

THE APPLICATION OF PALYNOLOGY TO ARCHAEOLOGY: LIMITATIONS

AND SOME PRACTICAL SUGGESTIONS

JAMES SCHOENWETTER
DEPARTMENT OF ANTHROPOLOGY
ARIZONA STATE UNIVERSITY

The following is the text of a presentation made at the 1976 meetings of the Society for American Archaeology, at St. Louis. The original request for a presentation on the subject was answered by myself and Mrs. Jannifer Wyatt Gish, who was then an Anthropology Graduate Student in this Department. Mrs. Gish, for various reasons, did not contribute to the attached manuscript though she was the senior author of the abstract prepared for the meetings and is listed as the senior author of the presentation in the official S.A.A. listing of presented papers.

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PRACTICAL SUGGESTIONS

Jannifer Wyatt Gish and James Schoenwetter

This paper is intended to define and explain limitations in the application of pollen analysis to archaeology. Particular attention is paid to the information an archaeologist can and cannot expect to obtain from initial palynological investigations. The difficulties involved in continuing the process through successful, verifiable, interpretations are emphasized. Finally, suggestions on pollen sampling design and sample collection techniques are provided.

When dealing with pollen records obtained directly from archaeological contexts we must be constantly aware that the deposits which contain the pollen are in whole or in part the result of "unnatural" geomorphological processes. Since the physics and the chemistry of the deposit sampled itself affects the preservation potential of entrapped pollen, one must consider the depositional process as a meaningful variable conditioning the character of palynological observations.

Let us say we have two pollen samples collected from a site which we believe to reference the same temporal horizon. One sample comes from a pit fill and one was collected from the floor level of a house feature beneath a cluster of flat-lying potsherds. Now let us further suppose that the floor level specimen contains abundant pollen and the pit fill specimen contains little pollen. Could the distinction in pollen quantity be interpreted as an indication that the two specimens actually reference two temporal periods--one period when pollen was abundant in the environment (say the Spring pollination season) and another when it was sparse (say the winter season)? Possibly, but the interpretation involved is not dependent upon knowledge of processes of pollen dispersal and preservation so much as it is dependent upon knowledge of the probability of multi-seasonal usage of the cultural features involved and assessment of the depositional processes which created the deposits sampled. These sorts of information are not revealed by the pollen statistics of the two samples, so it would be both unscientific and improper to suggest that such an interpretation was evidenced by the distinctions in the pollen record. Further, it is inappropriate to use pollen analysis in this way as other than a basis for hypothesis formulation which is testable by other means.

Pollen analysts accustomed to traditional methods of analysis and interpretation may not be aware of this sort of problem because they normally investigate the pollen records of natural geological strata. In those situations

each sample from a deposit of a given time or a given type can be assumed to have been subject to the same geophysical, geochemical and environmental conditions. Indeed, this assumption is basic to biostratigraphic analysis and geologists recognize that it must be made unless positive evidence exists to the contrary. In archaeological contexts the assumption of uniformity cannot be made without positive supportive evidence. Thus the question of which samples should or should not produce comparable results requires archaeological and geological judgement as well as the expertise of the pollen analyst.

One must also keep in mind the fact that the pollen record produced by any given sample collected in intimate and direct association with artifactual evidence of human activity may have been influenced by human behavior. The sample from a work area could, for example, easily include pollen derived from flowers gathered along with the green wood removed from a tree. The wood may have had a particular use, the pollen would essentially be a waste product of manufacture; the pollen on a house floor could be influenced by flowers of plants tucked into the house rafters to dry; the pollen record of a trash filled pit might be dominated by cattail or sedge pollen consumed by a fish whose entrails had been discarded in the pit. Clearly, no single sample of pollen rain derived from a cultural context can be assumed to be representative or characteristic of the time horizon or the spatial locus from which ~~ix~~ it was recovered. Again, this is directly opposite to the situation when one samples geological deposits.

The upshot of such situations is that archaeological sites cannot be treated as if they were peat bogs or lake beds from the pollen analysts' perspective. The archaeologist who wishes to undertake the pollen analysis of sediments from the site context itself must acknowledge the necessity of precautions as regards field sampling programs, controls, and interpretations

of resultant data. That being the case, why should an archaeologist concern himself at all with pollen records from site contexts? Traditionally, the pattern of research is to let the pollen analyst obtain the raw data from lake beds or other geological contexts and then correlate the site into the paleovegetational or paleoclimatic reconstruction using radiocarbon and stratigraphic analysis.

