AN ARCHAEOLOGICAL POLLEN STUDY OF CHECK DAM SAMPLES AT GRAND CANYON NATIONAL PARK

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In 1976, pollen spectra from check dam deposits associated with an Anasazi site at Marble Canyon, GCNP, were analyzed to address research concerns relevant to archaeological assessment of the antiquity and function of those features. From the perspective of a decade of subsequent palynological study of archaeological contexts, that pollen record well serves to illustrate affects of recently developed palynological methodology and theory. The conclusions of the original study are not negated, but they are in one case less secure and in other cases justified by a different argument. It is suggested that archaeological expertise is as significant to the apt assessment of site-context non-artifactual data as "specialist" expertise.

INTRODUCTION

The Marble Canyon palynological sequence derives from a suite of sediment samples collected behind check dams associated with AZ C:9:15 (PC), which is dated ca. AD 1050 - 1150 by ceramic/ tree-ring crossdating (Euler, in press). When the samples were submitted to this Laboratory in 1976, we were requested to address three specific concerns. First, there is some question whether the sediments were deposited during the prehistoric period. Check dams were constructed in the Marble Canyon area by CCC personnel to halt erosion, and deposition could date to the second quarter of this century rather than the period of prehistoric residence. Second, granting they are prehistoric, there is some question whether the check dams were

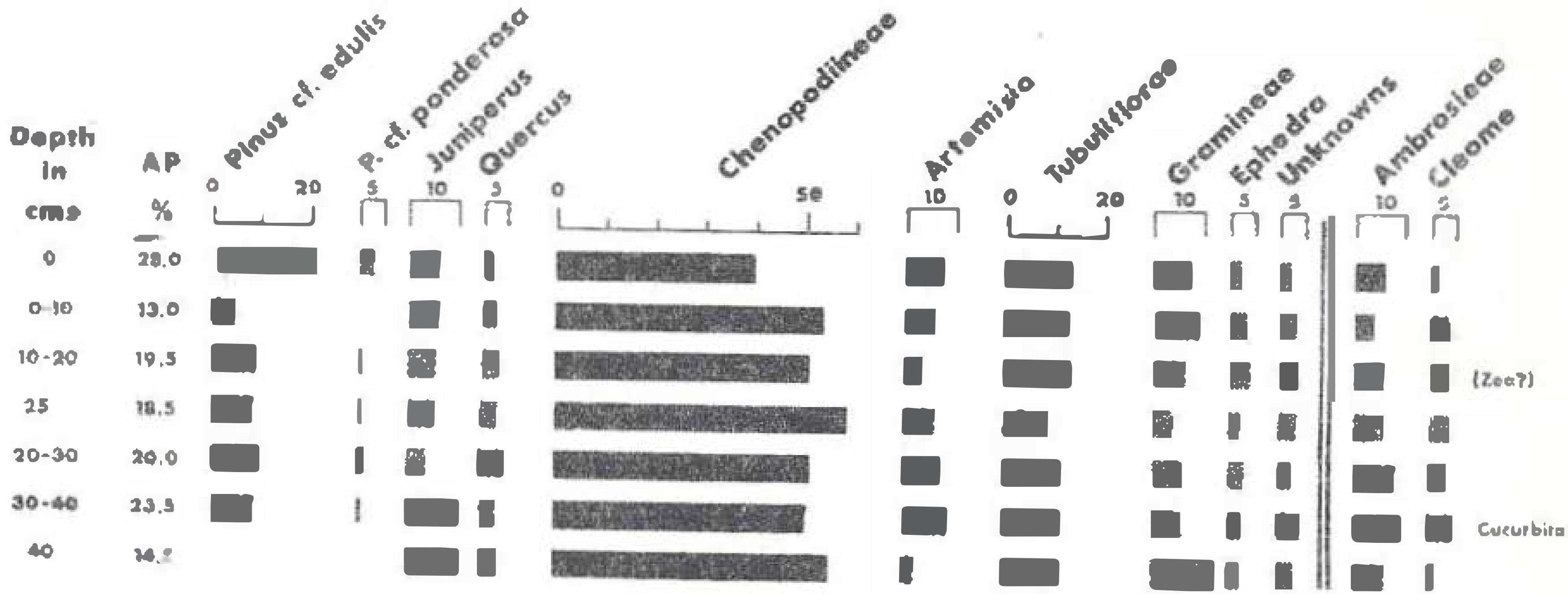

Figure 1. The pollen sequence from Marble Canyon (reprinted from Schoenwetter and Da Costa, 1976).

constructed solely as erosion control devices or if they were used as plots of arable land. Third, there is some question of the character of paleoecological conditions at the time of prehistoric occupation of the area. No potable water source exists today within easy walking distance. It was hoped the pollen record might shed light on this by providing evidence of the occurrence of relevant ecological change through time.

