PALYNOLOGICAL INVESTIGATIONS OF CACHE RIVER PROJECT SEDIMENT SAMPLES

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May, 1974

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In April of 1974 the Palynological Laboratory of the Department of Anthropology at Arizona State University received a suite of ten sediment samples submitted by the director of the Cache River Archaeological Project. It had been agreed that the Laboratory would conduct a study to determine the general nature and frequency of fossil pollen in the samples, and to assess the value of such samples to future palynological research.

The sediment samples derived from four different archaeological sites, and represented a number of different sorts of archaeological context. Pit fill, general midden, former cultural surfaces, specialized cultural associations such as post hole deposits and cache deposits, and burial contexts were represented. It is clear from the sampling design that the concern is with the potential of pollen study to provide information of value for archaeological analysis, and it is to this concern that the recommendations of this report are essentially directed.

RESULTS

The samples submitted were generally of a fine-grained texture, incorporating an unusually large fraction of inorganic substances of low specific gravity. This works to the disadvantage of the palynologist, for the process of extracting pollen from the sediment involves separation of the low specific gravity fraction (containing the pollen) from the heavier fraction. If the light fraction contains relatively large quantities of inorganic materials which must be separated from the organic pollen, more time must be spent on digestion of the light fraction through use of hydrochloric and hydroflouric acids than is usual. In addition, the extended use of these highly corrosive agents makes the extraction procedure more dangerous for the palynologist. In the case of the Cache River samples, approximately 1/3 more time was spent in pollen extraction than is normal for this laboratory. Similar problems have been encountered with sediment samples from the Koster Site in Illinois (Schoenwetter, 1971, 1974a) and from Salts Cave in Kentucky (Schoenwetter, 1974b).

The final result of the laboratory processing of ca. 150 cc volume of sediment sample was a one-fifth dram volume of extract containing a mixture of (a) pollen and spores, (b) organic tissue fragments and cells of about the same size and weight as pollen which are similarly resistant to the strong reducing agents and mild oxidants (including lye) used, and (c) mineral crystals and imperfectly digested light rock flour fragments. A sub-sample consisting of approximately one-tenth of this extract was submitted to microscopic examination.

TABLE I

Pollen Sample	Grains Observed	Projected grains/slide	Approx. hours needed for 200-grain count
2	7	30	10
4	10	50	6
5	0	5	60
9	1	10	30
11	3	15	20
14	2	12	25
15	3	15	20
17	9	50	6
19	0	5	60
20	7	30	10

One-fourth of the total area of one micro-slide was observed. Simple extrapolation allows approximation of the quantity of pollen that can be obtained per micro-slide for these samples, and the approximate number of hours that would be required for observation of 200 pollen grains (Table 1). 200-grain pollen counts are statistically perferable for "fixed N" pollen analysis (Mosimann, 1965), though Schoenwetter (1972) and Kitchen-Fish (n.d.) have demonstrated that reliable archaeological conclusions can be drawn from counts of 100 or even 50 pollen grains under controlled conditions.

With the exception of the single pine pollen grain from pollen sample 9, which may be a contaminant, the state of preservation of the pollen observed is rated good to excellent. None of the grains were so distorted that description of their aperture and sculpturing patterns could not be given with confidence, and no significant number of grains evidenced the surface corrosion indicative of _in situ_ degeneration of pollen exines. It would thus appear that the low frequency of pollen in these deposits is not an artifact of laboratory procedures or differential preservation. It would simply appear that the quantity of pollen and other organic materials per unit volume of deposit has never been very high.

The pollen observed in the samples is primarily of non-arboreal species, with Compositae pollen playing the pre-dominant role. Pollen of Chenopodinnae, Gramineae, _Quercus_ and _Populus_ was also observed. Spores, particularly of fungi, were very commonly observed in the samples. The quantity and variety of pollen taxa cannot be interpreted in paleoecological or paleoclimatic terms from data now available, since the data was not collected for such a purpose.

DISCUSSION

The ten samples submitted cannot represent the total range of variation in palynological features that could be expected from a large number of Cache River Valley pollen samples from archaeological context. But the general pattern of results is comparable to the pattern obtained in a number of other cases in the Midwest. Consideration of the series of samples as representative, if not statistically defensible, thus becomes credible.

A principal implication of Table I is that only a small minority of the pollen samples will provide statistically reliable pollen counts with relative ease. When one considers the time that must be expended in extracting the pollen from the sediments, and in reporting on the results in a scientific manner, it may be estimated that 20% of the specimens would allow for the regular production of one pollen count per man-day. Working a normal forty hour week, this would mean that the palynologist would extract pollen from approximately 100 samples in the course of a month, and achieve 20-25 pollen counts for statistical analysis and scientific interpretation. This level of productivity is approximately half of that normally expected of archaeological pollen samples from the Colorado Plateau (e.g. Schoenwetter, 1967; Hevly, 1964) or some other areas (Schoenwetter, 1965; Mehringer, 1965). But it is about equal to productivity of pollen at sites in California (Hevly and Hill, 1970) and Kentucky (e.g. Schoenwetter, 1974b). It is a higher level of productivity than has been obtained at the Koster Site or at sites in the Cahokia area of Illinois (Schoenwetter, 1974a, 1964).

