James Schoenwetter

1965, revised 1968

POLLEN STATISTICS FROM THE GALISTEO BASIN

Introduction

Forty-nine sediment samples were processed and analyzed from pollen from the Galisteo Basin in conjunction with the Galisteo Dam Archaeological Salvage Project. Eight of these were surface samples collected during the initial survey (1964) or during excavation (19650. Two subsurface samples were processed from LA 9142, three from LA 356, sixteen from LA 9147 and twenty from LA 6869. Six from LA 9147 and seven from LA 6869 yielded insufficient pollen for analysis.

Laboratory processing involved sieving and heavy liquid flotation. While essentially successful in recovering sufficient quantities of pollen from most samples, this extraction method still left much to be desired. Like the samples from Cochiti (Schoenwetter 1964), the Galisteo Basin sediments contain quantities of mineral matter (possibly pyrites) which remain undisturbed by this technique and make microscope work difficult.

The sub-surface samples were collected by the field archaeologists working on the sites as excavation proceeded. Due regard from contamination was taken following the sampling procedures outlined by Dittert and Wendorf (1964:32-36). Field personnel were also responsible for the collection of the surface pollen samples and records of surface vegetation following those outlined by Dittert and Wendorf (1964:9-13).

The objectives of the project were clearly recognized from its outset. On the one hand, I hoped to determine if the pollen analytic design developed for purposes of site cross-dating in northwestern New Mexico could be applied to sites in the Galisteo Basin. On the other hand, I hoped to determine whether the environmental conditions now evidenced at the site localities were similar or distinct to those occurring at the times of occupation. If conditions of vegetation and environment were formerly distinct, I hoped that the nature of the differences would be apparent in the palynological record.

Surface Samples

Surface pollen samples serve as empirical controls on samples collected from more ancient temporal horizons. The pollen statistics of a surface sample allow empirical recognition of a pollen spectrum which expresses a known pattern of vegetation. Analysis of surface samples from northwestern New Mexico (Schoenwetter and Eddy, 1964, Schoenwetter, 1966, Schoenwetter, 1967) indicates that the density of the arboreal vegetation at a locality is reflected in the arboreal pollen (AP) frequency. AP is more frequent when there are more trees and less frequent when there are less trees. It has also been determined that specific patterns of arboreal pollen frequency are demonstrable when the raw pollen statistics are treated in a particular fashion. If one excludes certain pollen taxa from the sum upon which the pollen frequencies are calculated, AP values within certain ranges are found to be characteristic of certain patterns of arboreal density. Utilizing the "adjusted pollen sum" (See Schoenwetter and Eddy, 1964:69-72), surface pollen samples from woodlands characteristically contain 60.0% AP or more, surface pollen samples from savannahs contain between 35.0 and 60.0% AP, and surface pollen samples from areas with no trees (arboreal density = 0) contain less than 35.0% AP. These general rules have been found to be violated when unusual edaphic conditions are involved, such as disturbed, cienega, or riverside sediments.

When the pollen data from the eight surface samples collected in the Galisteo Basin was calculated according to the adjusted pollen sum utilized in the northwestern part of the state, resultant AP frequencies agreed with those expected in large part.* The surface samples collected from undisturbed woodland vegetation contained AP frequencies ranging from 62.5 to 73.0 per cent; the single sample from savannah vegetation contained 57.5% AP; and the sample from an undisturbed locale in which trees were absent contained 26.5% AP.

The three samples which to not fit the expected pattern are known to be disturbed locales. The sample from LA 9146 was collected in an area where trees have recently been killed by chaining; the AP frequency is lower than expected. The two samples from LA 9142 contain about 35% more AP than would be expected as no trees now occur at that location. The site is recognized as heavily grazed, however, and its surface is definitely weathering. The exposed surface thus may date to a period prior to the present. This interpretation is partly supported by the occurrence of maize pollen in one of the LA 9142 surface samples. Maize is not planted at or near the site at present, so the pollen probably represents prehistoric maize cultivation.

The surface samples, taken collectively, yield some interesting information. First, as is the case with samples from the northwestern part of the state, AP frequency declines as arboreal density declines though conditions of edaphic disturbance tend to abrogate this generality. Second, the dominant arboreal pollen type is juniper when

* The raw pollen data is shown in tabular form in Appendix I; the pollen frequencies calculated on the basis of the adjusted pollen sum are shown in Figure 1.

juniper is the clearly dominant tree at the sampled locality or near to it. When significant quantities of pinyon occur at the locality, however, the frequency of pine pollen is much increased. Third, the frequency of *Ephedra* pollen is universally low in the samples, with less than 2.5% in any sample. The frequency of *Artemisia* and Gramineae pollen is also low, reaching only 6.0% in the former case and 9.0% in the latter.

