POLLEN ANALYSIS OF

SEDIMENTS FROM

SALTS CAVE VESTIBULE

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INTRODUCTION

In August of 1972 the Palynology Laboratory accepted a contract to accomplish archaeological pollen analysis of sediment samples submitted by the Cave Research Foundation through Dr. Patty Jo Watson. The Foundation submitted 17 specimens from the Carleston-Annis shell midden locality (Bt-5) and 19 specimens collected from the south profile of Test Pit J in the Vestibule area of Salts Cave. The Laboratory was requested to undertake as much analysis as could be accomplished during the equivalent of two weeks of laboratory research, and a priority system was provided for the samples. Thirteen of the Carleston-Annis and 15 of the Salts Cave specimens were given first analytic priority.

METHODS

Extraction of pollen from the 28 samples was begun with the standard procedure utilized in this laboratory. This involves separation of the light (polliniferous) fraction of a large (75-150 cc) volume of sediment through swirl flotation in an acid medium, decomposition of inorganic matter with hydrofluoric and nitric acid treatments, and decomposition of extraneous organic matter with dilute lye. Only one of the 28 samples provided sufficient pollen for analysis as a result of this extraction procedure. Microscope inspection of the samples revealed that reprocessing of the Carleston-Annis extracts to further reduce the quantity of remaining inorganic and organic residues would not provide a sufficient concentration of pollen because so little pollen was contained in the specimens originally. In the case of the

Salts Cave specimens, however, the pollen density was appreciably higher. Further processing offered prospect of obtaining statistically meaningful data from at least some samples.

The 14 Salts Cave samples were returned for further processing. Inorganic residues which had resisted a minimum of 48 hours rinse in hydrofluoric acid and a 30 minute rinse in hydrofluoric acid heated in a boiling water bath were reduced by placing them in crucibles with hydrofluoric acid and heating the mixture to the boiling point for 45 minutes. After rinsing the result with hot water and cold nitric acid, organic residues were attacked with Erdtman's (1943:28) acetolysis solution in a boiling water bath for 3 minutes. This was followed with hot water rinses and a 10 minute rinse in a 10 per cent lye solution. Further water rinses and the application of alcohol as an organic solvent completed the reprocessing treatment. This treatment reduced the specimens by about 60 per cent volume in most cases, concentrating the pollen of the original 75-150 cc samples in an extract of about 1/2 cc volume.

At this juncture, the two weeks research period had been completed with only one pollen record achieved. Two students participating in a current course in archaeological pollen analysis were pressed into the service of the project. As part of their classroom exercise, Mss. Rose Duffield and Jannifer Wyatt evaluated the reprocessed Salts Cave specimens through microscopic examination and obtained the pollen records of four samples. I found opportunity to observe the pollen of an additional three samples during this period. The eight pollen records provide all of the counts that can be obtained, given present technology, from the 15 Salts Cave specimens given highest priority

In consideration of the low pollen density in the samples, specimens were evaluated as profitable for analysis if a pollen density of 40 or more grains per drop of extract was evident. Observation was halted after 100 grains had been tabulated from a specimen, or after all the pollen on one slide had been observed, whichever occurred first. The use of a 100-grain pollen count is not statistically preferable. However, obtaining higher counts would have expended more time and would, in any case, not have allowed more confidence in interpretation. Though a given pollen frequency might then have been statistically evaluated within narrower confidence limits, the fact that only eight samples are available would still remain. Eight samples are hardly a firm basis for the sort of intensive statistical treatment that might be encouraged by larger pollen counts. This is especially true when it is recognized that each specimen represents a unique temporal horizon, since the samples were collected in vertical order.

Archaeological pollen analysis is defined (Schoenwetter, 1970: 35,36) as the establishment of research designs to provide information of archaeological character or to provide information pertinent to archaeological interpretation. In the present case the design selected was that which would allow discrimination between the portion of the pollen record which refers to the natural history of the Salts Cave area, and the portion which reflects the activities of man. As will be seen, this design provides information useful to archaeological interpretation of the Salts Cave Vestibule population.

The first question at issue, of course, is the probability that both a "natural" and a "cultural" component of the pollen record in fact exist. The stratigraphy of the sampled profile in Test Pit J is essentially one of midden deposits (Watson, 1970:2). All of the sediments observed could represent deposition during the period of vestibule occupation. Thus, all of the pollen could have been contributed to the sediments by human agency. Further, since the test pit is located far into the vestibule, well beyond the point that sunlight directly penetrates, it is impossible for pollen-bearing plants to ever have grown at the sampled location. Thus, the pollen of the deposits cannot reflect an immediately local flora.