The diagram illustrating the results of the analysis (Fig.1) incorporates two somewhat unusual conventions. One is the display of the arboreal pollen statistic (AP %) that Schoenwetter (1970) employed for purposes of chronology-building. As this statistic is calculated on the basis of a pollen sum that excludes certain taxa, the pollen data on the extreme right of the diagram are expressed as proportions of the 200-grain pollen sum rather than as frequency values. The other is that the single sample collected from check dam 2 at 25 cm depth has been incorporated into the stratigraphic column of samples collected at check dam 1.

PALEOECOLOGY

The surface pollen sample collected from the check dams area produced an AP % value consistant with the prediction of Schoenwetter (1970:43), since the collection area is essentially treeless today. Obviously, the prominence of Artemisia (sagebrush) in the local flora is not effectively reflected by the frequency of sagebrush pollen in the pollen rain. This is not unexpected, since the correspondence between floristic frequency and pollen frequency is often less than direct. West (1978) and Gish (1982) also record low *Artemisia* pollen frequency values for surface samples collected at sagebrush grassland plant association locations. Gish's data shows *Artemisia* pollen values above 10% only when juniper trees are strongly associated with the sagebrush-dominated flora. West (1978:75) notes that surface pollen records from sagebrush parkland average 8 % *Artemisia* pollen. Uniformitarian argument leads us the assume that this also would have been true in the past, so advises us that the pollen frequency values of the subsurface samples should not be used as a direct index of the abundance of particular taxa in the paleoflora.

However, Schoenwetter (1970) has suggested that statistically significant variation in the AP % may provide anindex of the effective moisture variable in Colorado Plateau ecosystems represented by the pollen rain preserved in sediment samples, and it has been determined that variations in this pollen statistic rise and decline in temporal correspondence with statistically significant increases and decreases in decadal means for tree-ring width (Schoenwetter 1971). Colorado Plateau modern pollen rain studies have long suggested that the pine:juniper pollen ratio indexes precipitation values to some rough degree, as the ratio increases with elevation (Hevly 1968). Hevly *et al*. (1979) maintain that changes in the ratio at a given elevation through time identify episodes of change in annual precipitation receipt. Also, that the direction and timing of these changes corresponds with paleoclimatic interpretations of episodes of statistically significant increases and decreases in high frequency variations of the tree-ring record and with the cut-fill sequence of arroyo sedimentation (Hevly 1983, Euler et al. 1979, Dean et al. 1985).

Comparison of the modern and fossil pollen spectra from Marble Canyon thus strongly suggests that the earliest pollen record was deposited under distinctive ecological conditions. The AP % value of that sample is significantly lower, no Pinus pollen was observed, and the pine:juniper pollen ratio has a negative value. Interpretation, however, must take the depositional environment of the pollen spectrum of the 40 cm level sample into consideration equally with the pollen statistics revealed.

This sample was not collected from alluvium, but from a gravel deposit apparently derived from the local bedrock. The pollen could have been trapped at the time the gravel was laid down, but this seems unlikely since stream waters moving with sufficient energy to keep silt-size particles in suspension would be expected to flush pollen grains from a sedimentary matrix rather than allow them burial (cf Peck 1973, Bonny 1976). It is more likely that the pollen observed in this sample fell onto the gravel surface soon after the check dam had been constructed, and downwashed into the gravel along with other fines. The 40 cm depth pollen record, then, might represent the pollen rain of a very short interval and be distinctive for that reason. Yet this interpretation seems unlikely for two reasons. First, with the exception of Pinus, all of the pollen taxa preserved in the surface sample are also preserved in this sample. There is no reason to suspect the former pollen spectrum represents a short interval, so there is reason to doubt that the latter does. Second, the pollen frequency values for Juniperus and most other taxa are comperable in the samples from the 30-40 cm depth and the 40 cm depth. The 40 cm depth sample, then, is different but it is not different in ways that suggest its pollen record is temporally truncated. Though the inference is somewhat forced, the best evidenced reconstruction one can offer is that check dam 1 was constructed during a period when the local ecosystem expressed a significantly lower effective moisture value than it does today. Interpretation of the pine:juniper ratio suggests this was a period when precipitation was reduced, and suggests that formation of the gravel was the result of an episode of arroyo cutting consequent upon that reduction.