Judging by these data, the present conditions of environment in the Galisteo Basin favor a pollen rain dominated by juniper pollen in the areas occupied by sites LA 9147, 6869, and 356. The AP frequency – being highest on more wooded undisturbed sites and lowest on least wooded undisturbed sites – may reasonably be taken as an index of effective moisture values in this area as in the northwestern part of New Mexico. The modern conditions of environment favor high frequencies of Chenopodiaceae pollen over *Artemisia*, Gramineae and *Ephedra* pollen.

<u>The La Bolsa Site, LA 356</u> (Fig. 2)

A single sample was collected from the structure identified as an early 17th century house. The sample was taken from sediment in the hearth is association with cultural debris. The pollen count of this sample is about half of that usually recovered (see Appendix I), but the grains were reasonably well preserved. Two samples were collected in association with another hearth believed to be of Archaic age. The lower of these is associated with the radiocarbon sample which yielded a date of AD 255$\pm$140. The upper pollen sample is probably of the same temporal horizon as the lower one since it was associated with similar artifactual materials.

The contrast in pollen spectra between the surface and the subsurface samples from this site is quite dramatic. The older samples contain very much less arboreal pollen, and the proportion of juniper to pine pollen is much reduced. Values for *Artemisia*, *Ephedra* and Gramineae in the subsurface samples, however, are quite similar to those obtained in the surface sample. The subsurface samples differ amongst themselves principally in the frequency of AP they contain. Yet in no case does the AP frequency reach above the critical level of 35.0% indicative of positive arboreal density. Since the AP distinctions between the samples do not evidence clear variations in tree density, all samples may be equally well interpreted as indicating a tree-less vegetation pattern.

Clearly, the sample collected in association with cultural material dating ca. AD 1625 and those collected in association with Archaic cultural detritus cannot be of the same age. Their similarity, however, would indicate that the site was occupied under environmental conditions which were much the same at the two separate points in time. On both the Archaic and the Historic horizons, the vegetation pattern at the site appears to have been tree-less, though it now supports juniper woodland. The interpretation is that a drier environment prevailed at these earlier times. Such a drier environment, however, cannot be recognized as being very distinct from environments now occurring in the Galisteo Basin area. The close similarity of the ancient and modern pollen records as regards *Artemisia, Ephedra* and Gramineae values would indicate too little climatic variation for establishment of a distinctive floristic pattern. The horizons represented would appear to be little more than periods of relative drought which reduced the number of localities favorable to tree growth.

The archaeological estimate of absolute age for the historic component, ca. AD 1625, (Honea, this volume, pp 1-10), though based on only one potsherd, cannot be very far wrong. Considering the known lifespan of the ceramic type involved, the site could be no older than AD 1600 and no younger than AD 1700. Palynological records of this horizon are known from the site of Picuris in Taos County, New Mexico (Schoenwetter 1965c) Those dated to the 17th century do not agree with those from LA 356, as they yield AP frequencies indicative of environmental conditions like those of the present while the spectrum from LA 356 suggests conditions drier than the present. Palynological records dated AD 1650-1700 are also available from localities near Chochiti Pueblo (Schoenwetter 1964). The Cochiti pollen spectra contain more AP than surface samples from the same localities, indicating a wetter environmental condition than prevails today. Dendroclimatic interpretations of moisture conditions in the Galisteo Basin over the years 1600-1700 are also available (Fritts 1965). The dendroclimatic interpretation is that relatively wet conditions may be considered probable fro the years 1611-1625 and 1636-1655, but no years of relative drought are indicated for this century in the area. Thus, neither existing palynological nor existing dendroclimatic data appears correlative with the environmental reconstruction offered for the Historic occupation at LA 356, though the pollen records from Picuris and Cochiti agree with dendroclimatic records.

The two prospects for error are that the dating of the sample is incorrect or that the pollen spectrum is not a true reflection of environmental conditions occurring at this time. The probability that the archaeological date is in error seems low. Though only one potsherd was recovered, it if of a type which is very well dated through its associated with tree-ring specimens and other well-dated ceramic styles at other sites. The potsherd was recovered from undisturbed fill in the same hearth which was sampled for pollen analysis. It would thus appear that the pollen spectrum is not a true indication of environmental conditions occurring in the Galisteo Basin between AD 1600 and 1700. If so, the environmental reconstruction offered above for the site at some time during the 16th century is also in error.

