POLLEN STUDIES IN THE MARBLE CANYON AREA, ARIZONA

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The palynological record now available from Marble Canyon derives from a suite of sediment samples collected behind check dams associated with AZ C:9:15 (PC). The archaeological sites of the "Marble Canyon Archaeological Community" are identified as affiliated with Kayenta Anasazi, and are dated ca. AD 1050-1150 by ceramic/tree ring cross dating (Euler, pers. comm.). The Laboratory was requested to address three specific problems through pollen analysis in this case. 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 the sediments could date to this period rather than the period of prehistoric residence. Second, there is some question whether prehistoric check dams were constructed primarily as water control devices which slowed erosion or primarily as devices for establishing 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. The prehistoric pollen record might shed light on the problem by providing evidence of paleoecological change.

The diagram illustrating the results of the analysis utilizes two distinctive conventions. On the one hand, 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. On the other hand, the arboreal pollen (AP) statistic used for interpretive purposes is that established for purposes of pollen chronology-building on the Colorado Plateau (Schoenwetter, 1970). The pollen taxa illustrated on the extreme right of the diagram thus are not calculated in the pollen sum, and are expressed as proportions to the 200-grain sum of taxa diagrammed to the left of the double bar.

The surface sample produced an AP % value consistent with the prediction of Schoenwetter (1970:43), since the collection area is essentially treeless today. The prominence of Artemesia (sagebrush) in the local flora is not effectively reflected in the pollen rain. This indicates, as expected, that the pollen record of the subsurface samples should not be used as a direct index of the frequency of particular taxa in the paleofloristic record. Statistically significant variation in the AP %, however, may provide an index of the density of arboreal flora and thus an index of effective moisture.

The occurrence of one pollen grain of Cucurbita in the sample representing deposition at 20-30 cm depth conclusively documents the presence of this taxon at the check dam locale in the past. In all likelihood this reflects the occurrence of cultivated plants, considering the context of the sample. Thus this single pollen grain essentially
serves to demonstrate both the proposition that the check dams are prehistoric and the proposition that they were constructed to establish plots of arable land. One pollen grain which might be referenced to *Zea* was observed in the 10-20 cm level sample. This identification could not be made securely because distortion obscured the grain and the diagnostic pore morphology of *Zea* could neither be observed nor denied. It was identified only as a member of the "Unknowns" category.

Comparison of the modern and the fossil pollen rain reveals that the earliest fossil record was deposited under distinctive ecological conditions. The AP % value of that sample is significantly lower, and all *Pinus* pollen is lacking. This does not indicate that no pine trees occurred, but that trees of all sorts were located significantly more distant from the site. The 40 cm level is not an alluvium, but a gravel deposit apparently derived from the local bedrock. The paleoecological conditions reflected palynologically at this depth probably refer to a temporal horizon much earlier than that of the prehistoric occupation, for it is not unlikely that contemporary alluvium was removed from the channel in order to construct the check dams.

The deposits sampled between 10 and 40 cm depth are, as a group, statistically indistinguishable from the modern surface sample. There is an apparent difference in the amount of *Pinus edulis* pollen, but this is not significant at the 0.05 level of confidence judging by the binomial confidence interval of the mean of these samples. It would appear that paleoecological conditions were essentially similar to ecological conditions occurring today when the check dams were used. The sample collected at the 0-10 cm level does have a significantly lower AP % value, indicating that it was laid down when ecological conditions were more arid than occur at the locale today and trees were more distant. This could have happened either during the late part of the period of use of the check dams or after Anasazi abandonment of the area.

If the hypothesis presented by Schoenwetter (1970) is correct, the period of usage of the plots must have been very limited. That synthesis of data would indicate that all of the fossil pollen records between 10 and 40 cm depth were laid down between AD 1060 and 1085. This leads to the suggestion that the lifespan of the Marble Canyon agricultural community may have been effectively limited to a single generation or perhaps two. If that is so, it must be recognized as an almost singular example of in-migration and establishment of a large, non-nucleated, community.

