69 *	0.4	7.9	3.97
Juniperus	1.58	1.61	0.3	1.1	0.2	0.1	0.3	1.14	0.7	3.66	4.73	2.21	1.03	4.69
Ephedra	0.2		0.5		0.1			0.6		0.4	1.68	0.8	0.6	0.4
Cactaceae	0.7	0.5	0.6	0.5	1.5	0.6	0.7	0.3	0.5	0.7	0.7	0.4	0.2	0.8
Unknown B	62.82	57.21	62.1 *	68.5 *	73.5	73.0	79.4	37.95*	52.87	18.5*	23.2 *	14.0	9.7	18.4
Zea	3.49	4.54	8.40	7.31	6.18	3.44	3.78	10.27	14.59	6.59	2.69	6.64	2.06	2.52
Cheno-Am	4.25*	10.16	5.48	7.12	4.08	1.72	1.89	6.56	5.02	9.89	13.13	15.5	26.4	15.88
Compositae	16.82	12.56	10.80	6.03	5.48	14.42	10.04	30.25*	15.55	31.5	31.3	34.7	27.65	32.85
Gramineae	4.92	6.95	6.69	6.58	4.66	1.45	0.9	2.85	3.11	8.42	7.74	7.01	6.44	4.33
Unknowns	1.9	3.74	1.7	1.3	2.1	2.4	1.5	2.0	2.15	2.4	4.37	1.1	2.7	6.85
N	630	374	583	547	857	756	687	350	418	273	297	271	482	277

TABLE 2: Percentage of various elements in replicate tabulations from Room 53

1st: Schoenwetter; 363 magnifications

2nd: Schoenwetter; 1250 magnifications

3rd: Martin; 1600 magnifications

* statistically significant difference between figures at 95% confidence level

was made at 1250 magnifications (oil immersion). A third tabulation was made by another observer at 1600 magnifications. Asterisks between figures denote differences not likely to be due to chance ($P < 0.05$). Percentages of the first tabulation are used in the pollen diagram (fig. 2). These statistics are included as an objective measure of the accuracy of the data incorporated in the pollen diagrams. It will be seen that there is likelihood of several of the absolute percentages graphed being too high (Quercus) and others being too low (Unknown B) but the relative percentages are likely to be correct.

RESULTS AND INTERPRETATIONS

Site 1205

Site 1205 is a small cave located in the area burned in 1934. The sediment samples from this locality were the first to be analyzed. After gaining more experience with the material from the Wetherill Mesa area, the entire series of samples was recounted and plotted (fig. 1). There was no change in the zonation of the pollen diagram, but it was felt that a recount was necessary because of probable misidentification of Juniperus in the earlier analysis.

The uppermost sample of the pollen diagram is dominated by oak pollen and appears to reflect the fire-instigated present oak scrub plant community. This sample is placed in zone I, probably time equivalent to zone I at Long House. The other units cannot be equated on a floristic basis with pollen-stratigraphic units at Long House, nor can they be adequately classified as chronological markers until they have been more reliably dated. For this reason I assigned them alphabetical rather than numerical epithets.

Unit Z is distinguished by high percentage of pine and juniper pollen with little oak, and probably represents mature forest of pinyon-juniper at this locality. The presence of Zea at the 6.0 foot depth indicates agricultural activity, doubt prehistoric. This places a maximum age of the base of the sedimentary profile at about 2,000 B.C. since this is the earliest record of agriculture in the Southwest (Eat Cave). Probably such data is far too old, in spite of the fact that no pottery has yet been found at the site, but this maximal date may be helpful in guiding future excavation.

Unit Y is characterized by abrupt increase in the percentage of oak pollen, similar to that observed in zone I. The lower portion of unit Y contains significantly more pine pollen than the upper portion, and the upper portion contains significantly more juniper pollen. The association of high oak, higher pine, and lower juniper pollen percentages in the lower portion of unit Y is reminiscent of this same association in zone I. If fire was the causal factor for the deposition of this pollen flora in zone I it is reasonable to assume that the same factor was operative in the time represented by the lower portion of unit Y. The sediments associated with unit Y, especially with the sample from 5.8 feet which contains a great amount of oak pollen, contain further evidence of burning in the form of charcoal and burnt rock.

As noted previously evidence of cultural activity in unit Y can be deduced from the frequency of pine poll breakage. This leads to the inference that the burning intentional, possibly land clearance technique preparing the area for agriculture. The lack of evidence of cultivation following the early fire remains barrier to this interpretation, but the lengthy record of high oak percentages through unit Y

is perhaps best explained on the basis of repeated burning. It is noted that the upper portion of unit Y contains more pollen of Juniperus than the lower portion. This may represent the regional succession pattern in which juniper precedes pinyon (Woodbury, 1947)

Unit X is dominated by pollen of the Compositae, family of mainly herbaceous plants of varied ecological preferences. The percentage of oak pollen is perceptibly decreased as is that of pine. The percentage of juniper pollen appears to increase in this unit, but it can be shown statistically that an increase in percentage of this magnitude may be due to chance. Presumably the pollen percentages at this point in the stratigraphy reflect conditions prior to the 1934 burn. As no information is available on the rate of deposition of sediment, however there is no way of determining the length of time represented by the unsampled interval between 0.0 and 0.4 feet. During the first tabulation of pollen percentages from this site one pollen grain of Zea occurred at the 0.4 foot level. If this pollen grain represents prehistoric agriculture, the vegetation which was decimated by the fire may never have contributed pollen to the sampled sequence.