The samples indicating a drier environment from the Archaic component were associated with a radiocarbon date of AD 255 $\pm$140. Analysis of the artifacts of this component, however, suggests they are representative of a horizon dating some four or five thousand years before the Christian Era. There are no presently available pollen spectra from New Mexico known to date to the fifth millennium BC with which those from the Archaic component at LA 356 might be compared. The C-14 date, however, places the pollen spectra in the middle of the third century AD $\pm$ 140 years. Pollen records from northwestern New Mexico (Schoenwetter, 1966) indicate the occurrence of relatively dry conditions from the beginning through the middle of the 2nd century AD. At a site dated 300 BC – AD 500 in western New Mexico (Schoenwetter 1962:179) palynological records indicating dry environmental conditions were also recovered. Hevly (1964:77) presents pollen records from Arizona archaeologically dated to the AD 200-500 horizon. They indicate a drier environment than presently occurs. All these may be correlative with the pollen records of the Archaic component at LA 356. Alternatively, pollen records from the Tumbleweed Canyon site in eastern Arizona (Schoenwetter 1962:178-179), dated AD 360$\pm$50 by associated charcoal, indicate environmental conditions similar to those of the present.

Thus, some pollen evidence from other sites would favor the possibility that the C-14 date accurately estimates the age of the Archaic component and pollen records from LA 356. But the lack of well-dated pollen spectra from the fifth millennium BC allows the definite possibility that Honea's artifactually-based estimate of the component's antiquity is indeed accurate.

The Waldo Site, LA 9147 (Fig. 3)

A series of pollen samples from heaths and other features at this site proved essentially pollen sterile and unanalyzable. Most of the samples from Pit House 2, however, were rich in pollen. The sample from the burned room debris of this dwelling did not yield to analysis because the pollen it contained was negligible in proportion to the amount of wood tissue fragments and other cellular debris. The floor sample in this series consisted of a piece of the plastered floor of level 3.* The fire pit sample was collected from the hearth in the Level 2 floor. The fire pit sample is thus stratigraphically equivalent to the sample collected 125 cm below surface. The other samples were collected from the fill of the collapsed structure.

The basal floor sample yields an AP frequency indicative of savannah conditions; the AP values of younger sediments are more consistent with an interpretation of tree-less vegetation. The site appears to have been inhabited during a period of substantially less moisture than now occurs, though it would appear that the relative drought which occurred was somewhat more severe during the occupations of Levels 1 and 2 than during the occupation of Level 3. The proportions of juniper, grass, mormon tea and sage brush pollen would indicate vegetation associations essentially similar to those observed today at drier locales in the district.

Archaeological evidence for dating Pit House 2 is limited because of the relatively few decorated sherds recovered. The site as a whole

*See Hammack, this volume p 16-17 for description of levels.

is considered a single unit of occupation, however, and dated AD 1275±25. All other palynological records dated to the AD 1275-1315 horizon show evidence of substantially drier conditions than prevail today. The famous "Great Drought" tree-ring specimens (see Schulman 1956) also evidence relative drought in Arizona and New Mexico at this time. The pollen spectra from Pit House 2, then, appear to conform to an expected pattern. Even the relatively less arid conditions evidenced in the basal floor sample are in conformity with other available records. Samples collected in the Chuska Valley (Schoenwetter 1967) and at Picuris (Schoenwetter 1965c) dated to the AD 1225-1250 horizon indicate that conditions wetter than those of the present occurred for a short while. Between AD 1250 and 1275 it is to be expected that pollen records would evidence conditions like those of the present or slightly drier than those of the present. The basal floor sample from Pit House 2 appears to represent this latter condition.

On the basis of palynological correlation, it appears than Pit House 2 was first occupied between AD 1250 and 1275 and last occupied before AD 1315. This interpretation is wholly consistent with the dates provided by the ceramic evidence. The pollen sample collected from the basal floor level contained a grain of *Juglans* (walnut) pollen. The present distribution of walnut in New Mexico (Benson and Darrow 1954:110-113) is primarily south and west of the Galisteo Basin, but given the drier conditions reconstructed for the period of occupation there is no ecological reason why walnut may not have occurred near the site of Galisteo Creek.

The sample collected 125 cm below the surface contained a grain of *Carya* (hickory) pollen, and a scan of 1000 grains from this sample yielded three grains of *Zea* pollen, though the original count showed none. Plants of the hickory genus now reach their westward extension in the gallery forests of eastern Texas (Vines 1960:127-137), and the occurrence of this unquestionable hickory pollen grain demands some explanation.