However, no evidence of human occupation is recovered from Test Pit J in levels 1 through 2, 14 through 19, or 21 through 23. These levels are of a lithological character distinct from those in which occupational evidence exists (the middens), and appear to be undisturbed decomposition products of the cave walls and floor, or sediment washed into the locus. Thus, there is at least equal probability that the pollen they contain is unaffected by human agency as that the pollen is so affected. Further, Test Pit J is located in a topographic low area within the vestibule, and the vestibule entry is located in a topographic low area (Salts Sink) of the district. Both gravity fall and water transport would tend to transport pollen from the vestibule entrance to the area of Test Pit J and concentrate it there. All the samples, then, potentially contain pollen provided by human agency and pollen provided by the "natural" agency of washing or blowing through the vestibule entry.

There are two traditional procedures for discrimination of aspects of a single pollen record. The most direct is to obtain records of pollen rain from modern examples of ecological patterns of known character. These records reflect a known "present" which may be utilized to identify the character of an unknown "past" in compliance with the uniformitarian principle upon which all paleoecological research is based (Odum, 1959:96). The less direct procedure, which is more traditionally used, is to base interpretation of the fossil record upon the known ecology of the taxa observed, and the frequency variations of those taxa in the record. This approach presumes that the distribution of pollen taxa in a record reflects the distribution of the plant taxa in the pre-existing vegetation in a substantially direct fashion.

In the present case, the direct procedure cannot be employed. No samples of pollen rain from the presently existing vegetation pattern of the region have been collected. Some surface sediment samples from southeastern Missouri have been subjected to pollen analysis (Fish, n. d.) as have some from the Illinois River Valley (Schoenwetter, 1966) and the American Bottoms of the Mississippi Valley (Schoenwetter, 1964). But these do not serve as adequate controls. The Missouri series is too small and the Illinois series are collected from locales too ecologically and climatically distinct from the conditions of the Salts Cave area. Discrimination of the "natural" from the "cultural" components of the Salts Cave fossil pollen rain, then, has proceeded on the basis of internal evidence, the evidence provided by association with known cultural phenomena, and judgements regarding the ecology of the taxa represented in the pollen rain.

ANALYSIS

The assumption has been made that pollen records occurring below and above the midden strata reflect no direct cultural impact on the pollen rain. This assumption is probably more justifiable for the record below the midden strata than the one above the middens, for we are aware that surficial deposits of midden and other materials reflecting human occupancy occur within the vestibule area. However, it seems a reasonable working hypothesis. The assumption has also been made that the stratigraphic series of pollen spectra accurately reflects a true passage of relative time. I recognize that the issue is debatable on two grounds: (1) cave stratigraphy is normally complex, such that instances of horizontal and reversed stratigraphy often occur which cannot be clearly discerned in test-pit excavations; and (2) reversed and horizontal stratigraphy would have a reasonably high probability of occurrence in such artificial deposits as midden. A third assumption is that a test of significant difference at the 95 per cent level of confidence is adequate for examination of hypotheses regarding these data. Following the argument of Mosimann (1965:638), the simplest test of critical value to pollen studies has been applied here: that provided by the confidence interval for percentage frequency of binomially distributed variables (Mosimann, 1965:642-3). This test is also advocated by Faegri and Iverson (1964:133). The test seems particularly appropriate because used with low pollen counts, as is the case here, it would tend to show less discrimination than other potentially applicable tests. Thus, a difference between two records

LEVEL/ Meters B. S.	Pinus	Juniperus	Quercus	Carya	Castenea	Juglans	Acer	Ulmus	Morus	Populus	Chenopodinnae	Ambrosieae	Tubuliflorae	Anthemidae	Liguliflorae	Gramineae	Cercis	Ribes	Caryophyllaceae	Umbelliferae	Cyperacea	UNKNOWNS	N	Analyst
2/.20	4		33	1	3						11	35	7			4						2	100	RD
3/.30	4	1	42	9			1			1	2	31	4		3	2							100	JW
4/.35	1		27	6		3					14	30	9	1	1	5		1			1	1	100	RD
Upper 5/.40			4	5							15	17	3		1	2				1		2	50	JW
Lower 5/.50	2		6	2							26	19	18			26						1	100	JS
6-7/.65	2		2	4							60	12	12			6			1			1	100	JS
8-10/.75-.85	INSUFFICIENT POLLEN																							JS
13/1.00	3		10	2		1		1	1		3	12	5			3	1					1	43	JS
14-21/1.05-1.50	INSUFFICIENT POLLEN																							JS
21/1.70	1		35	18				5			5	14	6			13						3	100	JS
22-23/2.00-2.30	INSUFFICIENT POLLEN																							JS

Table I: Pollen Observed.

which is accepted as significant is actually quite strongly indicated.