First, what the biostratigrapher may determine about regional vegetation patterns and paleoclimate from investigation of geological deposits may not be what the archaeologist wishes to know. For example, an abundance of biostratigraphic data indicates that coniferous forest vegetation was prominent over much of the area historically covered by deciduous forest in the 9000 - 7000 B.P. period. Though this conclusion is probably true, it is not necessarily anthropologically informative. The statement does not say, nor does it mean, that deciduous trees were absent. It does not say, nor does it mean, that deciduous trees could not have been locally prominent over territories as expansive as whole counties. It does not inform us of the distributions or densities of plant or animal resources critical to human existence during this interval. Biostratigraphically-oriented pollen studies -- those traditionally undertaken in North America-- can and do identify the boundaries of regionally-scaled vegetation patterns of particular intervals and they identify the horizons on which climatic changes occurred which were of sufficient magnitude to precipitate changes in regional vegetation. The archaeologist often requires or prefers more detail than such studies provide.

Second, the pollen records of site contexts are potentially informative about human behavior. Such questions as whether maize was or was not locally cultivated are more confidently answered by appropriately designed pollen studies than by the analysis of macrofossils, since the probability of preservation of pollen grains is greater than that of most other forms of

botanical materials. Note my usage of the qualifier "appropriately designed". When dealing with archaeological contexts, it is methodologically significant to identify research designs appropriate to both the site and the problem under investigation and to control the recovery of relevant data in ways that will insure probability that facts are not misinterpreted. This is ~~xxxx~~ as true of pollen records as of artifactual records. Again, sites are not peat bogs or lake beds and cannot be treated as such from the viewpoint of pollen analysis.

Third, the pollen of site contexts is related to the archaeological record by direct association, rather than indirectly through C-14 or some other device. It is a dictum of archaeology (perhaps as close to a theoretical statement as archaeology can make) that behavioral interpretation of the archaeological record is most secure when based upon materials recovered from in situ contexts of the location where the behavior occurred. No amount of classification and analysis of collections filed in museum cabinets of unknown provenance can be as convincing as in situ observation of the intimate associations of data. The intimate association of pollen records and artifactual records thus constitutes an important datum for interpretation of the former in behavioral terms. For example, maize pollen is found in the deposits of Horizon 6 at the Koster site. Because it is directly and intimately associated with the diagnostic artifacts of that Helton Phase deposit it must not only reflect the occurrence of maize at the site when those deposits were emplaced, but it also argues strongly that the behavioral analysis of the Helton Phase must incorporate statements about the economic relevance of cultivation and horticulture. No amount of indirect evidence could possibly be as convincing as the direct association involved.

I cannot emphasize strongly enough, however, that the decision to undertake any pollen analysis at a site must stem from an awareness of the potential of the samples to solve archaeologically significant problems. If what you want

to know about is regional vegetation pattern and the general characteristics of climatic horizons you should not be investign ~~in~~ the pollen analysis of samples from sites unless there is essentially ~~not~~ no alternative way of finding out what you want to know. In the American Southwest, where bog and lacustrine deposits are rare and alluvial deposits are normally difficult to date with precision, pollen records from accurately dated site contexts are used -- in conjunction with geological and dendroclimatic information-- to produce paleoenvironmental chronologies. There has been little alternative to finding out what we wanted to know. Alternatively, if what you want to know is whether or not the people at a site grew maize at a given time, you should not be investing in the pollen analysis of stratigraphic sequences from a nearby bog or lake.