It is not impossible to imagine that hickory was a native member of the local flora when this sediment sample was deposited. Martin (1963:54-55) feels that a good case can be made for the occurrence of species of *Carya* in Arizona, along with elm and basswood, in the mid-postglacial. *Carya* pollen has also bee recovered from postglacial sediments in eastern New Mexico (Hafsten 1961, Fig.20). Perhaps hickory was still not extinct in New Mexico 600 years ago. It is also possible that this pollen grain was blown from an eastern source, or rebedded from a more ancient horizon.

Another explanation is that the hickory pollen was unintentionally introduced by man to the sediment sampled. The 125 cm. Level is stratigraphically equivalent to the prepared floor of Level 2 in this structure. The few pollen grains of maize would tend to support a recognition of cultural contamination of the pollen spectrum of this sample. Hickory has served both Indian and White cultures as a source of food, but the foliage and bark are also sources of dyestuff and medicine. Hickory bark and foliage could well have been traded to the Waldo site from eastern sources, with occasional grains of hickory pollen clinging to the raw material. The prospect that such occasional pollen grains would be fortuitously dropped into the sediment sampled some six centuries later is, of course, not a highly probable one. It is more probable that this could have happened, however, than that long-distance transport or rebedding of pollen by natural factors is involved. The prospect of hickory being a native member of the flora in the 13th century has the lowest probability.

The Wheeler Site, LA 6869 (Fig. 4)

Approximately half of the 13 samples collected from the archaeological horizon at the Wheeler Site yield AP frequencies above the critical level of 35.0%. These samples would indicate the occurrence of a savannah vegetation at the site during the period of occupancy, while the other samples would indicate that a tree-less vegetation pattern existed at the site during the occupation. These data are not in conflict, for half of the samples indicating occurrence of savannah conditions were recovered below the floors of rooms. Apparently, the site was located in a savannah when early rooms (e.g. Rooms 20,3,31) were constructed, but tree density was reduced before the floors of the last rooms (e.g. 27,14,7,4) were laid down. The change from an earlier savannah to a later tree-less condition at the locality may not have an environmental cause. Trees could have been locally removed by the site's occupants.

The reduction in AP frequency relative to the surface sample would indicate that the occupational horizon was significantly drier than the present even during its earlier aspect. There are two factors, however, which must influence such an interpretation. On the one hand, the proportion of pine to juniper pollen in the subsurface samples is unlike that in the modern surface samples. It would seem that a significant number of trees at the locality during prehistoric times were pines, while the locality presently supports few pines even though a woodland vegetation pattern exists. Since pine requires somewhat more moisture than juniper for growth and maturation, it is possible that the pollen spectra of the subsurface samples reflect little actual moisture reduction relative to that at the site today. On the other hand, the frequency of Gramineae and *Ephedra* pollen in the subsurface samples is ordinarily significantly higher than that observed in the surface samples from the Galisteo Basin. It is also higher than that observed in the samples from the La Bolsa and Waldo Sites. Such higher frequencies would indicate that the environmental conditions occurring at the time of Wheeler Site occupation were distinctive from those occurring today. Perhaps an increase in moisture values is responsible for the distinctive pollen spectra.

The occurrence of large quantities of *Ephedra* pollen is not without precedent in surface or fossil pollen spectra from the American Southwest. Bohrer (1966P3) reports and *Ephedra* frequency of 24.5% from a surface sample collected in a dense stand of *Ephedra trifurca*. Another sample from a similar stand, however, yielded on 7.5% *Ephedra* pollen. Normally, *Ephedra* does not constitute a major component of the local vegetation in the Southwest; in the vast majority of surface sample cases, *Ephedra* values range below 4.0%. Fossil pollen spectra from certain archaeological sites in eastern Arizona, however, contain unusually high frequencies of *Ephedra* pollen. Hevly (1964, Fig. 16) reports *Ephedra* values between 5.0 and 10.0 per cent from trash and fill at various sites. In the fill of pits from the floor of one house in the Hay Hollow Wash area, Bohrer (1964, Table III) reports *Ephedra* values of 21.0 and 48.0 per cent. Bohrer interprets these high values as a function of cultural contamination.