Comparison of the samples from levels 2 and 21 (Table I) allows examination of statistically significant distinctions in pollen frequency which, granting the assumptions, must be distinctions of a natural order due to the passage of time. There may be some cultural influence on the frequency values of pollen types in the sample from level 2, but, if so, this is an indirect influence resulting from the effects of human activity in the area which occurred prior to the time of deposition of this sample. The comparison shows <u>no</u> significant difference in the <u>Quercus</u> pollen frequency, the Chenopodinnae pollen frequency, the Tubuliflorae pollen frequency, the Gramineae pollen frequency, or the Unknowns pollen frequency. Significant difference <u>is</u> observed in the <u>Carya</u> pollen frequency and the Ambrosieae pollen frequency. Significant difference is <u>not</u> observed in the presence/absence distinction of <u>Castenea</u> pollen, or in the presence/absence distinction of <u>Ulmus</u> pollen. The changes due to temporal order of these "natural" pollen rains, then, are two-fold: (1) a change in the representation of hickory, and (2) a change in the representation of Ambrosieae.

Which, if any, of these changes may have been related to the occurrence, before the time horizon represented by level 2, of cultural activity in the area? This question may be effectively answered by comparing the pollen rains of levels 2 and 21 with the pollen rains of the midden strata. The midden strata are the strata most likely to contain a reflection of cultural impact upon pollen records. Through comparison, we should be able to discern whether the changes involved occurred early in, during, or following the time periods represented by the midden strata. If a change occurred <u>early</u> in the period represented by the midden strata, there is some high prospect that the introduction of human behavior affected the otherwise "natural" record and so was responsible for the change. If a change occurred <u>during</u> the period represented by the midden strata the probability that human activity caused the change is somewhat lower and would only be really likely in the event that patterns of cultural action relative to vegetation themselves underwent change. If the change occurred <u>after</u> the cessation of human activity, the probability is relatively low that the change is a function of the human actions.

The change in Ambrosieae frequency occurs <u>after</u> the occupation period. The confidence interval surrounding the 14.0 per cent value for Ambrosieae of level 21 is the interval between 8.0 and 22.0 per cent. The value for Ambrosieae in level 13 (N = 43) is surrounded by the confidence interval between 12 and 39 per cent. As the two ranges overlap, no significant distinction is evidenced. Significant distinction from the Ambrosieae value of level 21 is not, in fact, evidenced in <u>any of</u> the midden samples. The significant change in Ambrosieae frequency occurs between levels 2 and 3. Thus, there is a low probability that this change is a reflection of the effect of human behavior on the pollen rain.

There are two significant changes which occur in the <u>Carya</u> pollen record. The value for <u>Carya</u> in level 13 is not significantly different from that of level 21, but the values of <u>Carya</u> in levels 6-7 and the lower sample from level 5 are distinct from that of level 21. This change occurs during the occupation period. However, the _Carya_ values for the upper sample of level 5 and the samples of levels 4 and 3 are not significantly different from that of level 21. Thus, the significant change represented in the difference between _Carya_ values in level 2 and those in level 21 occurs _after_ the period of occupation. In fact, it occurs between levels 2 and 3. This change, like the change in Ambrosieae frequency, has a low probability of reflecting cultural behavior. It would thus appear that the distinctions in pollen record between levels 2 and 21 are due to natural, not cultural, events.

The above exercise does not demonstrate that no cultural effect on the Salts Cave pollen record exists, however, and thus does not fulfill our objective of discriminating such cultural effects. It simply informs us that those distinctions which exist between the presumably pre- and post-occupational samples are not likely to be due to human activity. The essential purpose of the exercise has been to provide a baseline of "known" to allow analysis of the "unknown." The pre- and post-occupational samples serve as controls. Where distinctions occur between either of these records and the records of the midden samples, an assessment must be made of the probability that the distinction is a function of human behavior. Where no distinction occurs between the pre- or post-occupation sample and one or more midden samples, no assessment need be made.

