Report to: Rex E. Gerald Date: September, 1965

From: J. Schoenwetter

Title: Pollen Studies at Reeve Ruin and the Davis Ranch Site: Preliminary Report

INTRODUCTION

A series of 58 sediment samples were submitted to the Museum of New Mexico for pollen analysis in late July of 1965. Work throughout the month of August resulted in the laboratory extraction of pollen from all samples, palynological analysis of 25 of them, and the writing of this report. A priority system, devised by Mr. Gerald, was utilized to determine which samples would be analyzed and in what order. All of the first priority samples were analyzed, and a few second priority samples from the Davis Ranch Site. Two of the first priority samples did not yield sufficient pollen for analysis.

Pollen analysis is essentially a statistical technique. The raw data of a pollen study is only twofold: the types of pollen recognized and the number of each type observed. Interpretations of the meaning of these data revolve in large part about the analyst's recognition of meaningful ways in which the statistics of pollen variation through time can be related to problems at hand. There were two particular problems which this study was designed to resolve. First, the problem of obtaining palynological horizon markers by which the Reeve Phase could be broken into smaller time units for correlations of specific rooms between the two sites. Second, the problem of obtaining pollen spectra indicative of the environmental conditions during the Reeve Phase relevant to the reconstruction of agricultural patterns.

The use of the pollen analytic technique in southeastern Arizona is not new. Martin (1963) and Mehringer and Haynes (1965) have done extensive research in this region--indeed have worked in the same valley in which these sites are located. However, all previous work has been undertaken on alluvial sedimentary profiles and on problems relating to millenia-long time units. The work undertaken here, with sediments of cultural context and an entire time unit of less than three centuries, can be considered pioneering research. As such it is open to much error, both in the pollen analyst's problems of judgement and by virtue of a lack of comparative data. This report should be recognized in that light.

CONTROLS

All paleoecological inquiry proceeds on the basis of the principle of uniformity, and it is imperative that modern ecological controls be utilized as standards to which the paleoecological record can be compared. It must be recognized at the outset that the modern ecological controls of this study were far from adequate.

One cannot surmise, with any accuracy, what the pollen statistics of any given vegetation pattern is likely to be. One can anticipate, in a rough way, what pollen taxa can be expected in a vegetation pattern on the basis of one's knowledge of which taxa are anemophilous and entimophilous, but this is only educated guessing. There is no substitute for empirical, objective, control samples of modern pollen rain under conditions of different vegetation.

Modern surface samples were collected on this project, but only from the area of the two sites themselves. In effect, then, we have surface samples which illustrate the modern pollen rain 30 feet above the floodplain at Davis Ranch and something over 100 feet above the floodplain at Reeve Ruin. We have no adequate botanical analysis of how these two stations differ in vegetation patterns today, if indeed they do at all, and no samples of pollen rain from other plant communities in the region. That we must, perforce, do our best with what we have is no reason for complaint. It may, however, explain such errors as have crept into the interpretations of the data.

The recent work of Hevly, Mehringer and Yohum (1965) was at first considered to have been adequate compensation for the lack of control pollen statistics. This seems, however, not to be the case. The pollen data these authors recovered is applicable to a region of pure Sonoran desert scrub and desert grassland. The lower San Pedro Valley is one of mixed Chihuahuan and Sonoran desert scrub and desert grassland. Thus the surface sample data of Hevly, et al cannot be a priori presumed applicable as controls in this region. It is also clear that the pollen statistics of Hevly, et al and those from the surface and subsurface at Reeve Ruins and the Davis Ranch site have little in common. The latter have too little Celtis, Simmondsia, Eriogonum, or Cereus-type pollen to be likely to be representative of the same ecology.

But their report, and that of Mehringer and Haynes (1965) did illustrate one vital condition. In southern and southwestern Arizona, the pollen taxon Chenopodiaceae (or Chero-ams) and the various pollen taxa of the Compositae make up a very great proportion of the pollen spectrum. So great a proportion that, on an absolute frequency basis, few other taxa ever reach levels of statistical significance in their variations from sample to sample. It was