About 40% of the pollen samples submitted would be considered analyzable if a 100-grain count standard was acceptable. The disadvantage of this procedure is the weakening of statistical confidence in the conclusions drawn from the analysis. In practical terms, this disadvantage is not a great one, however, because only fine points of statistical difference would be discriminated at this level. For example, the difference between a pollen frequency of 1.0% and 5.0% could be discriminated at the 95% confidence level with a 200-grain count but not with a 100-grain count. It seems unlikely that the identification of paleoecological patterns would depend on such fine discrimination in the Cache River case, however. The advantage of accepting the lower standard is that twice as many pollen counts could be produced from the same number of samples in the same number of man days.

The primary value of archaeological pollen analysis lies in its potential to provide the archaeologist with two sorts of information. First, it may provide a biostratigraphic chronology which is associated with, but independent of, natural-stratigraphic and culture-stratigraphic (e.g. serriational) chronologies. The independence of a pollen chronology makes it extraordinarily valuable as a cross-check on chronological conclusions. Second, the pollen record may provide a base for interpretation of the character of pre-existing patterns of vegetation in the immediate environs of archaeological sites. These patterns may be interpreted in paleoclimatic terms or in terms of such ecological relationships as plant communities, carrying capacity, human impact on the environment, etc.

In the Cache River situation, the data presently available would indicate that the potential of pollen analysis to provide chronological control is substantial. Despite the very low numbers of pollen grains observed, patterns of difference may be recognized in the pollen records of the Ledbetter site, the Krebs site, and the Dalton Hill site. Ostensibly, these differences are due to the time distinctions of those sites. Alternatively, the present data indicates the need for a substantial investment of energy and particularly well-defined problem orientation and sampling strategy for exploration of peleoecological relationships through pollen analysis.

The principal means of substantiation of paleoecological conclusions drawn from pollen records is replicability of data. For example, it would be inappropriate to interpret the former existence of a climatic pattern on the basis of the pollen record of one sample attributable to a certain time horizon. One would not feel the conclusion was valid unless the results of two independent samples were in agreement, and one would not have strong confidence in the conclusion unless four samples independently recorded the paleoclimatic event. To obtain four replications from Cache River sites, however, we must presume the necessity to extract pollen from ten samples clearly attributable to this temporal horizon. To obtain ten samples that are clearly attributable to the same temporal horizon would demand a very rigorously applied sampling Since a single temporal horizon might not be revealed until substantial laboratory analysis had been accomplished, field collection of 30-50 pollen samples might be required to guarantee that then would be appropriate.

RECOMMENDATIONS

There are a great many archaeological sites in the Cache River Valley that will be impacted by the proposed construction. Since all the sites cannot be excavated, it is a matter of some criticality that the temporal and paleoenvironmental contexts of those which are explored be understood insofar as this is possible. Basicaly, there are four lines of evidence which may be used to determine those interrelationships: (a) the comparative analysis of the archaeological remains, e.g. serriation studies and studies of the contextual-spatial relationships of artifacts; (b) geomorphological-sedimentological studies of the geographic contexts of the sites; (c) radiometric assays of antiquity; and (d) analyses of fossil biological materials. Pollen analysis is one of the ways in which (d) may be accomplished. Analysis of recovered faunal remains, and analysis of macrobotanical remains recovered through flotation, are other normal procedures. Usually, archaeological study explores all four lines of evidence to varying degrees.

Pollen analysis is a recommended approach, in addition to the other forms of study, when three particular conditions are met. It is particularly recommended when problems of horizontal stratigraphy loom large enough to make it probable that relative dating on the basis of geomorphological-sedimentological context will not serve to refine radiometric assay dating in a number of critical cases. Second, pollen analysis is especially recommended when the broad paleoenvironmental contexts of prehistoric human behavior patterns are not well understood, and doubt exists regarding the probability that the analysis of macrofossil floral and faunal remains from archaeological contexts will resolve this issue. Finally, pollen analysis is also highly recommended when opportunity arises (by virtue of an interdisciplinary approach) to relate a pollen record to biological records of other sorts and to geological and cultural records.

Since all of these conditions seem met in the Cache River Project case, pollen studies are very highly recommended. The quality of pollen preservation in the samples aids to justify this. Also, the demands of sophisticated archaeological sampling strategies and research designs which are made upon the project as a whole comply nicely with the similar demands of palynological research. It would thus seem that a substantial investment in archaeological pollen analysis is in order. My recommendation is for a minimum of one man-year of expert palynological labor, with ancillary costs for implementation of the sampling design and laboratory needs.

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