There is no statistically significant variation through the time range of the record in two of the pollen taxa which are regularly represented in the counts: _Pinus_ and Unknowns. A number of pollen taxa are represented by rare occurrences: _Juniperus_, _Castenea_, _Juglans_, *Acer*, *Morus*, *Populus*, *Artemisia*, *Cercis*, *Ribes*, Umbelliferae, Caryophyllaceae, and Cyperaceae. As such, they have no statistical significance at all. To evaluate their effect on the pollen record, I combined these records with those of *Pinus* and Unknowns in each sample to determine if the cluster varied significantly through the time period sampled. None of the resulting values are statistically greater or lesser at one or more time horizons. Such records, then, do not serve to discriminate cultural from natural events.

Two of the pollen taxa, *Ulmus* and Liguliflorae, are represented by statistically insignificant values, but occur in two or more adjoining records and thus appear reflections of some temporal phenomenon. In the case of Liguliflorae, this seems to be wholly a phenomenon of the period of later midden accumulation. It may be a natural event, but its association would lead one to suspect that it is a cultural event. Further, the pollen type involved is disseminated solely by zoogamous plants and thus is not adapted to long-distance transport. It is likely, then, to have been incorporated in the deposits as a result of cultural activity. The observed record of *Ulmus* pollen, on the other hand, seems more probably a function of natural events. There is no statistical difference between the value for *Ulmus* pollen in level 21 and in level 13, so the presence/absence change which occurs in the *Ulmus* frequency after the time represented by level 13 takes place during, rather than early in, the cultural period. However, the presence/absence change in *Ulmus* pollen is not significant at the 95 per cent level of confidence.

The argument applying to the Chenopodinnae record also applies here, leading to the conclusion that this change is culturally induced.

The conclusion that the Chenopodinnae pollen record is culturally influenced has been drawn on pollen statistical and on associational grounds. This can be supported on the grounds of the archaeological recovery of _Chenopodium_ and _Amaranthus_ macrofossils and microfossils in human paleofeces from Salts Cave, and on the ground of pollination-fruit harvesting relationships. These are both ecological arguments which propose that if in fact the occupants of Salts Cave were harvesting and eating _Chenopodium_ and _Amaranthus_ seed, there is every reason to expect that these activities would contribute substantial quantities of Chenopodinnae pollen to the domiciliary environment.

The conclusion that the grass pollen records are highly culturally influenced has also been drawn on both associational and pollen statistical evidence. This conclusion does not find independent ecological support of the same order as the Chenopodinnae record. Grass seed is known to have been consumed, but the pollen-fruit harvesting relationships of grass seed and grass pollen are such that little pollen would be expected in the domiciliary area as a result of use of grass seed for food. I believe the power of the associational and pollen statistical evidence, in combination, to be great enough to justify the conclusion that the grass pollen variance is culturally induced. One might speculate that grass pollen may have reached the midden as an industrial waste, perhaps from the manufacture of a grass mat or bedding. But there is obvious need for independent testing of this conclusion.

Changes significant at the 95 per cent level occur in the records of *Quercus*, *Carya*, Chenopodinnae, Ambrosieae, and Gramineae pollen. The cases of *Carya* and Ambrosieae have been discussed previously. The first change which occurred in the hickory frequency (between levels 21 through 13 and levels 6-7 through 3) occurred during the occupation, while the second change (between levels 6-7 through 3 and level 2) occurred following the occupation. These changes thus most probably reflect natural events. The only significant change occurring in the Ambrosieae value occurs after the occupational period, and is thus interpretable as a function of natural events.

In the case of *Quercus*, there are also two changes. The earlier occurs early in the occupation in the significant distinction between the oak value of level 21 and the oak values of levels 13 through 5. This change has a high probability of being due to some cultural event. The later change, which occurs in the distinction between the oak values of levels 13 through 5 and the oak values of levels 4 through 2, occurs during the occupation and results in values not significantly distinct from those of the control records. This change has a low probability of being due to some cultural event.

Three significant changes in Chenopodinnae pollen values occur during the occupation period, showing up as wide fluctuations from sample to sample in the period encompassed by levels upper 5, lower 5, and 6-7. The disparity of these temporally sequential records, as well as their association with cultural materials, promotes assessment that the changes are due to cultural events. One significant change occurs in the Gramineae pollen value: in the lower sample from level 5.