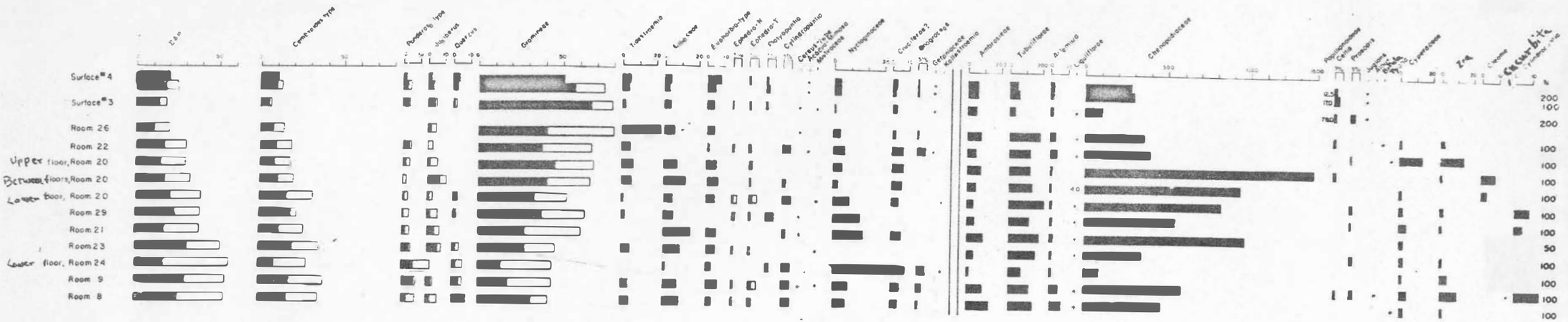

Figure 1

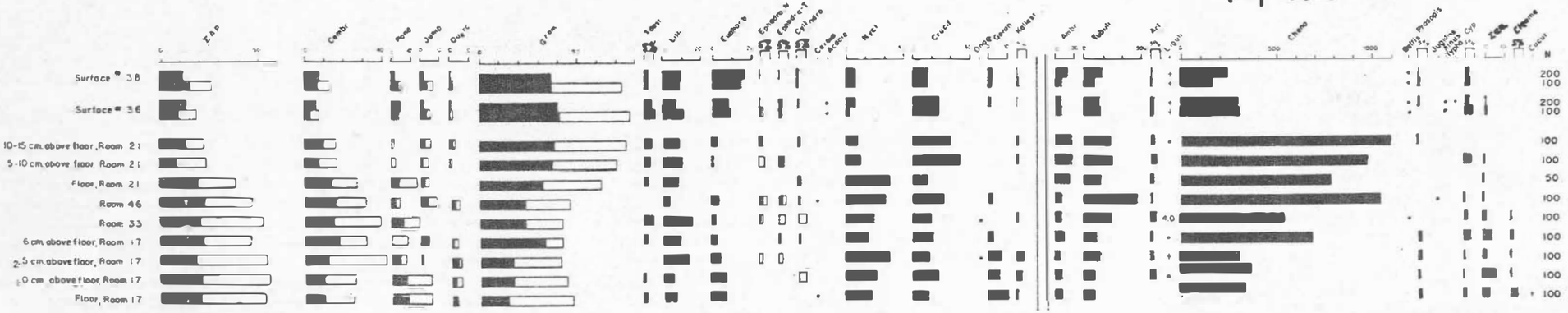

Figure 2

decided judicious to eliminate all Chenopodiaceae and Compositae pollen from the pollen sum, since they allowed little data of ecological value and obscured the more vital indicators. I also eliminated all riparian taxa and all economic taxa from the pollen sum for the same reasons.

THE POLLEN DIAGRAMS

Three separate statistical procedures were undertaken in the analysis of the samples from these sites. All operations are shown concurrently on the pollen diagrams (Figs. 1 and 2). Adequate understanding of those diagrams cannot proceed without comprehension of the things the diagrams purport to show.

First, the diagrams show two kinds of percentages. To the left of the vertical double bar on each diagram are the taxa included in the pollen sum. On the right are the taxa excluded. At the far right (N) is the size of the pollen sum. The pollen sum is the number on which the frequencies are based. If the black bar shows 20% Nyctaginaceae pollen, it means that there were 20 grains of this type observed in obtaining the 100-grain sum. But the taxa to the right of the double bar were not included in the pollen sum. One could thus have 350% Chenopodiaceae pollen, illustrating that 350 Chenopodiaceae grains were observed in obtaining the 100-grain pollen sum.

Second, the diagrams show the correspondence between the use of 200-grain pollen sums and 100-grain pollen sums. In the case of these surface samples (Numbers 38 and 36 on Figure 2 and Number 4 on Figure 1) both sizes of pollen sum were used, the close similarity in the statistics resulting from either 100 or 200-grain sums convinced me that 100-grain pollen sums were adequate for the fossil pollen samples.

Third, a refined pollen sum which incorporated only certain taxa was also employed. The frequencies resulting are shown as white bars. The frequencies resulting from the regular pollen sum are shown as black bars. The functions of the regular pollen sum and the refined sum are discussed below.