In the present case, the occurrence of a single pollen grain of *Cucurbita* provided all the evidence necessary to resolve two of the research questions originally asked of these data. Obviously, that pollen grain could easily not have been observed. From the perspective of statistical adequacy, the argument that the check dams are prehistoric is untenable. It is the context of association of the *Cucurbita* pollen with the masonry check dam structure which supports the conclusion of prehistoric agricultural use. Would it not have been profitable, in the present case, for the pollen analyst to have observed more pollen from the check dam sediments? Though it might have doubled the research
investment in the samples, because more time would be required in observation, could not the palynologist have resolved the issue more satisfactorily by observing more pollen of cultivated plants? The answer to this question, most emphatically, is negative. There are two reasons for this; one derives from the statistical character of pollen records and the other derives from practical experience.

Archaeologists recover information in quantitative forms which is subject to the same procedures of statistical treatment as are pollen records. They are thus trained to recognize and evaluate the strengths and weaknesses of pollen statistics as a form of data from which conclusions may be drawn. But it is not generally recognized that though a pollen sample is drawn from an archaeological context, it is not essentially similar in a statistical sense to the body of quantitative artifactual data drawn from the same context. The artifactual data (say a sherd lot) recovered from a provenience constitutes a sample of a population of similar proveniences. An associated pollen record (say of 200 grains) is recovered from a sediment sample of the provenience. Many more than 200 pollen grains may be recovered from each sediment sample. Many sediment samples can be collected from a single provenience, though the archaeologist normally takes only one. Thus the 200-grain pollen record is a sample of a population of samples of a population of similar proveniences, while the associated sherd lot is a sample of a population of proveniences. Normally, we make the assumption that a single pollen record characterizes the population of samples at the single provenience adequately. In a statistical sense, however, this assumption is nonsensical since the pollen count represents only a single sample of the population. It doesn't matter whether the pollen count is large or small; from the statistical perspective one sample is not adequate to characterize a population. We assume that it is adequate because we have neither the patience nor the resources to study a statistically adequate number of pollen records from each provenience. Further, there is no evidence that it is necessary to do so, because we find that we can replicate the palynological record drawn from the population of proveniences. Since our assumption is working, we continue to use it.

But we must recognize that the assumption exists, and that in fact the pollen record is a sample of a sample. Increasing the pollen count will make it a larger sample, but this will not make it a more representative sample. It will still be a single sample no matter how big it is, and a single sample can only be assumed to be representative. If we were to observe more pollen grains we might observe more examples of pollen of cultigens. Or we might not. It really makes no difference if we observe 1 cultigen pollen grain in 200 observations, as now occurs, or 5 pollen grains in 1000 observations. The value of proportions is exactly the same. It even makes no difference if we observe 1 cultigen pollen grain in the first 10 observations and then observe no more such pollen in the next 50,000 observations. The value is exactly the same as if we were to observe 5 such pollen grains in any similar set of observations. From the statistical perspective none of these observations is adequate to demonstrate the occurrence of any cultigen pollen in the population. From the non-statistical perspective, the occurrence of 1 pollen grain documents the presence of that pollen as well as does the occurrence of thousands of those pollen grains. So continued observation of the samples
now available is quite fruitless; it will tell us nothing we do not already know about the use of the check dams as plots of arable land.

Practical experience gained through the pollen analysis of sediments attributed to plots of arable land also clearly indicates that additional observation of the check dam deposits would not provide us with more information. Martin and Schoenwetter (1960) were the first workers to record cultigen pollen in archaeological contexts which could be considered prehistoric farm plots. Though observed in 15 of 18 samples, the frequencies of cultigen pollen only averaged 0.07 percent. In no case was a statistically adequate quantity of cultigen pollen observed. Martin and Byers (1965) investigated the pollen of check dam and terrace deposits at Wetherill Mesa. Again, about 0.07% of the pollen observed was unequivocally derived from cultigens, and no sample provided a statistically adequate value. That study also undertook investigation of surface pollen samples from modern maize fields. Values from 0.14 to 1.09% were obtained, but no single sample produced significant values of cultigen pollen. Bugel (1970) investigated six sediment samples from five archaeological terrace and check dam features at the Vosberg Locality. No cultigen pollen was observed in any of the 100 and 200-grains counts. Fish (1971) undertook observation of ca. 300 pollen grains in each of 78 surface samples from cultivated fields in the Valley of Oaxaca. Less than half (34) contained pollen of cultigens at all, and less than one out of three samples from fields contained significant quantities of cultigen pollen. She also undertook pollen counts of 91 surface samples from uncultivated plots in the Valley. In that series about one third (32) of the samples yielded cultigen pollen with significant frequencies occurring in 10% of the cases.

