

AN OUTLINE OF THE ENVIRONMENTAL CHRONOLOGY OF THE
LITTLE COLORADO DRAINAGE BASIN, ARIZONA

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In the past few years these meetings have witnessed a rash of reports on palynological researches associated with archaeological sites in the Southwest. Slowly, and with a great deal of preoccupation with the limitations and vagaries of the method itself, a pollen chronology has come into being for the desert zone south of the Mogollon Rim. This report deals with the pollen chronology formed on the basis of sites located north of this physiographic barrier, and the record of environmental fluctuations discovered.

The chronology is based upon sediment samples taken from ten archaeological localities. Dating of all but one of the sites is possible by radiocarbon, dendrochronology or intrusive pottery types so such fluctuations as occur in the pollen record are fairly well placed in time. In this regard it might be noted that this is the only southwestern pollen chronology exclusively related to archaeological localities. The one developed for the desert zone is taken from arroyo cuts in which the sedimentary sequence is dated by intrusive artifacts or fossils.

Samples were collected in stratigraphic sequence through the sites, with special care taken that a sample of the occupation level be recovered. In most instances this involved taking a sample of the sediment of the floor. While the fill samples are of greatest utility, only the floor sample can usually be definitely regarded as

dating from the period of construction of the site. The first slide shows the results of the pollen analyses of the dated occupation levels.

The sites are grouped in three categories: pre-pottery sites on ancient beaches; pithouse sites at higher elevations; and pueblo sites located on the floodplains of permanent drainages.

There were two beach sites, the Laguna Salada site and the Little Ortega site. The Laguna Salada site had been radiocarbon dated at 1420 ± 60 BC. The Little Ortega site was not datable by absolute means, but since it contained a greater quantity of chipped stone implements and a lesser quantity of ground stone implements it was tentatively considered earlier.

The pollen profiles from the two sites are significantly different. The majority of the pollen from Little Ortega is referable to the Compositae or sunflower family. The majority of the pollen from Laguna Salada is referable to plants in the Chenopodiaceae (goosefoot family) and the genus Amaranthus (pigweed). On the chart this is contracted to "Cheno-am". The sites appear, then, to date from periods of different environmental conditions and if Little Ortega is older it is substantially older.

The three pithouse sites cover a time range from 360 ± 60 AD to about 800 AD. All of the pollen samples from occupation levels reflect the same environmental conditions and these are quite different from those evident at the beach sites. In the pithouse samples cheno-am pollen and Compositae pollen show statistically equivalent percentage frequencies. In the beach sites one type is dominant over the other.

In the earliest pithouse--the Tumbleweed Canyon site-- corn pollen was recovered. This allows further confirmation of the hypothesis that the Mogollon pithouse-villages had an agricultural base.

The five pueblo sites cover a 450 year time span. Judging from pottery found on the surface, LS-28 has a considerable time depth. It may be as early as 900 AD and been occupied until 1250 AD. On the other end of the scale, the construction date on Table Rock Pueblo, ascertained through dendrochronology and carbon-14, is 1350 AD.

The floor sample from the oldest pueblo parallels those from the pithouses in pollen frequencies. All of the floor samples from later sites, with one exception, are significantly distinctive since they primarily contain pollen of the cheno-am type. It would seem that the cultural change manifest in the transition from pithouse-village to pueblo was not accompanied by a change in environment. A change in environment does occur, but probably about 200 years later. The estimated construction date on the Mineral Creek site, a pueblo, is 1100 AD. The shift had taken place by that time.

The time span between 1100 and 1350 was sampled intensively, since it is during this period that evidence of the Great Drought might be expected to appear. Out of seven well dated samples for this period six show nearly identical pollen frequencies. On palynological grounds, no evidence can be mustered for a change in meteorological conditions between 1100 and 1350 AD.

The period from 1350 to the present does not yield well dated samples from the study area since the region was abandoned by ~~agriculturalists~~ **pueblo builders** about 1400 and we therefore have no sites. From the few samples whose stratigraphic position indicates that the sediment was laid down after 1350, however, no evidence is forthcoming to substantiate hypotheses of major environmental

fluctuations.

So far, this discussion has revolved about the shifts evident in pollen frequencies relative to their chronology. Of equal importance, of course, is the nature of the shifts. The task of determining what sorts of fluctuations occurred can only be accomplished by referring the pollen found back to the ecological limiting factors of the plants themselves. Here in the midwest, shifts in pollen frequency occur between genera of plants in the postglacial period. One time period shows a maximum of spruce, the next of pine, another of oak. In the Southwest, however, the major pollen types are not arboreal species whose ecological requirements are well known but herbs whose modern referents are found in a variety of ecological niches. In order to adequately judge the importance of these pollen types we must obtain information on the pattern of present pollen distribution in the area.

The next slide shows the analysis of fifteen sediment samples of the modern soil surface. Most were taken in the same locales as the ancient samples.

We noted that the period from 1100 to 1350 AD was characterized by high frequencies of cheno-am pollen. This condition is duplicated in most of the samples of the modern surface. It would appear, then, that the environmental conditions prevalent today were also prevalent at that time.