Two symbols, a dot and a cross, are used on the diagrams. A dot indicates 1% or less pollen of this taxon, a cross indicates 2-3% of this taxon. The spectra are placed on the diagrams in relative time order. This order was determined on three bases. If wall bondings illustrated the relative order in which the rooms were constructed this was followed. Where internal stratigraphy (i.e., upper floor-lower floor) was available, this was followed. If neither internal stratigraphy nor wall bondings gave clear understanding of relative age, similarity in pollen spectrum was utilized. This was only necessary in the case of Room 29 (Fig. 1) and Room 46 (Fig. 2).

The ΣAP taxon of the diagram shows the accumulated frequency of all Pinus, Juniperus and Quercus pollen, i.e., the Arborbeal Pollen types included in the pollen sum. Pinus pollen types have been shown to be of two sizes in Southwestern species (Martin, 1963, p. 20) and on this basis a Cembroides-type of pine pollen (nut pines) has been differentiated from a Ponderosa-type of pine pollen. Pinus cembroides and Pinus ponderosa are not necessarily the species recovered. Ephedra pollen is similarly div sible into two type catagories. Ephedra-N refers to Ephedra pollen similar to that of Ephedra nevadensis; Ephedra-T refers to pollen similar to that of Ephedra-torreyana. See Martin (1963 pp. 50-51) for a discussion of the ecological meaning of these and other pollen types recovered.

The taxon Cruciferae (?) of the pollen diagrams is an approximation. Without available reference material I was unable to be assured of this identification, but it seems most probable that this small, reticulate, tricolpate or tricolporate pollen type is of the mustard group.

The taxon Papillionoideae refers to a pollen type found only in the surface samples from Reeve Ruin. It is very apparently overrepresented in the pollen record and has been excluded from the pollen sum. It seems to be some unknown legume, perhaps a low-growing annual of this large group such as loco weed. It is not bean pollen.

The taxon Cylindropuntia is shown both within and without the pollen sum. Cylindropuntia (cholla) pollen is quite commonly found in trash middens and other cultural contexts in quantity, but is rare in surface pollen samples. Since the surface samples from Davis Ranch co ain some Cylindropuntia pollen it is apparent that not all such pollen is in the record as an economic plant. I have accepte up to 5% Cylindropuntia pollen in the record as possibly due to non-human factors (a very generous estimate). Beyond this amount, all Cylindropuntia pollen has been relegated to the category of economic flora.

HORIZON MARKERS

Both the Davis Ranch Site and Reeve Ruin are known to date in part from the same cultural horizon. All the subsurface pollen samples submitted are of the Reeve Phase. While relative dating below the phase level can be accomplished within each site on the basis of internal stratigraphy, there has been no way to cross-date units of the two sites on smaller time horizons since the artifactual data is insufficient evidence in itself. Pollen spectra from the sites can be placed in relative order on the basis of the internal stratigraphy of each site. Then the spectra can be used as horizon markers, or index fossils as the paleontologist might consider them, to allow cross-dating of small units between the sites. This was the function of the regular analysis shown as black bars on the pollen diagrams.

The earliest samples at Reeve Ruin can be recognized as distinct from the later ones on the basis of higher ΣAP frequencies and lower Gramineae frequencies. Nyctaginaceae frequencies above 7% are found in 5 out of 6 of earlier rooms, but in none of the later ones. Chenopodiaceae values of 450% or better occur in the earliest samples, and in the samples from Rooms 21, 29 and 20, but not in other samples. Using the Reeve Ruin sequence, then we can integrate these data to determine five horizons within the Reeve Phase. From youngest to oldest these are:

	Horizon I	Horizon II	Horizon III	Horizon IV	Horizon V
ΣAP	11-18%	11-18%	18-26%	17-32%	27-31%
Gramineae	37-42%	41-46%	28-38%	19-33%	18-32%
Nyctaginaceae	< 7%	< 7%	> 7%	> 7%	>7%
Chenopodiaceae	< 450%	> 450%	> 450%	< 450%	> 450%
	Rooms 22, 22	Upper Samples Room 20	Rooms 20, 21, 29	Room 24	Rooms 8, 9

Turning to the data from the Davis Ranch Site, it is seen that the two youngest samples cannot be as young as those of Horizon I at Reeve Ruin since they contain too much Chenopodiaceae pollen. Yet they also contain too little AP pollen to be as old as the samples of Horizon II at Reeve Ruin. We can assign these above floor samples from Room 23 a relative date, then, between Horizons I and II at Reeve Ruin.