The case for Liguliflorae pollen representing cultural events is based on associational evidence and on the ecological evidence of the known pollen dispersal mechanisms of the taxon. This conclusion must thus be regarded as rather weaker than that drawn for the grass pollen.

The pollen statistical evidence that one of the changes in the oak pollen record is culturally induced is countered by the evidence that another such change is naturally induced. Again, independent ecological support for the conclusion is lacking. In fact, there is reason, to believe on ecological grounds that the conclusion of cultural inducement is erroneous. While oak did constitute a food resource, its pollination-fruit harvesting relationships are more like those of *Carya* than of *Amaranthus*. Thus, we would anticipate its pollen record to be like that of *Carya*: a natural events record. Further, we may note that in the case of Chenopodinnae and grass pollen, the pollen statistical variations occur as short-term fluctuations. This is not the case for oak pollen; once established, a change persists through continuous records. Thus it would appear that the conclusion that one of the changes in the oak pollen frequency is culturally induced is indeed quite weakly drawn. I have chosen to dismiss it, substituting the conclusion that both of the significant changes in the *Quercus* pollen record are due to natural causes.

The arguments presented reasonably justify the inference that variations which occur in the records of oak, hickory, and Ambrosieae pollen are due to natural events. There are too few samples of any temporal horizon, however, to provide a firm basis for argument regarding the *character* of those environmental events. Were the events more firmly fixed in absolute time, argument could be drawn by bio-stratigraphic reference to contemporary paleoecological and paleoclimatic fluctuations. Were the events more firmly associated with independent biological evidence such as plant or animal micro- or macrofossils, the combination of data might provide a convincing pattern. Were the nature of cultural ecological relationships of the Salts Cave inhabitants effectively understood, the pollen records could be evaluated by reference to them. Had we a body of pollen records representing patterns of relationship between pollen frequencies and known climatological, ecological, or vegetational events, controlled comparison could be made which would provide such inference. But none of this information is presently available. Unable to work "from known to unknown" I am able only to speculate and offer hypothese which may prove testable.

My speculations proceed from the presumption that the Salts Cave pollen record represents four temporal horizons of natural events (Fig. 1). The youngest of these is represented by level 2, which is isolated by its distinctively low pollen value for hickory. The next youngest horizon (Horizon II), encompasses levels 3 through upper 5. The hickory pollen value is higher than in Horizon I, and the Ambrosieae values, while not higher than in Horizon I, are higher than occur in the contiguous samples of Horizon III. The oak values of the two upper samples of Horizon II are equivalent to those of Horizon I, while in the lowermost sample of Horizon II the oak value is equivalent to that of Horizon III. Though the statistical significance of the fact is nil, Horizon II may also be isolated by the occurrence of more pollen types than the other horizons.

Horizon III is isolated by the combination of hickory values higher than those of Horizon I, and low oak and Ambrosieae values. It is reflected in the samples of levels lower 5 through 6-7. Horizon IV is isolated by the combination of higher hickory values than occur in Horizon I, high oak values and low Ambrosieae values, plus the occurence of Ulmus. The frequency value for Ambrosieae in level 13 is not low, but because so few grains were observed this value is not statistically higher than the Ambrosieae values for levels 6-7 or 21.

I interpret Horizon IV as the expectable palynological reflection of a mature oak-hickory climax forest biotope. Within such an ecosystem the forest canopy would be generally closed and the range of plant associations would be small. Such habitat variations as exist in response to localized conditions of substrate and micro-climate would be generally masked by the monotony of the highly adapted oak-hickory plant association, to the effect that little species diversity would occur. In the present case, elm and perhaps walnut are possibly the only taxa which were consistently to be found as indices of habitat variations such as would be expected to occur near the vestibule entry in the Salts Sink area.

With the advent of Horizon III the oak-hickory climax state of the local forest seems to have been disrupted. It appears that the hickory was immediately affected to a greater degree than the oak, but the latter diminished as well. The result was an opening of the canopy, allowing more frequent occurrence of light-tolerant taxa such as mulberry and red bud. During this period, elm seems to have lost its position as the prominent indication of habitat variability. On the whole, the pollen record of Horizon III seems to me most interpretable as a disclimax vegetation pattern, suggesting the advent of a climatic fluctuation.