The period from 360 to 1100 was characterized by statistically equivalent percentages of cheno-am and Compositae pollen. This condition is recognized in the sample from the Mineral Creek site and the sample from LS-34, pithouse 2. These sites occur in locales where local conditions allow somewhat more favorable

moisture conditions than are usual for the area. Apparently, this is reflected in the pollen spectrum by a greater quantity of Compositae pollen.

The sample from Little Ortega showed a dominance of Compositae pollen. A sample from the modern surface (not shown on this slide) which was taken at a pond also showed a dominance of Compositae pollen. Apparently, the more moisture available the more Compositae pollen will find its way into the pollen spectrum.

It is important to realize that all of the surface samples were collected from sites under the same climatic regimen. Since the ancient pollen samples can be matched to the modern surface samples it is apparent that the range of variation in the environmental chronology constructed is not substantially greater than the range of variation evident in the area today. It would seem that there is no evidence from pollen analysis to indicate that the area has undergone changes in climate in the time period studied.

It is evident, of course, that something has caused the changes that occur in the palynological record, for the regularity of patterning in the changes seems sufficient indication that they are real. These changes must merely be related to meteorological fluctuations which are expectable under the present climatic regime. It is not necessary to postulate climatic changes to account for them.

Under the present climatic regime the most variable factor affecting plant growth in the study area is available water. Rains occur only in the summer and winter seasons, with summer rains accounting for the major fraction of the small total yearly fall. Variability from the mean precipitation value is 25-30 %.

The winter rains are slow drizzels or snowstorms associated with frontal movements; the summer rains are torrential downpours from cyclonic storms. While the winter rain and snow penetrates the soil to some depth and soaks it well, most of the moisture is dissipated in the two dry months preceeding the growing season. The high energy summer rains pelt the soil surface but penetrate only a short distance. Most of the water runs off the land and collects as flash floods in the arroyos where it cuts and erodes the floodplains in its rush downstream.

The plants which seem best adapted to the present rainfall regimen are the weeds of the Chenopodiaceae and the genus Amaranthus, i.e. the cheno-am pollen producers. Many species in these groups are found in the deeply dissected arroyos, for disturbed sediment conditions are their favored habitat. Also, the plants rely only on summer rainfall for germination, growth and flowering. Under the present conditions they are a vigorous group and, as can be seen by the number of surface samples in which their pollen is the dominant fraction, they disseminate a large amount of pollen.

On the other hand, the Compositae play a more important role than the cheno-ams in the modern surface samples only at high elevations or at locales which are unusually mesic. The cheno-ams are well adapted to the type of precipitation pattern in effect today, when most of the rain comes in the summer and there is a lot of disturbed sediment; the Compositae seem to prefer well soaked ground, such as is the case after winter storms.

On this basis the fluctuations in the pollen record may be explained in the following way:

~~The~~ The samples of the present surface ^{and} ~~to~~ the samples dated ^{back to} AD1100 all show cheno-am pollen as the predominant type. The environmental pattern appears to have been similar to that of the present day.

From 1100 to 360 AD, cheno-am and Compositae pollen frequencies are statistically equivalent. This implies, if not a pattern of more winter rainfall, at least less intensive summer rains and higher water tables.

At 1420 BC we recognize a period when cheno-am pollen is again the dominant type. A shift to summer rainfall similar to that of the present is indicated.

At some earlier time, as yet undated, Compositae is the dominant pollen type. Much more available moisture seem evident.

Because the question deals directly with a point of honor among Southwesternists--the importance and impact of the Great Drought-- I should like to redirect attention to the pollen analysis of sites dated between 1100 and 1350.

Hooper Ranch Pueblo is especially important in this regard because from the pottery taken from the site it appears that it was occupied during the drought itself, from 1275 to 1300, and was then abandoned. The pueblo was built in two stages. A small pueblo was constructed and occupied for a while, then it was filled in with trash and a second pueblo built on top of it. At some time a great kiva was built at the site. It was in this kiva that Martin's field party found a figurine hidden in a secret crypt last summer.

Both the upper and lower levels of the pueblo were sampled, as was the kiva. The occupation fill of the earlier construction

period yields a pollen spectrum distinctive from that of the later construction period. The samples from the kiva show a relationship only to the samples from the later construction period, hence it appears that the kiva was built when the pueblo was expanded.

The samples from the earlier occupation level yield about 50% corn pollen. The samples from the upper occupation level and the kiva yield a maximum of 6% corn pollen. Obviously, an economic, if not an environmental change had taken place.

There is no good evidence that environmental fluctuations are involved. The Mineral Creek site and Rim Valley Pueblo, both earlier than the early construction period at Hooper Ranch, have cheno-am dominated pollen spectra. The upper level at Hooper Ranch also has cheno-am pollen as the dominant and it is, at most, only 25 years younger than the lower level.

It is noted, however, that along with a decline in corn pollen there is also a decline in Typha, or cattail, pollen. Cattail only grows under conditions of very high water tables and very poor drainage, usually in marshes and still ponds. Under the environmental conditions postulated for this period, i.e. a rainfall pattern similar to that of the present, marshes and ponds are quite rare because of the widespread erosion.

I suggest, however, that the high frequency of corn pollen and the presence of cattail pollen are together indicative of man-made conditions of high water tables and poor drainage; in effect, irrigation. Irrigation by damming or ditching of the nearby Little Colorado would form a habitat for cattails.

With conditions of intense summer rainfall, however, the time