The interpretation of the *Ephedra* values in the Wheeler site samples as cultural contaminants holds some attraction. However, the Wheeler site samples show one particular, and I am sure significant, difference from other wimples where cultural contamination seems reasonable. In the case of Bohrer's and Hevly's data only some samples from any given temporal horizon yield unusually high *Ephedra* values. Bohrer analyzed seven samples from the same dwelling, and only two produced high *Ephedra* values. Comparison of a series of floor samples of the same age from different sites (Hevly 1964, Fig. 17) shows that *Ephedra* values are ordinarily about 0-2.0% but 3.0-5.0% values are occasionally obtained. In the Wheeler Site sample, however, *Ephedra* pollen values are consistently high. Thus the *Ephedra* values at the Wheeler Site are unlike those at other sites which have been interpreted as due to cultural contamination.

The frequency values of known cultural contaminants are also different from those of *Ephedra* at the Wheeler Site. This is well illustrated by the frequency variations illustrated for "economic" pollen types in Hevly's Figure 17. The series of pollen spectra collected from floors of storage rooms at Broken K Pueblo all show significant quantities of maize and beeweed pollen which are undoubted cultural contaminants (See Martin and Sharrock 1964). Yet the frequency values vary widely from sample to sample. Maize values range from 7.0 to 32.5 per cent in the eleven samples; *Cleome* values range from 0.5 to 25.0 per cent. Indeed one would expect that pollen types introduced by man into sediments would vary in frequency from sample to sample. Being microscopic, the pollen would be culturally handled in quite differing volumes if it was handled at all. The pollen-bearing plants would not be expected to be culturally handled in any fashion which would allow repeated introduction of similar volumes of pollen to any type of sedimentary context. In addition, the culture history of any specific sedimentary context at an archaeological site may be expected to be somewhat distinct from that of any other such context. Thus, the systematic retrieval of approximately the same volume of pollen of any type introduced by man to various sediments seems highly unlikely.

The high frequencies of *Ephedra* pollen in the Wheeler Site samples are thus unlike similar high *Ephedra* values which have been interpreted as due to cultural contamination. They are also unlike high values of other pollen types which are undoubted cultural contaminants. Beyond this, there is little likelihood that consistent frequencies of any pollen type would be due to a cultural practice because of the varying cultural histories of the different sedimentary contexts from which pollen is extracted at archaeological sites. The most reasonable interpretation of the *Ephedra* values in these samples is hat they accurately reflect conditions of natural vegetation occurring at the site during the period of occupation. Judging by the rare surface samples collected under dense stands of *Ephedra*, it would appear that the plant was unusually common at the site.

Unfortunately, the known ecology of *Ephedra* is of little value for reconstruction of moisture conditions at the Wheeler Site during occupation. The genus presently occurs at many elevational positions in the Southwest, in association with such desert plants as creosote bush in such steppe plants as sagebrush. The morphological variety of *Ephedra* pollen observed indicates the probability that *Ephedra trifurca* or *E. torreyana* is the species involved. These species have an ecological tolerance almost as wide as that of the genus in New Mexico (Benson and Darrow 1954), though they tend to be more prevalent on shallow stony soils or on sand dunes. Stony and sandy soils effectively trap moisture from rains which do not penetrate deep soils. Since the sediment in the site area is that of a gravel ridge with a thin soil mantle, one might conclude that the *Ephedra*, which very likely occurred at the site in some density, indicates the occurrence of an interval sufficiently moist for *Ephedra* but not wet enough to support a stand of juniper. Such an interpretation may be supportable, but I think it likely to be an over-interpretation of the available data. One wonders why, is such reconstructed conditions of moisture were true; more trees were not growing at the locality. If trees were suppressed by human action, one may wonder to what extent other ecological balances were affected. Perhaps the *Ephedra*, though growing naturally, achieved its ecological position through many types of human interference and thus, after all, is an artifact which does not reveal the true state of environmental conditions.

I do not feel that the pollen spectra from the Wheeler Site can be trusted as an index for the reconstruction of environmental conditions. The AP frequencies appear to indicate the early presence of a savannah and the later presence of a tree-less vegetation pattern. These frequencies, however, must be recognized as a partial statistical function of the *Ephedra* pollen values which cannot yet be interpreted. There is also some possibility that the reduction in tree density is culturally controlled. The occurrence of unusual quantities of *Ephedra* in the local vegetation during occupation seems evidenced, but the reason for this is unclear as yet. About all that can be presently said is that the vegetation at the site during occupation was significantly different from that occurring today. It was composed of the same floristic elements that now occur in the Galisteo Basin, so no major climatic change can be reasonably postulated, but we know very little about how those elements were distributed upon the landscape or what distinctive plant associations may have occurred. In light of this no reconstruction of moisture conditions can be confidently proposed.