R.H. Hevly and his students have recently synthesized the results of their investigation of both modern surface samples from corn fields and fossil pollen samples from ancient plots on the Colorado Plateau (Hevly, n.d.). At Horse Flats on Cedar Mesa, modern maize fields yield a 0.90% frequency of such pollen. At Hay Hollow Wash the average frequency of cultigen pollen in ancient plots is 0.17%; at Miriam Crater it is 0.27%. Hevly's investigations are characterized by very large pollen counts per sample. However, in no case has the amount of cultigen pollen recovered in the pollen record of a sample from a probable prehistoric plot ever been significantly large.

At the .05 level of probability, we must accept the statistically supported conclusion that the population of pollen grains from ancient plot proveniences does not contain cultigen pollen. Essentially, this means that the odds are against ever demonstrating through cultigen pollen statistics that such proveniences were used as plots of arable land. But it is perfectly clear if we do not employ statistical standards that they were so used. It is also perfectly clear that it is quite impossible to tell if a given plot was so used on the basis of a small number of sediment samples, irrespective of how many pollen grains are observed.

Taken together, these results indicate four things. First, cultigen pollen is not likely to be observed in a pollen count from an ancient farm plot deposit unless the pollen count is quite large. If cultigen pollen is observed in such samples (irrespective of the size of
the pollen count), it is unlikely to occur in a significant frequency. Second, cultigen pollen is not likely to ever be deposited in the sediments of farm plots in significant frequency. Most surface samples from known farm plots do not contain significant quantities of such pollen. This is true even in Oaxaca on farm plots where cultigens have been continuously grown for millennia. Third, if cultigen pollen is found in significant frequency in a sample this does not document that it derives from a farm plot; cultigen in surface deposits at some locations known positively not to be cultivated. Cultigen pollen also occurs at low frequency at both cultivated and uncultivated locations. Fourth, cultigen pollen tends to occur in a significantly larger proportion of samples from modern cultivated plots than those from modern non-cultivated plots. Contextual evidence of the association of cultigen pollen with deposits considered to represent ancient farm plots indicates that this generalization probably holds true for prehistoric times.

It would thus appear that pollen analysis of the deposits can be used by archaeologists to determine whether or not a given terrace may have been used as a prehistoric farm plot. But this is not demonstrated on the basis of a single suite of stratigraphically superimposed samples. If cultigen pollen is observed in any given sample or samples of such a suite it will serve to document that cultigens were part of the paleoflora. But since each pollen record in a stratigraphic series is a sample of sample, none can provide statistically adequate palynological evidence that a farm plot occurred at the sampling site at any given level. The contextual evidence may justify the conclusion, as occurred in the present study. But the palynological evidence is insufficient. To obtain adequate palynological evidence the archaeologist must collect a statistically large number of sediment samples from the provenience at each stratigraphic level he considers likely to have been the ancient surface of the farm plot. The pollen analysis of the statistically large number of samples will constitute a sample of the provenience. If the provenience was a farm plot, a significant number of those specimens will yield cultigen pollen even though no one sample is likely to yield a significantly large quantity of cultigen pollen.

Considering the costs involved, it is to be expected that an archaeologist would only seriously consider utilizing pollen analysis to derive such a conclusion in rare cases where other forms of evidence are conflicting and equivocal. Generally speaking, pollen studies demonstrated that the structures archaeologists diagnose as prehistoric farm plots in the Southwest on the basis of ethnographic analogy and other evidence were, in fact, very probably used to grow cultigens. But no study has yet demonstrated that a particular structure was so used by virtue of the evidence provided through pollen analysis alone. It is our suspicion that there will never be need to do so.
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