If any evidence of climatic change exists in the pollen record from site 1205 it is to be found in unit X. In this unit the arboreal elements decrease in frequency and the herbaceous element is dominant. One is obliged to interpret this as a period when the number of trees decreased in the site area, an event which may have been due either to a general warming of climate or to man's activity. The warming hypothesis would necessitate an altitudinal elevation of ecological conditions now found below the mature pinyon-juniper forest, in this case the parkland described by Erdman (1960). Upon first observation this seems adequate explanation, but Erdman contends that the formation of such parkland is

due to edaphic, not climatic, conditions.

The decreased frequency of trees may also be related to the effect of man's lumbering of the area for firewood and/or agriculture. If the presence of corn at 0.4 feet is indicative of prehistoric agriculture, the shrub zone which Erdman considers local prior to the burn may not have contributed pollen to the sequence, in which case cultural activity seems a better explanation for the lack of trees than climatic change.

Two pollen grains of Agave were found at the 5.2 foot depth in unit Z during the recount of the material, and another fossil of this genus was identified in the first tabulation from the 2.4 foot level in unit Y. Members of this genus do not occur in Colorado presently (Harrington, 1954). With the exception of Zea all of the other elements of the fossil pollen flora at this site are native to the locality. To extend the present range of the genus to include the Wetherill Mesa area would require a major change in climate. If this occurred, not only would Agave move into the area, but many other plants would invade and replace the established flora. The pollen record, however, indicates no basic changes in species composition of the flora: the size of pine pollen is not greatly variable, indicating no climatic trends and no indications of changes in native plant community structure are evident that cannot be explained on the basis of man-made disturbance. It would seem that a simpler explanation of the anomalous pollen type is one based on the trade of foliage, fruits, or fiber with imbedded pollen from a southerly source.

In summary, the pollen record from site 1205 shows ecologic conditions similar to those of the present. The effect of fire is probably in evidence at two places in the pollen record, in zone I which is the 1934 burn and at an earlier time at the base of unit Y. Corn pollen at the 6.0



foot depth indicates the presence of man in the area throughout the period of deposition, so the older fire may have been intentionally caused. At one period late in the fossil record an open park-like plant community is evidenced. This may have been a natural occurrence, climatically controlled, but is more likely to have been caused by the agency of man. Anomalous elements in the flora are difficult to explain on the basis of natural conditions: they may also be attributed to the activity of prehistoric man.

Site 1200: Long House

The pollen diagram (fig. 2) is a series of short profiles arranged in probable chronological order. The pollen record from Long House fulfills the function of a relative chronology, since samples from various localities within the site can be correlated. The samples from Area I are a case in point. They were originally of unknown age, but their pollen spectra can be shown to fit the local chronology best in zone IIa. The single sample from room 24 is more troublesome. It contains higher proportions of sagebrush and other Compositae than any other sample, and a low percentage of broken pine pollen grains, so it might be placed in zone IIc. Associated pottery, however, is P III.

The time represented by most of the sedimentary deposition at this site takes place during the period of occupation. At this time the sediment was being trampled and disturbed, and was wholly or partially roofed. It may not contain a pollen flora, then, which is comparable to that of an undisturbed, unroofed, site. Upon examination of the pollen record we see that except for the post occupational period a large percentage of the fossil flora consists of the pollen of economic plants. This likely reflects the unintentional import of the pollen of those plants by the inhabitants during

the process of cooking, facturing, and food storage which was done in the dwelling.

Zone I is characterized by high percentage of iron and copper. The poling of economic plants probably represent mining from the sediments.

subdivided into three units, Ia, Ib and Ic. Zone I is characterized by high percentage of iron and copper. The frequency greater than 0% Unknown frequencies greater than 0%.

According to the sediment sample may be identified in the stratigraphic sequence by knowledge of the poling spectrum. Thus the sample from room 53 has a depth of 100 cm. The period of occupation is about 1000 B.C.

Zone II is characterized by high percentage of iron (over 20%) and copper. The nature and growth of the plants which the

stratigraphic marker. The poling type high frequency way associated with pottery. The poling types are the same and the same.

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findings.

Zone Ib is distinguished by high percentage of iron (over 20%) and copper. The nature and growth of the plants which the

stratigraphic marker. The poling type high frequency way associated with pottery. The poling types are the same and the same. The poling type is the same. The poling type is the same.

The boundary between zones Ib and Ic is not as clear as that between zones Ia and Ib.

between zones I and IIa or IIa and IIb. Zone IIc is recognized as a separate entity as it generally contains less than 10% of Unknown B, higher percentages of *Compositae* and *Pinus* pollen than zone IIb, and as pine breakage is less than in zones IIa and IIb. Associated culture is ordinarily older than P III.