In the light of a lack of environmental reconstruction, comparative analysis with palynological records from other sites becomes quite difficult. There are many other localities where AP values have been observed which are similar to those at the Wheeler Site, but none where similar *Ephedra* values are recorded. Since the AP frequency is a percentage value partially controlled by the frequency of *Ephedra* pollen in the sample, direct comparison of Wheeler Site AP values with those from other sites seems unsupportable. Comparison is made possible, of course, by virtue of the fact that the Wheeler Site is well-dated in absolute time. The occurrence of two "r" tree-ring dates indicates that the site's kiva (from which no pollen spectra were recovered) was constructed about AD 1386. As the site is believed to have been occupied only for a short time, the pollen spectra must date between AD 1375 and 1425.

Pollen spectra dated to this horizon at sites in eastern Arizona (Hevly 1964), at the site of Sapawe (Schoenwetter 1965b), and at the site of Picuris (Schoenwetter 1965c) all yield higher AP values than surface samples from those sites. Pollen spectra dated to this horizon from sites in the Cochiti area (Schoenwetter 1964) contain AP values like those at the Wheeler Site, but are associated with unusually high frequencies of *Artemisia* pollen or contain unusually high amounts of cf. ponderosa pine pollen. They thus indicate moister or cooler conditions of environment than occur at present: the Wheeler Site samples offer no corroboratory indications of such an environmental condition, though they offer no contradictory evidence.

<u>The Signal Site, LA 9142</u> (Fig. 5)

Two samples were processed from the occupational horizon of the Historic Period site. The floor sample was collected from Room 2; the other sample was collected 10 cm above the floor in the fill of this room. Judging by the debris associated with the fill, both samples appear to have been deposited on the same temporal horizon.

As has been previously noted, the surface samples from this site appear to illustrate the effects of local sediment disturbance. The AP value seems too great by a factor of 30-40%, judging by other available data. The AP values recorded by the fossil pollen spectra, however, lie within the range of those expected for this presently tree-less site: below 35.0%. The relatively low *Artemisia* and *Ephedra* values in the fossil pollen spectra allow additional evidence for interpretation of a pre-existing environment much like that expected for a similar, but undisturbed, site today.

This interpretation is somewhat modified by recognition of the higher proportion of pine to juniper pollen in the more ancient samples relative to surface samples from the Basin. This could indicate a somewhat moister environment than presently occurs. Alternatively, a grain of *Juglans* pollen was recovered from one of the fossil samples. If this is not a cultural contaminant, it would indicate a northward extension of range for *Juglans* and hence the existence of a somewhat drier environment than now occurs. In effect, the results of this analysis are somewhat contradictory. The best interpretation possible, however, is that environmental conditions evidenced for this episode of Historic time were approximately those observed today.

Pollen spectra covering the AD 1550 to 1800 period are known from the site of Picuris. Those records indicate that, except for a period of drought in the 1550-1600 period, and a short period of relatively high moisture between 1625 and 1650, environmental conditions like those of the present generally prevailed. This palynological interpretation is fully supported by paleoclimatic reconstructions offered on the basis of tree-ring data (Fritts 1965). By correlation, the pollen spectra from the Signal Site would be expected to date AD 1600-1625 or anytime between 1650 and 1800.

The palynological interpretation of absolute age of the Signal Site is, unfortunately, of little aid in determining the true date of occupation. Ceramic evidence indicates the site to have been occupied in the late seventeenth or early eighteenth century. The palynological estimate of age is not in conflict with the ceramic evidence, but does not allow any further refinement in dating.

Conclusions

The first objective of this study was to determine if the pollen analytic design developed for purposes of cross-dating in northern New Mexico could be applied further to the south. Cross-dating is accomplished through recognition of similar conditions of environment at sites considered to be equivalent in age. As surface samples from similar environments in the Galisteo Basin and the Colorado Plateau appear comparable, it was though that subsurface pollen spectra would be similarly comparable.