Paleoecosystem change to a condition approximating that represented by the modern surface sample, however, is suggested by the contrast between the pollen spectrum of the 40 cm sample and that of the 30-40 cm depth sample, and the relationship of the AP% value of the surface sample to those collected from the check dam fill between 10 cm and 40 cm depth. Considered as a population, this group of samples is statistically indistinguishable from the modern surface sample. Within the group, the most ancient sample contains significantly more Juniperus pollen than the other samples. Pine:juniper ratio assessment would suggest that the ecosystem conditions at the time this sample was laid down involved lower annual precipitation values than was true subsequently. A liberal paleoecological interpretation of the pollen records of the bulk of the check dam fill, then, would be that they represent both alleviation of the reduced effective moisture conditions and alleviation of the reduced precipitation conditions indicated by the oldest sample in the Marble Canyon sequence. A more conservative interpretation would be that the pollen records only document that construction of the check dam alleviated the affect of reduced effective moisture in the local ecosystem to the degree that it approximated the effective moisture condition which occurs locally today. Neither interpretation is clearly helpful as regards the question of potable water.

The pollen sample which represents deposition at 0-10 cm depth has a significantly lower AP % value than the modern surface sample or the population of samples representing the prior paleoecological episode. Its pine:juniper pollen ratio is distinct from the former but not the latter. The spectrum thus suggests the interpretation that local effective moisture conditions were again reduced relative to today's, but not as the consequence of a further reduction in precipitation.

Considered in stratigraphic order, it would seem that the Marble Canyon pollen sequence identifies an early period when ecosystem conditions were significantly different from those represented by the modern pollen rain; a middle period when conditions were only somewhat different, initiated by a transitional horizon; and a late period when conditions were again distinctive (Schoenwetter and Da Costa 1976). A liberal interpretation would suggest that these paleoecosystem changes were consequences of regionally significant changes in climatic variables of the types which induce variations in tree-ring growth patterns on the Colorado Plateau. A conservative interpretation would suggest that they were consequences of the construction of the check dam itself.

Most archaeologists would accept the liberal interpretation if an argument could be presented that the direction and timing of the paleoecosystem changes were synchronous with those reflected by tree-ring width variations. Otherwise, the conservative interpretation would seem more acceptable. Thus it would seem that the primary test for paleoecological interpretation of the Marble Canyon pollen sequence would be the congruence of that interpretation with paleoecological interpretations derived from an independent body of data and/or an independent method of paleoecological research.

Unfortunately, this is not in fact the case. Each of the pollen spectra which constitues raw data for either of these interpretations (or any alternative paleocological interpretation,for that matter) is temporally isolated from each of the others as a result of its unique stratigraphic position. The question of the degree to which each or any of these pollen spectra is representative of the pollen rain it ostensibly samples is both real and, because of the depositional context from which the samples derive, particularly relevant to paleoecological interpretation.

The temporal isolation of each of the pollen spectra of the analysis constrains us to appreciate that each consititues a single sample of the population of pollen grains trapped by sediments of that location at the time. A single sample drawn randomly from a population may be representative of that population. But one cannot demonstrate whether it is representative or it is not. Larger or smaller numbers of pollen grains may be observed from the sample, and it is not difficult to demonstrate that as the number of grains observed is increased the probability increases that the frequency values of the pollen spectrum are truely representative of those contained in the sample. But this does not demonstrate that the sample contains pollen taxa in the frequency values that are representative of the pollen rain trapped in all homologous depositional environments at the time this particular one was laid down. The sampling strategy applied to the check dam sediments could have been designed to produce different samples of arguably comperable antiquity. If a number of such samples had been available, and submitted for analysis, it would have been possible to calculate the probability that a particular pollen spectrum or population of contemporary spectra constituted a representative sample of the pollen rain preserved from any particular time period. Presently, such calculations cannot be performed. We are left only with the choice of arbitrarily accepting or rejecting an assumption that the pollen spectra of this analysis are representative.

Archaeologists are aware that paleoecological interpretations of stratigraphically organized sequences of pollen spectra are commonly undertaken, so they may be prepared to accept the common palynological judgement that the assumption of representativeness need not be justified. Following an argument I have presented elsewhere (Schoenwetter 1981), I suggest it is relevant here to understand the basis for that judgement and to assess whether or not it is applicable. The historical structure of pollen analysis has created a research tradition of Natural Science, as opposed to Social Science, character. As a result, comperability between present and past ecosystem events and processes is normally comprehended through arguments of homology and application of the principle of uniformity. The research tradition upon which modern scientific archaeology is based, for better or worse, is one of Social Science character. It comprehends comperability between present and past behavioral events through arguments of analogy and applies the principle of uniformity in a different way. If one presents evidence that two events or processes are homologous it is the responsibility of critics to identify evidence to the contrary, and until such evidence is presented the argument is accepted as logically secure even if it is disbelieved. If one presents evidence that two events or processes are analogous, it is the responsibility of the presenter of the case to examine reasonable counterarguments and determine their inadequacies. The argument is not logically secure until each alternative position has been convincingly negated.