The direction of the fluctuation is extremely difficult to attempt to reconstruct from these data. The earliest available radiocarbon dates indicative of Salts Cave occupation fall in the 15-1400 B. C. range. If a disclimx-creating climatic fluctuation occurred shortly before we observe it represented in the midden stratum of level 13, and if this stratum does date to the 15-1400 B. C. period, the fluctuation involved may be that which marks the end of the xerothermic (Hypsithermal) post-glacial interval. However, Wright (1970) has presented a forceful argument that there was in fact no synchronous xerothermic interval throughout central and eastern North America, and that peleoclimatic reconstruction for various regions and districts within this large geographic area must be independently controlled and evaluated. Also, see Watts (1971) and Webb and Bryson (1972). Given the present state of knowledge, it can only be pointed out that the temptation to make a bio-stratigraphic correlation linking the onset of environmental conditions of Horizon III at Salts Cave to paleoclimatic reconstructions elsewhere, and thus inferring the establishment of a more temperate paleoclimate, should be resisted.

I would reconstruct the conditions of Horizon II as an amplification of those of Horizon III: a further reduction in the general canopy and the establishment of greater species diversity. A weedy ground cover also seems indicated. The re-emergence of hickory as a forest dominant, and oak as such somewhat later, may be considered indicated at this time.

To draw such an inference, however, would demand that we consider that neither taxon was a forest dominant during Horizon III. I think this is too extreme a reconstruction of the disclimax state during Horizon III. I believe both oak and hickory were the forest dominants in Horizon III. However, during that time I would say their dominance status was more a reflection of their earlier status as climax species than it was due to their innate capability to compete more effectively than other taxa for a dominance position. After the disclimax-creating environment became established, oak and hickory were less adapted to the new environment than they had been to the old. But no other taxa existed in the area in sufficient reproductive strength to achieve a dominance position in the local forest during Horizon III. Oak and hickory were not better adapted to Horizon II conditions than other taxa, but they were the taxa which, by virtue of a dominance position achieved under different conditions of environment, had the reproductive strength to maintain positions of dominance by default.

During Horizon III, however, other taxa could have generated sufficient reproductive strength to achieve dominance in Horizon II. They seem not to have done so. Perhaps this is because the environmental conditions of Horizon II were distinct from those of Horizon III, so oak and hickory were more favored as competitors. Alternatively, it may be that the stress of the disclimax environment served to generate a genetically distinctive, more adapted, population of oak and hickory by the time of Horizon II. I would consider the latter somewhat more likely, personally, because of my feeling that the disclimax environment of Horizon II is an amplification of that of Horizon III.

I interpret Horizon I as reflecting the establishment of sub-climax oak-hickory forest. Species diversity had become reduced relative to Horizons II and III. However, as the canopy was more open than it had been in Horizon IV (witness the higher Ambrosieae pollen value), more ecotones and greater species diversity probably existed than had been the case during Horizon IV.

The reconstruction offered above is highly speculative. It cannot, in good conscience, be utilized as a basis for interpretation of cultural ecological patterns of the inhabitants of Salts Cave. But it does justify the hypothesis that the inhabitants of Salts Cave lived at the site through a time when ecological changes were occurring which could have dramatically affected the types, distributions and qualities of the plant and animal resources upon which they were dependent for survival. If this is true, technological variations observed through the period of occupation may be functionally related to these processes of environmental change. The reconstruction offered here, then, may find independent support or may find criticism through analysis of technological variation. Further, the analysis of other forms of biological fossils (e.g., animal bone and charred vegetal remains), may tend to support or deny the reconstruction. However, it will be necessary to require these other forms of evidence to meet the same stratigraphic controls as does the pollen record. The analysis of faunal remains from the midden deposits as a whole (Duffield, 1970:5), for example, is not adequate to the task. Variability from stratigraphic level to level within the middens must be considered.

Because of the tenuous nature of the reconstruction, little can be said as regards the relationship of conclusions drawn by this study and the study of the pollen of samples of human paleofeces from Salts Cave. The two types of pollen records have such distinctive points of origin and refer to such distinctive orders of elapsed time that comparison of almost any sort is inherently strained. None of the conclusions or inferences drawn independently by either study appears challenged by the data, inferences or conclusions drawn by the other. However, there is also no sense in which the two studies operate to mutually confirm any of the conclusions or inferences reached.

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