Fossil pollen spectra from the Waldo Site (LA 9147) do appear comparable to those from more northerly sites known to be of the same age. Spectra from the Signal Site (LA 9142) also seem to indicate environment conditions similar to those represented by more northerly pollen spectra of comparable age. Pollen spectra from the Wheeler Site (LA 6869), however, are not comparable to others of the same age at sites on the Colorado Plateau. There is some prospect that the lack of similarity is due to some natural or cultural condition specific to the Wheeler Site occupation, but this cannot be demonstrated from available data. Also, there is a curious resemblance in AP frequency between samples from the Wheeler Site and those of comparable age from the Cochiti area. This resemblance could indicate that temporally equivalent localities in central New Mexico might yield pollen records more comparable with each other than with spectra of the same period from more northerly locales. The pollen records from the La Bolsa Site (LA 356) offer an interpretation of environment at ca. AD 1625 which conflicts with other palynological and dendroclimatic data. Those associated with Archaic cultural materials are not sufficiently well dated to allow evaluation of the comparability with other Archaic Horizon poll records. In any case, these Archaic spectra agree with some pollen records similarly dated by radiocarbon and disagree with others so dated.

It would thus appear that, despite the similarity in surface pollen spectra, ancient palynological records from the Galisteo Basin do not allow cross-dating with those of sites on the Colorado Plateau. There are horizons on which cross-dating appears possible, but the bulk of evidence would indicate that these are fortuitous cases. Certainly, reliable cross-dating cannot be said to be suggested as a general probability by the data of this research.

The latter possibility is a very real one. The analytic design used in this study was developed from a comprehension of the palynological character of surface samples collected on the Colorado Plateau. The Colorado Plateau presently is classified as having a BSk climate, while the Galisteo Basin and the Cochiti areas are classified as having BSw climate (Trewartha 1954). The fact that the pollen sum used has been empirically established as valid for purposes of cross-dating in the one area does not necessarily vindicate its use in the other. Perhaps a distinctive pollen sum, or some other analytic design, is needed to illustrate palynological reflections of moisture conditions in the present BSw climatic zone.

The available data, however, would indicate that the analytic design employed here does not account for the failure of the sites to cross-date. Though the surface sample data is limited, it agrees quite well with the surface samples collected in comparable vegetative environments to the north. Sub-surface pollen spectra of known age in the Cochiti area agree in AP frequency (the point of this analytic design) with those of similar age from the Galisteo Basin in the two cases where comparison is possible. Also, the samples from the Waldo and Signal Sites do cross-date with pollen records of comparable age from the Colorado Plateau. It seems improbable that this would occur if the analytic design was not adequate to assign similar conditions of environment to these horizons. It would thus appear that the analytic design properly fulfills its function in both climatic zones: it allows identification of an AP frequency with indicates the density of arboreal vegetation at the locality and thus allows interpretation of the relative status of available moisture.

I feel the more probable cause for the failure of the sites to cross-date lies in the prospect that environmental conditions in the Galisteo Basin at certain periods actually were distinct from those occurring on the Colorado Plateau at the same time. In the case of the Historic Horizon at the La Bolsa Site, a period of relative drought seems to have occurred in the Galisteo Basin when no drought occurred to the north (ca. AD 1625). In the case of the AD 1386 period, sites to the north seem to have enjoyed relatively wet conditions, while Cochiti area sites were only existing under cooler conditions and Galisteo Basin sites were occupied under conditions which were distinct from those of the present and conducive to growth of *Ephedra*, but not more specifically characterizable. On the AD 1275-1315 horizon, however, similar drought conditions prevailed in the Galisteo Basin, the Cochiti area and on the Colorado Plateau. In the latter part of the seventeenth and the early part of the eighteenth centuries conditions similar to those observed today occurred in the northern Rio Grande area at Picuris and also further south in the Galisteo Basin.

Development of the environmental reconstructions at the Galisteo Basin sites has required the assumption that they can be based on the analytic design. Granting this, it must be recognized that the present conditions of vegetation and environment occurring at the La Bolsa, Waldo and Wheeler Sites are <u>not</u> similar to those occurring at the time of occupation. The La Bolsa and Waldo sites were occupied which less arboreal vegetation was present. Probably as a response to a drier environment. The Wheeler Site was also occupied during a period when fewer trees were present, though the cause of this distinction in vegetation pattern is not clear.

There is little reason to assume that the types of plants and animals now present in the Galisteo Basin differ from those once exploited by aboriginal and Spanish-Mexican inhabitants. A probable exception to this generality is the walnut tree, which seems to have lived in the area from at least AD 1`275 to 1700. Another exception is the Tamarisk tree, which is a recent introduction. Though hickory pollen has been recovered, the plant may not have been a native member of the flora during aboriginal or historic episodes of occupation. However, it seems not unlikely that the nature and distributions of plant associations in the Galisteo Basin are now distinct relative to earlier horizons. During drought periods, arboreal vegetation would have had a somewhat different distribution than now occurs – probably more limited to the Ortiz foothills and the rocky outcrops of the La Bajada scarp. During the period around AD 1386, the distribution of *Ephedra* was certainly distinct from that seen in the area today. In light of the reconstruction of wetter conditions on this time horizon north of the Galisteo Basin at Picuris, and cooler conditions to the south at Cochiti, the occurrence of Douglas fir and ponderosa pine beams in the Wheeler Site kiva may be more explicable. Such trees may have been lumbered from relatively low elevations in the Ortiz Mountains or from the La Bajada scarp at that date.