Pollen analysts traditionally deal with stratigraphically organized pollen spectra which derive from depositional environments engendered by processes that are unaffected by human behaviors, such as the deposits of peat bogs and lake beds. In those situations, there is no reason to anticipate any human behavioral affects upon the pollen record. Certainly, there is no reason to presume that the affects of human behavior could act to produce a pollen record which mimics one which results from non-behavioral processes. Comperability between fossil pollen spectra and control pollen spectra which arguably represent the operation of non-behavioral ecosystem ewents and processes can therefore be justifiably assessed as homolouges. Paleoecological interpretations of such pollen spectra are logically secure in the absence of evidence to the contrary, and they are logically supported by the occurrence of congruent interpretations of independent forms of evidence. Though the presenter of such an analysis may recognize the possiblity of alternative paleoecological interpretations, it is not necessary to present counterarguments to them. Counterargument through presentation of existing or new evidence is the role of such critics of the interpretation as might appear.

The difficulty encountered here is that we cannot ignore the evidence that the Marble Canyon pollen spectra derive from deposits that were engendered by the action of cultural events and processes. Thus there <u>is</u> sufficient reason to anticipate that the pollen spectra are to some degree effects of those events and processes, and to that degree they should be interpreted through analogical, not homological, argument. In this case there is no basis for doubting that the affect of behavioral events and processes on pollen rains could not mimic the affect of non-behavioral processes. Indeed, there is justification for assuming just such an affect has occurred until evidence has been adduced to the contrary.

This assumption is justified by both by Social Science logic and by the traditional practise of archaeological research. By definition, archaeological sites are loci of human behavior and we are aware that the variety of forms of evidence of human behavior is very great. The archaeologist frequently encounters phenomena during the course of research which must be judged as either the result of non-behavioral processes and events or behavioral ones, and continuation or change in discovery and recording strategies will depend on that judgement. Such phenomena vary quite widely in type and character, ranging from the textural quality of the matrix in which artifacts may be embedded to patterns of spatial or numerical distributions of the individual fragments of a single broken artifact. Dealing with this common problem involves application of a methodological principle which derives from the necessity for analogical argument in Social Science analysis. Since archaeological sites are *loci* of human behavior, all material phenomena present at a site locus, and all the observable attributes of such phenomena, are granted the prior probability of being present as one observes them as a result of human behavior -- *but controls are maintained that act to assure the identification and recovery of any evidence to the contrary which may exist*.

Pollen grains, individually or in the populations of pollen spectra, are no less material than the artifacts, the sedimentological properties of deposits, the charcoal fragments or any other of the things that are observable at archaeological sites. They simply happen to be microscopic, and thus they are not observable until they are revealed by appropriate technology. If we follow the logic and normal practise of archaeological research we are obliged to assume that the frequency properties of pollen spectra that are recovered from an archaeological context have a higher prior probability of resulting from human behavior than any other cause. Recognition of their recovery from a locus of human behavior obliges us to doubt, until evidence is adduced to the contrary, that the pollen records of the Marble Canyon sequence are amenable to paleoecological interpretation at all until we have determined the degree to which they are interpretable as products of human behavior. This is logically required even if we are prepared to accept the assumption that they are representative of the temporally isolated pollen rain populations they respectively sample.

Either of the two paleoecological interpretations of the pollen sequence of the check dam deposits, then, or some alternative, may be valid. But neither can be forcefully argued because it is not possible to document whether or not any of the pollen spectra upon which paleoecological interpretations must be based are representative of the pollen rains trapped sequentially during the aggradation of sediments behind the check dams associated with the site. If the pollen spectra involved had derived from a locus where evidence of the occurrence of human behavior was minimal, the assumption that the spectra are representative would be logically secure until evidence was adduced to the contrary by critics. Then, paleoecological interpretation of the sequence could be tested by its degree of congruence with the paleoecological interpretation provided by analysis of a set of independent, but temporally coincident, data. But this is not the case. These spectra derive from a locus where evidence of the occurrence of human behavior prior to and during the period of deposition of the sampled deposits is quite convincing. Lacking evidence to the contrary, we are obliged to accept the prior probability that the pollen records are consequences of that behavior. The primary test of the alternative paleoecological interpretations of the Marble Canyon pollen sequence, then, is not congruence with paleoecological interpretations of coincident tree-ring records or geomorphological patterns, etc. It is the analysis of evidence that will test the assumption that the pollen spectra of this study are representative and the assumption that they are consequences of human behavior. Both tests require strategic attention to the recovery of pollen samples from Marble Canyon which are distributed in such a way that they can serve this purpose. This sample set is not so distributed.