The samples from the floors of Rooms 21, 46 and 33, and that from 6 cm above the floor in Room 17 are all members of Horizon III as defined at Reeve Ruin. The remaining samples from Room 17 at the Davis Ranch Site are members of Horizon IV as defined at Reeve Ruin. No Horizon II samples or Horizon V samples were analyzed from the Davis Ranch Site.

There is one sample in the analyzed series which does not fit this scheme of horizons: that collected from the floor of Room 25 at Reeve Ruin. According to the wall bonding of this room it should be of approximately the same relative time horizon as Room 22, which adjoins it. But the pollen spectrum of the floor of this room contains too much AP pollen for inclusion with Rooms 22 and 26 on Horizon I, and at the same time it contains too little Nyctaginaceae pollen to be associated with Room 24 on Horizon IV. This sample was collected from under sherds on the floor of the room. Perhaps cultural activities in this room have affected the pollen record, incorporating more AP pollen into the floor sediments in some way.

Considering the wall bonding shown by DiPeso (1958, p. 52), one may wonder how the floor of Room 24 could be earlier in time than those of Rooms 23, 22, 21 and 20. The sample was collected from below the Room 24 floor excavated by DiPeso, and seems to represent a use surface established before Room 24 was constructed. One could also question the dating of the floor of Room 22 as younger than those of Rooms 20 and 21 which were evidently built at the same time. This is only an apparent problem. The rooms must date from the same approximate time. The sediments which entrapped pollen collected from the floors of those rooms were not necessarily laid down at the same time. The floor of Room 20 was described (DiPeso, 1958, p.65) as of bedrock with mud paving used to fill irregularities. The floors of Rooms 21 and 22 (op.cit., pp. 66,69) are described as bedrock covered with mud paving. It seems entirely possible that while the mud paving of Room 21 was laid down about the time of construction, the floors of Rooms 20 and 22 were not emplaced until later dates. The pollen content of floor samples seems most likely to be of an age somewhat later than floor construction, the pollen having been trampled in while the floor was in use.

ABSOLUTE DATING

Absolute dating cannot be secure in this region through pollen analysis except for large time units. Pollen cannot be recovered in association with tree-ring specimens or ceramic types which have good dendrochronological dates associated because these simply do not seem to be recoverable in the region. Pollen spectra taken in association with radiocarbon dates yield an absolute chronology of pollen horizons, but such horizons are millenia-long affairs rather than one-half to one century horizons most useful in the archaeological record of the past millenium. The only mechanism of absolute dating through the pollen record available, then, is that of correlation. In northern New Mexico and Arizona a pollen chronology has been developed (Schoenwetter and Eddy, 1964; Hevly, 1964; Schoenwetter MSa, MSb, MSc, and others) on the basis of paleoecological variations occuring through time. This northern chronology is well dated, since the pollen horizons of which it is composed were associated with treering specimens, radiocarbon specimens, and well-dated ceramic complexes. If similar variations can be observed at the Davis Ranch and Reeve Ruin sites, these variations can be correlated with those occuring to the north and thus be given the same absolute age.

The analysis which was used to recover horizon marker pollen spectra is not adequate for the reconstruction of paleoecological events. The kinds of pollen variation utilized to define horizons of relative time are not sufficient to inform us of the kinds of paleoecological variation which can be related to the northern chronology. The northern chronology is based upon movements of the lower border of the savanna and forest zones of Southwestern vegetation. At some times these borders are seen to retreat upwards

from their present elevational positions, at other times they are seen to expand downwards relative to their present positions. A different type of analysis was necessary to determine whether correlative phenomena occurred during the Reeve Phase in southeastern Arizona.

On the advice of Mr. Mehringer, a refined analysis was undertaken which considered only the frequency of the arboreal pollen types included in the regular pollen sum, the frequency of Gramineae, and the frequency of Ephedra. Mehringer has had far more experience than I in the analysis of pollen spectra from this region, and we together considered the following proposition: The dominant Anemophilous taxa of this area are Chenopodiaceae, Ambrosieae, Gramineae, SAP and Ephedra. Chenopodiaceae and Ambrosieae are known to be locally overrepresented under conditions of water table variation, so would not serve as an adequate index of ecological change. The remaining three pollen taxa can be expected to be ubiquitous in the area because they are of wind-pollinated groups. Variations in their frequency should be reliable indices of ecological change through time.