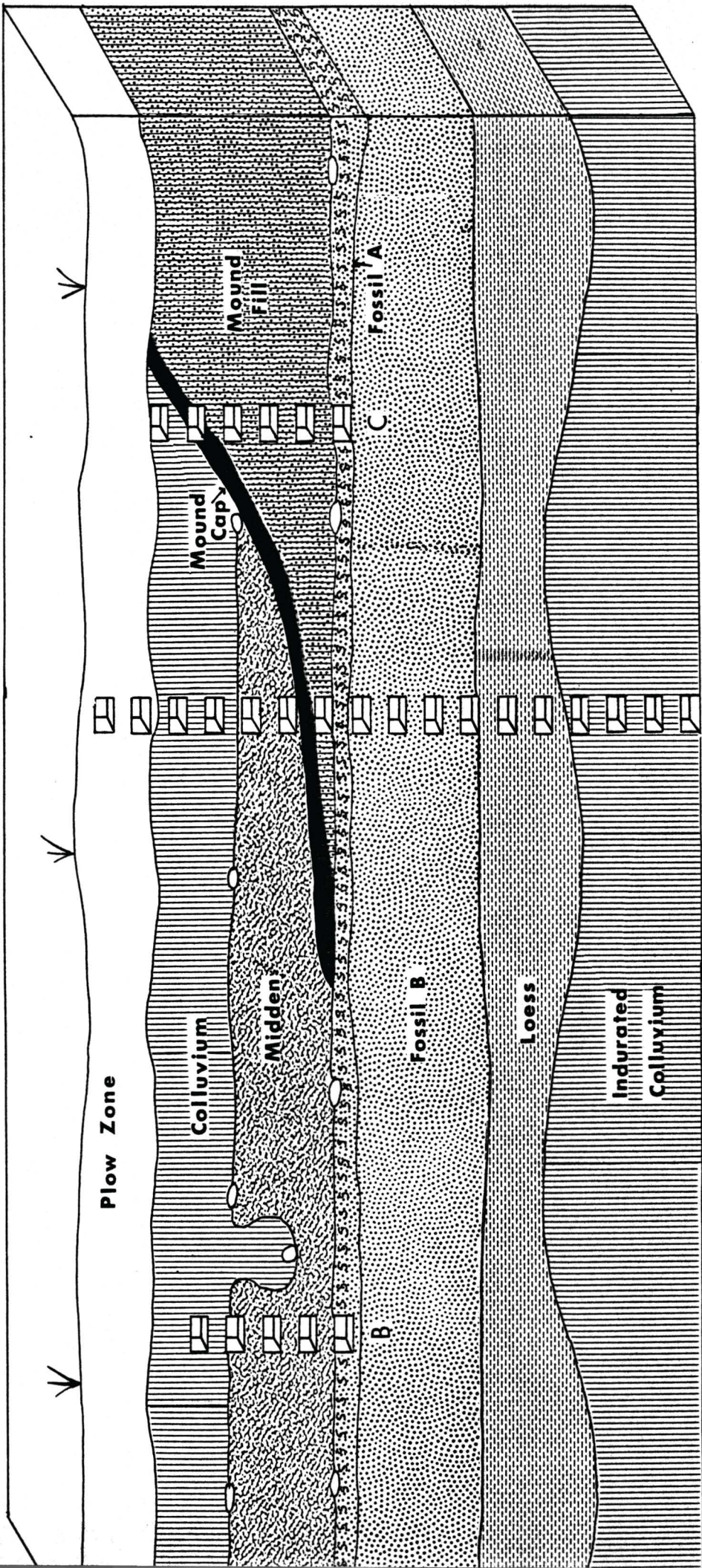
Pollen analysis is expensive. It consumes field time, it consumes storage space, and it consumes an ungodly number of hours of expensive expertise. There are not twenty people in the United States who are experienced in the specialized problems of pollen analysis of archaeological site contexts. The odds are overwhelming that if an archaeologist decides to make an investment in the pollen analysis of archaeologically meaningful samples there will be no person capable or willing to do the work or that it will cost more than the archaeological project can afford to support. Thus one must have good and sufficient reasons for wanting to have archaeological pollen analysis accomplished, one must have a fistfull of money to bear the true costs of the study, and one must have a good deal of patience, perserverance and good humour to get through all phases of the work. These realities cannot be ignored.

The sampling of geological deposits is accomplished with cores or borers, usually, and is a job best left to the expert. The sampling of archaeological contexts, though, I believe to be a job which is much better accomplished by the archaeologist responsible for site excavation. He, after all, is the

person trained to define the ~~xxxx~~ anthropological relevance of the deposits being sampled in ways no botanist or traditional geologist can appreciate. The sampling design one employs should relate to the research design of the excavation. It should always attempt to do two things insofar as these are logistically feasible: (a) to sample any context which offers prospect of providing palynological data significant to archaeological questions the dig is attempting to resolve; and (b) to sample other contexts for their potential as a body of data ~~by~~ for use ~~by~~ by other~~s~~ investigators.