CULTIVATION

The occurrence of one pollen grain of *Cucurbita* in the sample representing deposition at the 30-40 cm depth very strongly suggests that the checkdams were prehistoric and were used as plots of arable land. This inference can be made emphatically because of the nature of the pollination ecology of this genus. As Berlin *et al.* (1977:594) note, "Because squash is insect pollinated, the recovery of [its] pollen is likely only where the plant is being grown or stored." I would generalize the latter option, though, and suggest the presence of this pollen in a sample is not unlikely at any location where a pattern of human behavior (intentional or unintentional) could intrude the pollen into that context. The latter possibility seems at first rather remote in this case, but it must be recognized that cultivation practises incorporate many behavior patterns that may transport pollen from one context to another. Application of human waste or composted midden as a fertilizing agent, for example, (cf Donkin 1979:44-45) could intrude squash pollen from other sources if the checkdam fill deposits were used as garden plots.

Since the genus Cucurbita incorporates both wild and domesticated species, and species identification in this genus on the basis of pollen morphology is insecure, it is not possible to infer the practise of cultivation from the taxonomic record of the pollen analysis alone. The context from which the sample derives, however, is best characterized as a locus of human behavior with the potential for establishing a functional plot of arable land. Since the prior probability we are obliged to acknowledge in such situations is that the characteristics of pollen records of such contexts are created by behavioral events or processes, logic requires us to accept the position that the pollen derives from a cultivar as the more probable.

Minnis (1985) and Berry (1985) advise caution in interpreting low pollen frequency values for cultigen pollen as evidence of local cultivation. They point out that similar values are expectable as the result of contamination. Though they address their argument towards maize pollen, it applies as well to the pollen of other cultivar taxa. Minnis' and Berry's concerns are to some degree misplaced, however, because the issue is not whether one can be absolutely sure that the observed pollen record could never have been contaminated. The issue is whether such contamination is likely to have taken place.

One measure of likelyhood is the degree of comparability between the ostensibly contaminated pollen spectrum and younger pollen spectra that could have served as the source for the contamination. Schoenwetter (1985) argues that this measure is applicable because contamination cannot occur except as the result of some mechanism. Mechanisms that act to selectively contaminate a sample with the pollen of only one taxon are very, very rare, and means exist that allow assessment of the likelyhood that an older sample has been contaminated with the pollen of a younger one. In the Marble Canyon case, the pollen records of samples which are younger than the one which contains the cucurbit pollen are of two types. The type represented by the surface sample contains more _Pinus edulis_ pollen than occurs in the 30-40 cm sample, and it is difficult to imagine how the squash pollen could have been displaced from such a source without the simultaneous displacement of a significant quantity of that pollen type. The other type of younger pollen record is represented by the pollen spectra of 0-30 cm depth. Without exception, these contain less _Juniperus_ pollen, but statistically identical frequencies of _Pinus_, Chenopodiineae, Tubuliflorae, Gramineae and _Ephedra_ pollen than the ostensibly contaminated pollen sample. If this type of younger pollen spectrum were in fact the source of a contaminant grain of _Cucurbita_ pollen, the observed frequency for _Juniperus_ might be the effect of dilution of the older spectrum through contamination by the prominent taxa of the younger pollen spectra (*Pinus*, Chenopodiineae, Tubuliflorae), along with the intrusion of the squash pollen. But it is difficult to imagine that the result of such a process would not increase the prominence of one or more of those taxa in the older sample to the same degree as the *Juniperus* value was diluted, thus presenting us with a contaminated pollen record with different values for those pollen taxa than occurs in uncontaminated cases. This is not observed. In short, Minnis' and Berry's cautions remind us of a very real possibility of contamination, but it can be shown that the possibility is not particularly likely to have affected this sample.

One pollen grain which might be referenced to *Zea* was observed in the 10-20 cm depth sample. The identification is insecure because distortion obscured diagnostic pore morphology attributes. This really has no affect upon the conclusion that the check dam deposits were used prehistorically as a gardening area, which is based on the context and associations of the *Cucurbita* record, however. If the pollen grain involved is *Zea* it is likely to represent the effect of ancient cultivation behavior on the pollen rain, but its antiquity cannot be well estimated. If, on the other hand, it is not *Zea* the pollen spectrum of which it is a part suggests no more or less probability that the location was used for cultivation than any of the other members of its palynological samples population. The context of that population of samples obliges us to accept the prior probability that the observed characteristics of the pollen spectrum reflect behavioral processes and/or events, but they do not require that the particular behavioral event of cultivation should be identified as controling its observed attributes.

DISCUSSION

In the Marble Canyon case, observation of a single grain of Cucurbita pollen provided all the evidence necessary to resolve two of the concerns that originally stimulated this analysis. Obviously, that pollen grain could easily not have been observed. From the perspective of statistical adequacy, the inference that the check dams were used as agricultural plots in prehistory is untenable. It is the association of the squash pollen grain with the check dam structure itself which supports the inference. Is this as it should be? Wouldn't the inference be more scientifically justified if it were based upon the observation of a larger number of cultivar pollen grains in a larger number of samples?