One would expect that if trees were actually closer to the site the frequency of AP would rise, as it would fall if the trees were distant. However, it is known that the proximity of an anemophilous pollen producer to the site is not the only reason for high frequencies of its pollen in the record. Martin (1964) showed that when there are few or no local anemophilous plants--as occurs on barren ground--then the frequency of the pollen of a distant anemophilous type can rise sharply since it has little competition for space in the pollen spectrum.

It was felt, then, that the AP/Gramineae ratio might be an unsure index of ecological variation, since there might be more AP if the trees were closer, or there might be more AP if the trees were farther away and the site supported little anemophilous vegetation. By including Ephedra frequencies, it was felt that the AP frequencies could be properly evaluated. Since most Ephedra species in this region are more adapted to the drier ecological conditions it was expected that high Ephedra frequencies would reveal the existence of dry conditions when they occurred in the chronology. Accordingly, I counted 100 grains of AP plus Gramineae plus Ephedra pollen from most of the pollen samples after the first analysis was completed. The resultant frequencies are shown on the diagrams as white extensions of the black bars.

Not all the samples contained enough pollen for these extra 100-grain counts. At Reeve Ruin the frequencies are based on a 32-grain count in the sample from Room 24, and a 23-grain count in the sample from Room 21. At the Davis Ranch Site the frequencies are based on a 26-grain count from the floor sample of Room 21, a 51-grain

count from the Room 46 sample, a 38-grain count from the 1 cm. above floor sample in Room 17, and a 40-grain count from the floor sample in Room 17.

The results of this analysis are best expressed on the diagrams by the successive decrease in ΣAP frequencies through time. There is no consistent series of samples wherein Ephedra values are particularly high, which indicates that the high ΣAP values of the older samples are most likely to be due to the fact that trees were closer to the sites at that time than they were when the youngest samples were laid down. Significantly high Ephedra values occur more frequently in the Davis Ranch series than in the Reeve Ruin series, but this is probably a reflection of the lower elevational position of the Davis Ranch Site.

The ΣAP values of samples from Horizon I at Reeve Ruin and the ΣAP values of samples younger than Horizon III at the Davis Ranch Site are not significantly greater than those of the modern surface samples. ΣAP values from Horizons IV and V, however, are significantly greater while Horizons II and III yield transitional values. It seems, then, that during Horizon I the sites were located about the same distance from the lower border of the savanna as they are now. We cannot, because of a lack of comparative surface sample data, determine how much closer to this border the sites were on the earlier horizons, though we can be assured that they were closer.

In the northern chronology there are a number of horizons on which the forest and savanna borders are observed to retreat up the elevational gradient from positions below those they hold today. DiPeso (1958) marshalled what evidence he could but could give no more secure dating of the Reeves Phase than between AD 1250 and AD 1550. Gerald (pers. comm.) accepts the more restricted period between AD 1300 and AD 1450 for the Reeve Phase, and DiPeso (op.cit., p. 145) intimates a tentative calendrical date for Reeve Ruin of the late 1400's or early 1500's.

Within the time-period AD 1250 to 1550 there are three periods when the savanna and forest borders appear to have been lower than they are now in northern New Mexico: about 1225-1240 (Schoenwetter, MSa), between 1375 and 1425, and again for a short period about 1490 (Schoenwetter, MSb, MSc). Considering DiPeso's admittedly tentative dating of Reeve Ruin, and Gerald's more recent opinion of the age of the Reeve Phase, it is unlikely that the paleoecological change observed at Reeve Ruin and the Davis Ranch Site between Horizons IV and II is correlative with the AD 1240-1275 forest withdrawal of the northern chronology. The AD 1490 border advance in the north was a short-term fluctuation which is only barely recognizable even in the northern chronology, and seems

unlikely to be reflected so far south. The most reasonable correlation seems to be with the major forest advance that occurred between 1375 and 1425 (Hevly, 1964; Schoenwetter, MSb, MSc) and the subsequent retreat. I would say, then, that Horizons V and IV date between 1375 and 1425, Horizons III and II date sometime between 1400 and 1450, and Horizon I is younger than 1450 but older than 1490.

CULTURAL ECOLOGY

Wringing cultural ecological information out of the pollen record is yet another problem distinct from those of relative and absolute chronology. Cultural ecology is notthe study of environment, but the study of relationships between man and environment. The information the pollen record yields about the environment existing at different periods in the occupation of the sites must be considered in its cultural context.