Anomalous elements in the pollen flora are the few pollen grains of *Juglans* and *Agave*. The argument against climatic change to explain the presence of *Agave* is also to be considered here. Walnut bark is noted in the ethnobotanical literature in the Southwest as an important source of dye for deerskin (Whiting, 1939). As deer were hunted by the inhabitants of Long House it is not implausible that walnut bark may have been traded into the area as a dyestuff. Since the walnut is a wind pollinated tree which produces much pollen each year, pollen grains trapped in the bark would have been traded with it. The boiling of the bark for dye would not have injured the pollen and some would no doubt make its way into the sediment of the floor.

Within zone II a waxing and waning of agriculture may be evidenced by the fluctuation of the percentage of corn pollen. The mysterious dominance of the pollen diagram during zone IIa by Unknown B invites speculation. It is noted that Unknown B reaches its highest frequency prior to abandonment (since it is man-instigated) and after a decline in *Zea* dominance. This raises the intriguing possibility that it is from an emergency food item adopted as corn agriculture declined in the area, possibly due to drought. Further conjecture awaits identification of the pollen type.

The pollen record also gives evidence of trade relationships to the south or west in plant raw materials by the occasional occurrence of pollen of *Agave* and *Juglans*. This agrees with the evidence of trade from pottery.

and means the archaeologist may intensify his search for trade materials in addition to pottery and cotton through pollen studies.

Site 1444, Bobcat Canyon, and the Transect Samples

These samples were taken at localities and depths where it was expected that evidence of cultural activity would be found as pollen fossils of economic plants. When it was observed that many of the samples which had been processed were unproductive those of the remainder which were considered most likely to contain corn pollen were processed. Of the 103 samples 49 were processed and an estimate of the amount of corn pollen contained in the 12 productive samples was made. Of those twelve only one contained any corn pollen.

All samples from profile 2 at site 1444 (a terrace) were processed. Those of the upper 1.2 feet contained pollen but of the 1000 grains observed in each of these samples none was referable to Zea. It was felt that profile 1 from this site would be similarly unproductive and it was not investigated.

Transects 1, 2, and 3 yielded 58 samples of which 22 were processed. Only three yielded pollen at all; two contained no corn pollen. One sample (Cat. No. 12254a, Pit 6, Transect 2) contained about 25% corn pollen on the basis of a 1000 grain estimate. Pit 6 was located twenty feet northeast of a P I site.

Since the only pit sample to have yielded corn pollen was one associated with a site all site associated samples from Bobcat Canyon were processed. Of the 15 samples five contained pollen but none contained Zea. No relationship could be observed between the depth at which samples were selected and their productivity. In some places pollen was preserved near the surface (site 1444) while at others (Bobcat Canyon pit 1 Cat.

Nos. 12268c and d) it was preserved at depth.

The technique of selection of samples along transects in a search for corn pollen proved highly unfruitful. It may be argued that since corn pollen was obtained from one locality the technique is not at fault, but in general it appears to be an odds-long procedure and may not justify the expense.

The sampling of terraces (sites 1444 1398, and 1397) has yielded no useful information on agricultural practices. Such structures have also been sampled in the Point of Pines area and have failed to produce corn pollen. This may be a function of water runoff over the terraces, preservation of corn pollen in soil, subsequent erosion, or any number of other factors. The possibility that the structures were never used as fields cannot be excluded.

SUGGESTIONS FOR FUTURE RESEARCH

1. Pollen sampling at site 1205 should be continued as excavation proceeds. Any datable artifacts may now be related to the pollen-stratigraphic units. The sediment described as top soil should be sampled at close intervals (ca. 0.1 feet) to determine the nature of such ecological changes as may have occurred.
2. A collection of the flowering plants of the area, inclusive of herbaceous forms should be assembled to enrich the backlog of reference pollen types. Information on the habitat of each species should be included if possible.
3. A collection of the pollen of pines in the area should be made from different species, different populations and different ecological niches. This would enable us to learn more of the meaning of size-frequency changes in the fossil record.
4. Sediments should be sampled which may be expected to contain a long pollen record uncomplicated by cultural activity. My suggestion is a water deposited sediment such as Mummy Lake. The Bobcat Canyon profile may not be productive unless a great amount of effort is expended in excavation. If the Bobcat Canyon profile is resampled, samples should be taken from a deeply cut fresh face and a description of the lithology included.
5. An attempt should be made to date the pollen zones at Long House by pottery typology and dendrochronology at the earliest possible time.
6. The use of pollen analysis as a survey tool in the search for ancient cornfields is an intriguing possibility. Three experiments appear needed to aid in the resolution of the problem of survey collecting:
 - (a) samples should be taken at 2 cm. intervals to a depth of two or three feet in an area likely to have been cultivated in the past. This

may lead to information on the depth to which prehistoric corn pollen can be expected.

(b) surface samples should be taken before and during the corn pollination period at different distances from and within a modern cornfield. This will provide information on pollen dissemination.

(c) the potential cornfield at Transect 2 pit 6 0.5 feet depth should be investigated. Surface indications of such agricultural use should be noted and hand excavation at the 0.5 foot depth may be productive.

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