The answer to this question is negative, unless one is prepared to accept the position of those who advise us that archaeology is not a scientific enterprise. Basically, the reason this is true is that archaeological inferences may be supported by statistical arguments, or they may be constrained by them, but they do not require them. They do, however, require appropriate appreciation of the association of one form of evidence of behavioral events or processes with another. In archaeology, comprehension of context and association takes priority over statistical adequacy. The fact that an archaeologist has recovered but one historic artifact from a site is far less significant to accurate dating than the context and associations of that artifact. Though the data sets of this analysis are pollen grains, which are the products of non-behavioral events and processes, the research concern is whether or not a particular cultural pattern occurred at this locus in the past. This is an archaeological question, it was persued through investigation of the material remains incorporated in sedimentary matrices which formed at the location as a result of (and during) an episode of human behavior, and it is appropriate that that investigation should be structured as an archaeological activity. From archaeological perspective, it is clear that the observation of more cultivar pollen grains in more samples would not have made the behavioral inference more secure. Given the context, they would only have replicated the evidence for a conclusion that does not demand it. The association of the squash pollen with the check dam structure is as intimate as it can be, since there is positive evidence which suggests that association is not the product of contamination. It would not become more intimate if more examples were presented, nor does failure to present them make the association less intimate.

Practical experience gained through the pollen analysis of sediments attributed to plots of arable land also clearly indicates that additional observation of samples of the check dam deposits would not provide substantially more information. Martin and Schoenwetter (1960) were the first workers to record cultigen pollen in contexts which were assessed as the deposits of prehistoric farm plots in Arizona. Though cultigen pollen was observed in 15 of 18 samples, the frequency of such pollen only averaged 0.07 percent. In no case was the quantity of cultigen pollen observed large enough that the possibility of its presence in the sample as a result of chance could be excluded. Martin and Byers (1965) investigated the pollen of prehistoric check dam and terrace deposits at Wetherill Mesa and again observed that no individual sample provided a statistically adequate value. That study also undertook investigation of surface pollen samples from maize fields. Values ranging from 0.14 to 1.09 % were obtained, but no single sample produced significant values for cultigen pollen. Berlin et al. (1977) independently replicated these results with their analyses of samples of incontrovertable prehistoric cultivated field context at Miriam Crater, Arizona, and Bugé (1970), Schoenwetter (1977) and Fish (1980) have undertaken studies elsewhere in Arizona with the same result. Fish (1971, also see Schoenwetter and Smith 1986:186-190) observed ca. 300 pollen grains in each of 81 surface samples from cultivated fields in the Valley of Oaxaca, Mexico. Only 76.5% contained pollen of cultigens and only 56.8% contained statistically significant amounts of cultigen pollen. She also undertook pollen counts of 93 surface samples from uncultivated plots. In that series about one fourth of the samples yielded cultigen pollen and significant values occurred in three cases.

Taken together, these studies reveal three things. First, cultigen pollen is not likely to be observed in a pollen count from an ancient farm plot deposit in statistically significant amounts. Second, the amount of cultigen pollen recovered from a sample itself suggests nothing about whether the sample derives from a cultivated or uncultivated plot. Third, cultigen pollen tends to occur in a significantly larger proportion of samples from cultivated plots than non-cultivated plots. From the perspective of the results of palynological investigations performed on modern and ancient farm plot deposit samples, then, it also is clear that palynological observation of additional samples would not have been a better means of determining if the check dams were used as farm plots, nor would it have produced a test of the inference which is based on the association of the single grain of ostensible cultigen pollen with the check dam structure. The occurrence of cultigen pollen in a larger number of samples would be independent evidence of such use, but lack of cultigen pollen in a larger number of samples would not beevidence that the terraces formed by the check dams were not used for garden plots. As often is true, this is a situation in which absence of evidence is not evidence of absence.

REFLECTIONS

When the Marble Canyon pollen work was initiated certain perceptions of the character of significant contributions that pollen studies might make in archaeology were accepted conventional wisdom. One of these was the idea that the cultural ecology of prehistoric populations could be effectively analyzed by identifying and emphasizing the contrasting palynological expressions of cultural processes and events and the palynological expressions of events and processes of nature which occur largely unaffected by human behavior. It was understood that there are areas of significant overlap and interrelationship between the two, but it was generally believed that their analytic segregation was valuable and their operational segregation was not difficult. This sort of thinking justified analytic appreciation of modern surface pollen rain records as controls that illustrate the characteristics of essentially "natural" processes and events (e.g. Schoenwetter 1970), and justified appreciation of the contrasts among the pollen spectra associated with functionally different architectural features as indices of the distinctive behavioral processes related to their use (e.g. Hill and Hevly 1968).