Economic Flora

Pollen of Zea, Cucurbita and Cylindropuntia are obvious indicators of plants utilized for food. Typha (cattail) and Cyperaceae (sedge) pollen are not such obvious economic plants. Hevly (1964) suspected that they were economic plants because it is rare that these pollen taxa are recovered far from the source plants. Since these aquatic pollen types could not have been growing in or near the rooms of dwellings, he felt that the presence of their pollen was an index of some economic activity. There are ethnographic and archaeological records of the use of aquatic plants for mats among the Navajos and Pueblcans. Use of floor mats made of cattails and sedges seems to be the culture trait represented by pollen of these types in floor and near floor sediments.

The presence of Cleome (Rocky Mountain beeweed) in the records was a complete surprise. This plant does not grow in southeastern Arizona today and should not occur as a natural element of any pollen flora containing Kallestroemia, Euphorbia-type and Nyctaginaceae pollen in quantity. Yet Cleome pollen is a common occurrence in cultural associations in the northern regions of higher elevation. It appears to have been intensively used after AD 1000 as a food source, a source of organic pigment, or both, and it today plays a prominent role in Pueblcan mythology. The occurrence of Cleome in the records also has a strange distribution. It is absent in samples of Horizon V age, occurs in all samples of Horizon IV age at Davis Ranch and in some of those of Horizon III at that site but from neither Horizon at the Reev Ruin, occurs in Horizon II at Reeve Ruin, and occurs at neither site during Horizon I.

Considering that the occupants of these sites must have had to travel some distance to obtain the beeswed which pollen was recovered from, I suggest that there might well be some connection between the occurrence of pollen of this type in a room and ceremonials undertaken using this exotic plant. It seems significant to me that at Reeve Ruin Cleome pollen is only found in Room 20--the only room which opens directly onto the ceremonial chamber at the site, Room 15. There is a large ceremonial chamber at the Davis Ranch Site, but I have not been informed of its spatial relationship to Rooms 17 and 33, which contain the Cleome pollen. I suggest that the Davis Ranch Site ceremonial chamber was probably exclusively used in the region before Horison III of the Reeve Phase, but was later abandoned or utilized only sporadically as other sites invested in ceremonialism to a greater degree independantly. While outrageously speculative, this hypothesis offers intriguing prospects for a study of the dynamics of prehistoric southwestern ceremonialism, which can be tested independently by analysis of artifactual data. Strength would be lent to the hypothesis, for example, if it could be determined that the underground ceremonial chamber at the Davis Ranch Site was abandoned before the end of the Reeve Phase.

Other plants of the pollen record were no doubt utilized economically (mesquite, yucca, walnut, sugaro) but have not been segregated as economic plants because their pollen does not occur in sufficient frequency to indicate that they were extensively collected. They may well have been so collected, but there is no evidence from these records.

While scanning thousands of pollen grains from each sample to obtain 100-grain counts of AP, Gramineae and Ephedra only one more pollen taxon was recognized. One grain, much crushed and broken, of pollen was found which might be that of Gossypium (cotton). This identification has not yet been verified, and in any case would not necessarily indicate that cotton was being grown at or near the site.

Agricultural Potentials

The inhabitants of these sites were obviously committed to an economy based upon agriculture. The frequency of Zea pollen is not a reliable index to this since the corn pollen could become incorporated into the sediments in so many different ways that high or low values are meaningless. But the entirety of our understanding of Southwestern culture history leaves no doubt that these sites were occupied by people who had a subsistence base of maize agriculture even if, as occurred in modern times with the Pueblean peoples, only 30-40% of the yearly food intake was of domesticated forms.

We recognize that change occurred during the time that these sites were occupied which resulted in retreat of the forest and savanna borders away from the sites to roughly the positions held today. What caused this change? The most obvious cause is man himself.

The savanna could have been chopped down near the sites through time for firewood and construction material. But this does not seem reasonable when one considers the number of axes and other construction tools recovered. DiPeso specifically characterizes axes at Reeve Ruin as "not plentiful" (op.cit., p. 110) and he recognized no other rough woodworking tool. Also, this explanation of the reduction of arboreal coverage during occupation does not explain why the sites were closer to the savanna margin at one time than they are at present.

It seems quite reasonable, then, to invoke an explanation of environmental change (see Schoenwetter, 1962, pp. 191-194 for definition of terms) to account for the variation in the paleoecological record apparent in these samples.* What kind of environmental changes would have been necessary to bring trees closer to the site than they are now, sometime before occupation, and then cause them to retreat up the elevational gradient during occupation? The most obvious change in this semi-arid region would be one involving the variable of effective moisture, i.e., the entire complex of precipitation, evaporation, temperature and competition variables to which plants actually react. Effective moisture values in the Southwest seem basically to be related to two major aspects of precipitation: the total annual rainfall value, and the periodicity of the precipitation. Winter rainfall in the Southwest contributes more water to the roots of the plants than summer rainfall, because it is not imparted with such a great velocity to the surface and tends to sink in rather than run off as flash floods. A larger number of winter rainstorms would yield a higher effective moisture value even if the total annual rainfall received were unchanged. But the rainfall periodicity pattern could remain unchanged and higher effective moisture values could be engendered by more numerous storms, i.e., an increase in total annual precipitation.