The simplest sampling design which accomplishes both these tasks can easily be implemented as a routine of excavation. Collect a pollen sample from each and every archaeological provenience. If you're digging in levels and squares, take a sample from each level of each square; if you're separating features from the levels, take a pollen sample from each feature as well as each level; every time you make out a collection bag with a new provenience on it, make out a label having that provenience for a pollen sample. If this is done consistently you'll end up with hundreds of pollen samples from an average dig. That's a lot of samples to store and too many to analyze at one time. But you'll have a ~~pollen~~ pollen sample which is directly associated with each artifact or non-artifact from the site. One way or another each of those samples ties directly into the report you will prepare on the archaeology of the locus.

If all archaeologists sampled all sites in this way our storerooms would split at the seams. Most archaeologists will modify the design to reduce the number of samples collected that represent any specific type of provenience. If, for example, most of the site is unstratified sheet midden, many will develop a random sampling design to provide coverage with a lesser quantity of samples. However, the basis for judgement that most of the site is, indeed, unstratified sheet midden may not be available until the field program is completed and analysis of recovered materials is long underway. It would be



more judicious to cull stored samples under these conditions than to make field judgements which may result in reduced collections.

One of the things a pollen analysis can accomplish for the archaeologist is to provide an independent mechanism for stratigraphic analysis. So a common question is how a site should be sampled to obtain a set of stratigraphically significant samples. On the diagram, column A is what most archaeologists would collect. Arbitrary intervals of collection are generally used, though non-arbitrary ones would be just as adequate if this would produce a set of samples one would have more confidence in. Column A produces 17 samples. Notice, however, that there are two occupation surfaces at the site: the top of the fossil A soil upon which the mound was laid down, and the top of the midden. Column A samples neither of these surfaces.

Remember that the samples from column A which are from cultural deposits cannot be assumed to be representative ^{while} ~~which~~ those from the geologically "natural" deposits must be assumed to be representative. Thus columns B and C must be collected to provide minimal evidence of the stratigraphic value of the A profile pollen records of the cultural deposits. The samples from the mound fill will probably never be analyzed. They represent a recognizably rapid depositional phase that has no temporal significance in the stratigraphic sequence. But they should be collected because they may be significant for some other problem. Now we're up to 28 samples, of which 25 must be analyzed to ~~at~~ minimally address the stratigraphy question. But we still have no samples of the two evident occupation surfaces. The contact between the fossil A zone and the midden must be sampled horizontally, as must the contact of the midden and the superimposed colluvium. Again, we must sample a sufficient number of times to provide reasonable assurance that human behavioral affects on the pollen record will not be interpreted in stratigraphic terms. Problems of horizontal stratigraphy would complicate the sampling problem further, but I'll assume there is no evidence indicating that

a given surface or deposit is not temporally uniform.

We're now up to 37 samples. These do not represent a statistically adequate series for unequivocal demonstration of the pollen stratigraphy of the deposits. One of the depositional units (the mound cap) is represented only by one sample. The maximum number of samples representing a given stratigraphically-identifiable interval (the midden-colluvium contact) is five. To do the job with statistical confidence, we need a minimum of 30 samples of each temporal interval in the ultimate sequence. Now you can see why few pollen analyses are unequivocal.

The 37 samples constitute a minimum for potential resolution of the question posed. My personal inclination would be to collect many more samples from the site, but to submit only a series of about 50 for pollen analysis after reviewing other forms of evidence which would relate the selected samples to other stratigraphic and temporal indices. If all the samples yielded sufficient pollen for analysis without necessity of unusual extraction procedures, it would take between a two and four months of half-time research to recover the pollen and write up the results in a report of archaeological utility. The odds are against the work being this easy, however. It is likely that 25% of these samples will not prove productive using any known technology of pollen extraction as a result of inadequate preservation, and another 10-20% will require extraordinary effort to either extract or observe sufficient numbers of pollen grains for a confident analysis.