This perspective continues to be profitably employed in many archaeological pollen studies, but a developing body of experience and information is beginning to suggest that it may be more nieve than the character of the research questions and the data base warrants. Thirty years of intensive palynological study of Southwestern archaeological site-context deposits (Hall 1985) have generated many practical results based upon a trusting faith in the view, but nowhere have we been able to confirm that it is more secure than an alternative which is beginning to make itself recognizable in some palynological literature and which has surfaced in this analysis.

Briefly stated, the alternative is that site-context pollen records should not be viewed as the result of behavioral processes and events, <u>or</u> as the result of natural processes and events, <u>or even</u> as the result of a blend of both that presents itself in ways which allow their segregation. Thinking of them in those ways does not misrepresent them, and it may serve best to identify the archaeological value of the analysis of a sample suite from any particular site. But it also does not present us with an apt appreciation of their information potential. That is better achieved when site-context pollen records are viewed as one more of the many outcomes of the interaction of behavioral and natural processes and events that are represented by various data forms at archaeological sites.

In many ways, this perspective views recovery of site-context pollen data in the same fashion archaeologists view site-context recovery of the raw material of a manufacturing process. There is no question that what is observed is the product of natural events and processes. How much of it one observes, the proportional relationships one observes, how it is distributed in the context, etc., however, are assumed to be products of the behavioral events and processes that affected their occurrence as we observe them. By appropriate use of applicable methodologies we may examine the raw materials as reflections of nature, of behavior, or of expressions of relationships between nature and behavior that we may identify and segregate one from another. But successful application of those methodologies does not exhaust their information potential because it does not rest on a sophisticated appreciation of what they are. Both the raw materials of a manufacturing process and the pollen records of sediment samples represent something much more complex, when the context of their recovery is confidently identifiable as a locus of human behavior. They represent the product of interaction between behavioral and natural events and processes. Perception of palynological records from archaeological context in the way we have thought about them during the past quarter century is analogous to thinking about the archaeological discovery of basketry at a site as nothing more than support for the inference that the site's population had identified this technology and incorporated it into its cultural repertoire. The inference is valid. But it does not express the information potential of the discovery.

The alternative perspective recognizes the palynological record of site-context samples as a body of archaeological data. It does not deny the proposition that the samples may be amenable to analysis under the operating assumption that their observed attributes only minimally express their nature as a product of the the interaction of behavioral and natural processes and events. Nor does it deny the proposition that convincing demonstrations may be made that the contextual qualities which identify them as bodies of archaeological data do not affect the analysis undertaken, so are irrelevant. But that perspective allows the analyst to treat pollen records of site-context deposits as bodies of archaeological data which are different in kind, but not function, from other forms of archaeological data. Particularly, it justifies the development of archeologically rationalized means of approaching the problems of appropriate recovery, analysis and interpretation of palynological data of archaeological context. Presently, with a few exceptions, the methods of pollen analysis applied to archaeological site-context samples are methods which are rationalized by our comprehension of the natural processes and events affecting pollen production, distribution, deposition and preservation (e.g. Hevly 1981). Those are certainly important, but an archaeological methodology would not prioritize them over comprehension of the behavioral process and events which affect context and association, or comprehension of the interactions of behavioral and natural events and processes that (for example) are expressed as post-occupational site formation process phenomena. In this study, the alternative perspective has been instrumentalized in developing the inference that the check dam terrace was a cultivated area. Had it not been employed, the only secure inference that could have been drawn is that at least one squash plant once grew on that terrace.

Another bit of the conventional wisdom of the times, which influenced both the sampling strategy and the nature of the problems identified for resolution, was the idea that pollen spectra advised us more about the character of prior vegetation patterns than any other natural events. This idea was driven by the common success of palynological interpretation of pollen spectra from non-site contexts in vegetational terms, and by our apparant ability to characterize particular vegetation patterns by the pollen records of appropriate surface samples (e.g. Schoenwetter 1962, Hevly 1968). Though clues which advise us that this assessment fails adequately to account for a substantial fraction of variation in the modern pollen rain were already recognized a decade before this study was performed in 1976, they were yet ignored. In the course of the succeeding decade, however, they have piled one upon the other to the degree that they must now be accommodated theoretically or at least explained away. One such clue was identified early in this analysis: the fact that the relationship between the floristic characteristics of the vegetation pattern which produces the pollen rain and the frequency characteristics of the taxa which compose the pollen rain are often far less than direct.

One means of accomodating information of this sort is to accept the theoretical posture that the pollen rain of the particular geographic area expressed in a sample is not a monitor of the vegetation pattern of that area at all. Rather, to posit that both the vegetation pattern and the pollen rain are expressions of the ecosystem conditions existing there, and they monitor it in different ways (Schoenwetter and Smith 1986). There is a definable relationship between the vegetation pattern and the pollen rain of the area because both are responses to the same set of ecosystem conditions and because such responses are not generally stochastic. But there is a higher prior probability that the relationship will be accurately expressed by a multivariate function than a univariate one (cf Turner and Hodgson 1979, Solomon <u>et al</u>. 1980, Delacourt and Delacourt 1985). The AP % or the pine:juniper ratio value is thus more likely to express a major ecosystem condition such as the quantity of moisture effective for arboreal growth and reproduction than to expresses a vegetative condition such as the density of trees on the landscape or the character of the plant community.