So there are two conditions, or a combination of both, which might have brought trees down the elevational gradient (relative to present positions) before the occupation of the sites. Can we discover which cause was operative? Not from the pollen record itself in this instance. Martin (1963) has argued that the ratio of Chenopodiaceae to Compositae (Ambrosieae plus Tubuliflorae plus Liguliflorae plus Artemisia) pollen is an index to summer or winter rainfall dominance in southeastern Arizona, but his usage is restricted to floodplain environments and more recent surface sample work (Hevly, et.al., 1965; Mehringer, pers. comm.) indicates that even this usage may be insecure. The lack of surface samples from this region does not allow us to clearly define the roles of the pollen statistics of such winter rainfall dependent pollen types as

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* If such an explanation is rejected, incidentally, the correlation of these records with those of the northern chronology is invalidated and the absolute dates are not evidenced.

Onagraceae and Cruciferae in our prehistoric records, though their values do seem higher than one might expect under a summer rainfall regime. We can, however, turn to the geological index of past prior climatic conditions recorded in the alluvial sequence of the region.

Martin, Schoenwetter and Arms (1961) proposed that in the semi-arid lands periods of erosion of the alluvial sequence could be the result of a storm pattern dominated by summer rainfall, while periods of deposition might be related to a winter-dominant storm pattern. This argument was based on palynological evidence, but Schoenwetter and Eddy (1964) feel that there is hydrological evidence to support the same conclusion. If this hypothesis is accepted, then we should attempt to date the periods of alluvial deposition in the San Pedro Valley to discover when the occurrence of a winter-dominant storm pattern might have increased effective moisture values. Such alluvial research has not been accomplished, but along Whitewater Draw Sayles and Antevs (1941) dated the most recent period of deposition to the AD 1200-1800 range on the basis of contained artifacts. This would be correlative with deposition elsewhere in the Southwest (Bryan, 1950; Brayan, 1954; Reed, 1958; Hack, 1942; Cooley, 1962) of a similar age. I believe it wholly likely that during the entire period of occupation of the Davis Ranch Site and Reeve Ruin a winter-dominant rainfall pattern was in effect. The simple occurrence of such an environmental condition, however, did not guarantee a high enough effective moisture value to bring trees closer to the site than they are today. I suggest that there were still variations occurring in total annual rainfall receipts during this period--just as occur today--and that their influence be taken into account. It seems most reasonable to me that the retreat of trees from nearer the site to farther away during occupation was a function of a decrease in total annual precipitation, while the lowering of the tree line prior to occupation was a function of a change from a summer-dominant to a winter-dominant storm pattern.

Schoenwetter and Eddy (1964, pp. 119-122) discuss the relationship of effective moisture values to floodplain maize agriculture in some detail, and the point of view established for that northern area is applicable in the region under study. If the peoples occupying these sites were floodplain farmers, the agricultural potential of the San Pedro Valley would have been higher than it is today throughout the period of occupation whether irrigation was practised or not. The floodplain was probably undergoing aggradation rather than dissection, as at Whitewater Draw. This would have raised the water table along the floodplain to levels at which the crop roots could obtain the water they needed. If effective moisture values were sufficient to lower the elevational requirements of trees, they were probably sufficient to allow respectable yields of maize. Later, when effective moisture drought forced the trees to retreat to higher elevations, the germinationsrequirements of the maize could still have been met by the hydrology of the undissected floodplain. We know that the area was still inhabited and that maize was still being grown during Horizon I and later. Obviously, then, the drought was not sufficient to eliminate the crops, though the yield per acre would probably have undergone a relative decrease unless irrigation was practised.

Overview

Again, these reconstructions of environmental conditions and potentials must be taken in their cultural contexts to supply cultural ecological interpretations. One reads the cultural record of these sites as something like the following: at some point in time around the middle of the 11th century A.D. the Davis Ranch Site was occupied by a small population, apparently indigenous to the general region. During the Reeve Phase a migration occured into these sites of peoples whose culture patterns relate to the mountain regions and the Colorado Plateau. The population of the sites increased quickly during this period. At the end of Reeve Phase, apparently, Reeve Ruin was abandoned and the population of the Davis Ranch Site declined.