APPENDIX I

This table records the number of pollen grains of each type observed in the analysis of the Galisteo Basin samples. The letter N in the center of the table identifies the sum of all pollen to the left. This is the adjusted pollen sum upon which percentage calculations are based for that sample.

REFERENCES CITED

Benson, L. and R.A. Darrow

1954 The Trees and Shrubs of the Southwestern Desertsa University of xNew Arizona Press, Tucson, and the University of New Mexico Press, Albuquerque.

Bohrer, V.L.

1966 Pollen Analysis of the Hay Hollow Site East of Snowflake, Arizona. Geochronology Laboratories Interim Research Report No. 12. Multilithed. University of Arizona, Tucson.

Elmore, F.H.

1944 Ethnobotany of the Navajo. University of New Mexico Bulletin, Monograph Series Vol. 1, No. 7, Albuquerque.

Fritts, H.C.

1965 Tree-ring Evidence for Climatic Changes in Western North America. Monthly Weather Review Vol. 93, pp. 421-443.

Hack, J.T.

1942 The Changing Physical Environment of the Hopi Indians of Arizona. Papers of the Peabody Museum of American Archaeology and Anthropology Vol. 35, pp. 1-87, Cambridge.

Hafsten, U.

1961 Pleistocene Development of Vegetation and Climate as Evidenced by Pollen Analysis. in Wendorf, F. (assembler), Contributions to the Study of Late Pleistocene Environments of the Southern High Plains. Museum of New Mexico Press, Santa Fe.

Hevly, R.H.H.

1964 Pollen Analysis of Quaternary Archaeological and Lacustrine Sediments From the Colorado Plateau. PhD Dissertation, Department of Botany, University of Arizona, Tucson.

Martin, P.S.

1963 The Last 10,000 Years: A Fossil Pollen Record of the American Southwest. University of Arizona Press, Tucson.

Martin, P.S. and F.W. Sharrock

1964 Pollen analysis of Prehistoric Human Feces: a New Approach to Ethnobotany. American Antiquity Vol. 30, pp. 168-180.

Schoenwetter, James

1962 Pollen Analysis of Eighteen Archaeological Sites in Arizona and New Mexico. in Paul S. Martin et al., Chapters in the Prehistory of Eastern Arizona, I. Fieldiana: Anthropology, Vol. 53, pp. 168-209. Chicago Natural History Museum, Chicago.

1964 Pollen Analysis of Cochiti Project Materials: Preliminary Report. Report submitted to Charles H. Lange, Department of Anthropology, Southern Illinois University, Carbondale.

1965a Preliminary Palynological Investigations on the Archaic Horizon.

Report submitted to C. Irwin-Williams, Department of Anthropology, Eastern New Mexico University, Portales.

1965b Pollen Studies at the Sapawe Site: Preliminary Report. Report submitted to F.H. Ellis, Department of Anthropology, University of New Mexico, Albuquerque.

1965c Pollen Studies at Picuris Pueblo: Preliminary Report. Report submitted to H. Dick, Department of Anthropology, Adams State College, Alamosa.

1966 Pollen Chronology of the Last 2,000 Years in the American Southwest. Paper delivered at the Second International Congress of Palynology, Utrecht.

1967 Pollen Survey of the Chuska Valley. in A. H. Harris, J. Schoenwetter, and A.H. Warren, An Archaeological Survey of the Chuska Valley and the Chaco Plateau, New Mexico: Part I, Natural Science Studies. Museum of New Mexico Research Records No. 4, Santa Fe.

Schoenwetter, J. and F.W. Eddy
1964 Alluvial and Palynological Reconstruction, Navajo Reservoir District. Museum of New Mexico Papers in Anthropology, No. 13, Santa Fe.

Schulman, E.
1956 Dendroclimatic Changes in Semi-arid America. University of Arizona Press, Tucson.

Trewartha, G.T.
1954 An Introduction to Climate. McGraw-Hill Book Co. New York.

Vines, R.A.
1960 Trees, Shrubs, and Woody Vines of the Southwest. University of Texas Press, Austin.