Adoption of this theory of the information content of pollen records requires their assessment in somewhat different ways.

Culturally controlled behavior patterns are recognizable as significant elements of most ecosystems on this planet, and significant contributors to the character of ecosystem relationships at any given time. So the likelyhood is increased that the univariate expressions of ecosystem conditions we observe in pollen rains are affects of behavioral events and processes in many more modern and ancient pollen records than we have acknowledged. This theory also justifies particular recognition of the significance of comprehensive awareness of the geographical scale of the ecosystem conditions represented by a pollen record. In the present study this recognition underlies one of the major contrasts between the liberal and the conservative interpretations of the paleoecology identified by the pollen records. The liberal view accepts the assumption that the paleoecological variables being monitored by the AP % and pine:juniper ratio pollen statistics have broad geographic scale. The conservative view accepts the assumption that they have no greater geographical scale than the context sampled -- check dam 1.

From the perspective gained by an additional decade of work, what seems clearest is that the ideas that controlled appreciation of how many pollen samples would be needed to produce a data set adequate to deal with the research concerns, what spatial relationships those samples should have one to another, the character of adequate control samples, and how the pollen counts should be organized, have changed or are in the process of changing. It is not simply that the collection of more pollen samples might have been done so that more could have been analyzed if and when the theory and methodology of pollen analysis underwent change. That sort of field recovery strategy is very appropriate for salvage and mitigation program archaeology (though it aggravates the already complex problem of proper curation of archaeological information), and it has been already incorporated into research designs (e.g. Fish and Miksicek 1982). Additional samples would not have been relevant in this case unless they were collected from appropriate contexts and had appropriate associations. In effect, unless the person who established the sampling strategy was able to appreciate the potential of a given archaeological context situtation to yield a palynological record which would serve as a source of either raw data relevant to the research concerns or control data.

Fish (1980, Fish et al. 1982, 1984; 136-7: Rice, Henderson and Fish 1980) has devoted considerable effort to defining the character of palynological investigations appropriate to different sorts of agricultural sites situations. It is fairly clear from her efforts, or those illustrated by Boher and Adams (1977), that establishing a sophisticated palynological sampling strategy does not derive from the experience of having been instructed by a specialist on how pollen samples are collected, nor even by thoughtful assessment of text-book familiarity with the potentials and limitations of the pollen analyses that have been accomplished in non-site-context situations. If palynological data of archaeological context is perceived as archeological data which is distinct in form from the data provided by potsherds, but not in anthropological information potential. it must be our concern as archaeologists to accept responsibility to assure that it is dealt with with equal competancy in the course of field, of laboratory, and of interpretive efforts. When it comes to artifactual data in such contexts, archaeologists are prepared to take the nature of the site into as serious consideration as logistical and research objective factors, and they are prepared to implement and invent new data recovery methods as they recognize them to be relevant. It is appropriate to apply the same standards to pollen grains or any other form of non-artifactual remains. The sort of intimate co-operation expected of co-principle investigators seems to be necessary.

Archaeologists who prefer to think of pollen analysis as a technology, rather than a set of methods, and who prefer to leave palynological resolution of questions relevant to archaeological research totally to "specialists", may be discomfited to learn that such modifications of the conventional wisdom of a decade past are already in the air. It means that some inferences archaeologists never imagined were not well resolved (e.g. more tree pollen means more trees) will soon require re-evaluation, and some of the conclusions palynologists have drawn which influence our present appreciation of prehistoric cultural ecology will have to be identified and reconsidered critically . It suggests that in the forseeable future sites may have to be considered as much or more in terms of their potential to reveal archaeological information through non-artifactual than artifactual data analyses (which archaeologists are not traditionally trained to do); that fieldworkers will need to gain experience with the varieties and potentials of non-artifactual data recovery/ sampling strategies and their control requirements; and that even more priority often should be given to evaluation of the details of context and association when research designs involving non-artifact analyses are being formulated, executed and, particularly, modified during the course of field and laboratory work. These things will make archaeological work more complicated, less dependent on traditional archaeological practise and expertise, and more expensive. In the social environment in which the bulk of archaeological research is now undertaken, which de-emphasises such expensive scholarly interests as methodological development, these affects may be thought threatening. Perhaps, but I would suggest that they are threats only to the degree that archaeologists perceive them as such. They may also be perceived as means of learning more about the true character of the past and man's true role in the reality of that past.

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