I think it can be assumed that human beings, like other animals, tend to have a rather specific relationship between population size and food supply. The small population of the Davis Ranch Site which seems to have continued for at least five, more probably ten, generations before the Reeve Phase, was probably limited by this factor. In effect, then, it is highly improbable that the peoples occupying the site during the Davis and Sosa phases were irrigation farmers. We know they were farmers; the presence of the permanent dwellings itself establishes that. But if their farming was undertaken through irrigation, a very highly effective and efficient technique in this region of long growing season, their population should have risen in response to the availability of food. I would suspect that they were floodwater farmers, relying on the placement of fields to trap flash floodwaters draining the surrounding hills during summer storms. This is an inefficient farming technique, compared to floodplain or irrigation farming, only slightly more advantageous than dry farming. Perhaps, however, it was all that could be undertaken. Going by the geological evidence at Whitewater Draw and elsewhere, the period just before AD 1200 saw floodplain dissection. This would have made floodplain farming unprofitable and would have acted to cut out the heads of irrigation canals if, indeed, these peoples ever attempted to use this farming method.

Then, just before Reeve Phase, environmental conditions changed. The floodplain began to aggrade and the crop potential of the area increased. This seems to have been a response to an increase in winter moisture receipts. The opportunity arose for the indigenous peoples to develop a surplus of food and support a greater population. But they were, quite literally, invaded.

The same increase in winter storms that made the lower San Pedro Valley more attractive to farmers must have made the mountain and plateau regions of the Southwest less satisfying. Those areas would now, except for locales with particularly favorable morphology, have experienced longer, colder winters and shorter growing seasons. Peoples had to abandon their homes as their crops declined, and these

were peoples--as at Mesa Verde or Chaco Canyon--who had large populations to support. The mountain and plateau peoples had to seek new lands or suffer an entire cultural collapse. The San Pedro Valley must have looked like Eden.

They invaded in sufficient numbers to occupy the Davis Ranch Site and remodel it to their own style, and to establish the defensive Reeve Ruin with its walls and strategic position. Apparently the indigenous occupants of the region, who were not entirely satisfied with the invaders, or perhaps the earliest intruders were securing themselves from the possible attacks of others on their heels. The intruders brought a sophisticated ceremonial complex with them, established it at the Davis Ranch Site, and even sojurned back into their native areas to bring such ceremonial equipment as the beeweed plant to their new quarters.

During this time floodplain farming was practised, in all probability. Effective moisture values were high enough that floodwater farming was generally ineffecient, and irrigation farming would not have increased the yield so substantially as to have made it worthwhile. Dry farmed plots and floodwater farmed plots probably occurred as an insurance against bad years, but the mainstay was most likely floodplain farming. Population size increased as the food surplus supported more children through critical years and as fertility remained at a high rate. At Reeve Ruin, one can see that the early inhabitants expected this, building a walled compound large enough to expand in for many generations.

The intrusion pumped a whole new set of cultural concepts into the area, but it was not all one way. The region was still a desert ecologically, with a flora of the different potentials for food, medicine and tool-making than the intruders were familiar with. No doubt indigenous patterns of resource exploitation were quickly adapted and amalgamated into the intruders' way of life, with attendant ceremonials.

Then came the years of decline. The Garden of Eden began to dry out and through Horizons III, II and I of Reeve Phase the crop potential dwindled with it. This seems not to have had any immediate effect. Apparently the population was not large enough to exploit all the crop potential of the region anyway, so population--as indicated by house-building--continued to expand until the end of Reeve Phase. But it was a one-way street. Population expansion and crop potential reduction seem to have met the inevitable impasse at the end of Reeve Phase. Now the people were stuck with a large population and an ever-dwindling food supply.

If they had had irrigation, they could have reached some balance with the food potentials of the district and maintained themselves indefinitely. But the record shows an abrupt population decrease at the end of Reeve Phase. Apparently most of the peoples

inhabiting these sites resorted to the same resolution of the population/food problem that their ancestors had some hundred years earlier: they moved to greener pastures. It seems that they did not have the technique of irrigation to support them, or if they did they moved to another site or sites where it would work more efficiently because of local topography.

Some people still lived at the Davis Ranch Site after Reeve Phase. Whether this population was a remnant of the intruders who refused to leave or a reoccupation by the natives is unknown to me, but should be evident in the artifacts. Whoever they were they had achieved a balance between their crop lands and their population size on the basis of floodplain farming, dry farming or floodwater farming or some combination. They had not the population to evidence, or even support, irrigation systems.

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