The Present Conditions

The east and west sides of the El Rito valley in the Sapawe area are physiographically distinct. A deeply incised bank of alluvium (The Recent Terrace) marks the valley's east side for the purposes of this discussion. Below the steep face of this terrace, sloping gently east toward the El Rito River, is a sandy and gravelly flood plain. Immediately west of the El Rito one encounters a series of cobble stringers mixed with sand and gravel. Continuing east, there is no Recent Terrace to speak of, though a slight ridge illustrates that one once occurred and has since been eroded almost level. The effective flood plain on the west side gradually slopes back to the foot of a Pleistocene (?) cobble terrace. The site of Sapawe is situated on this (first) terrace and extends from the eastern margin of the terrace across most of the terrace surface. A second terrace is located only a few yards west of the westernmost extension of the site.

The plant communities of the area are similarly diverse. The
top of the sheet washed Recent Terrace on the east side supports a sagebrush (*Artemisia*) community in which the plants are well spaced with plenty of barren ground between them. Progressing west from the foot of this terrace one encounters an area on the eastern flood plain where young salt cedar (*Tamarix*) trees have gained a precarious foothold on the oft-flooded sands. Near the stream these give way to willow (*Salix*) thickets. The permanent stream supports a series of algal communities, and grasses and sedges (the latter quite spotty) line its banks. Continuing west, the cobble bars are densely covered with *Salix* and, at their western margins, with cottonwoods (*Populus*). The low ridge to the west of the *Populus* community segregates it from a patchy much-grazed grassy region with a few compositaceous shrubs and an occasional *Populus* sapling. These "swales" probably represent areas where water stands in pools during the spring drought. A mixed growth of leguminous trees, compositaceous shrubs (including *Artemisia*), and dense grass with an occasional juniper occurs at the back of the western flood plain where it joins the slope of the cobble terrace.

The slope of the first terrace supports an interesting *Artemisia*-Cylindropuntia (sagebrush-cholla) complex, with an occasional young *Juniperus* (juniper) on its cobble substrate. The top of this terrace is the site area and is very much disturbed. The house mounds and kîva depressions of the site comprise an excellent habitat for
annual weeds, and an occasional *Artemisia* survives, but most of
the area is sheet-washed barren ground. On the western part of
the site a fairly dense *Artemisia* community is established, with
quite a bit of *Cylindropuntia* and an occasional young *Junciperus*.
The western margin of the first terrace, and the slope of second
terrace, supports a sparse juniper woodland, well mixed with
*Artemisia*, *Cylindropuntia* and some pinyon (*Pinus edulis*). On the
second terrace and above, this association grades into relatively
dense pinyon-juniper woodland.

The plant ecology of the Sapawe site area seems presently
controlled primarily by a combination of edaphic factors and avail-
able moisture. There is no reason to suspect that these two basic
controls were not operating in a similar manner during the occupa-
tion of the site.

The Surface Pollen Samples

A series of pollen samples was collected

- face in (1) the sparse juniper woodland at the base of the second
terrace,
- (2) the *Artemisia* community on the western margin of the
site,
- (3) the *Artemisia-Cylindropuntia* community on the slope of the
first terrace,
- (4) the mixed shrub and grass community at the back
of the floodplain,
- (5) the "swale" area of the floodplain, and
- (6) the *Salix* community. The palynological records are illustrated in Figure 1.

The sample of the willow community (6) is quite aberrant, show-
ing the riparian trees (*Salix* and *Populus*) as well as true fir (*Abies*),
spruce (Picea), and pinyon and ponderosa pine in quantity. The other samples, however, are quite illustrative of the niches from which they were collected. The frequency of arboreal pollen is dramatically reduced once the woodland is left behind, and as one descends the elevational gradient the sagebrush pollen frequency declines. On the floodplain the grass pollen frequency is significantly higher than in the upper vegetation zones.

From analysis of about 100 published and unpublished modern surface pollen spectra in Arizona and New Mexico (Schoenwetter, n.d.(a)) definite relationships have been shown to exist between the frequency of arboreal pollen and the density of the coverage of pinyon, juniper and oak at a locality. Consistent pollen statistics in this regard are obtainable through the technique of pollen sum adjustment in the manner described by Schoenwetter (Schoenwetter and Eddy, 1964, pp. 69-72), when those vegetation units are considered which occur in and below pinyon-juniper woodland on the elevational gradient. Arboreal pollen (AP) frequencies greater than 60.0 per cent are associated with pinyon-juniper woodland, AP frequencies of 50-60 per cent are associated with pinyon-juniper or juniper savanna, and AP frequencies less than 35 per cent are associated with treeless, or prairie, vegetation types. Frequencies between 35 and 50 per cent may be associated with either savanna or prairie conditions. As a matter of definition, savanna is considered as existing when trees, or clumps of trees, are scattered on the landscape at an average distance of 10 or more meters apart. Denser coverage is considered woodland.
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<th>Chamaecyparis</th>
<th>Ponderosa</th>
<th>Arizona Foothills</th>
<th>Sagebrush</th>
<th>Populus</th>
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Fig 1
Because of the poor distribution and preservation of *Salix* and *Populus* pollen in contrast to other species in this region, even densely wooded riparian vegetation conditions are not accurately reflected in the AP frequency — as is evidenced by sample 6 of the Sapawe surface series (Fig. 1). What the AP frequency really illustrates is the proximity of pine, juniper and oak trees to the sampled locality. From presently available data, however, it is impossible to completely justify utilizing the AP frequency of a sample of 200 pollen grains for very detailed vegetation analysis; that is, it cannot now be proclaimed with certainty than a sample with an AP frequency of 35.00 per cent is necessarily closer to a stand of pine, juniper, or oak than a sample with an AP frequency of 25.0 per cent. This problem seems to be one reflecting vagaries of sample size, differential pollen distribution, and differential pollen preservation among the various species. For the moment, at least, it is possible to recognize only the larger vegetation unit classes (woodland, savanna, and prairie) in the general Southwest region on the basis of pollen spectra.

But this does not mean that it is necessary to operate only on this level of analysis in particular small geographic areas. The surface pollen spectra from the Sapawe area well illustrate the proposition that the various vegetation units existing today in that place can be differentiated not only on the basis of the AP frequency, but also on the basis of the frequency of *Artemisia* and Gramineae pollen.
While the AP frequency will distinguish between the wooded and non-wooded parts of the site area, the *Artemisia* frequency can be used as an indicator of greater and lesser amounts of sagebrush and the Gramineae frequency can be used as an indicator of greater and lesser amounts of grass. When *Artemisia* is the dominant member of the floral association today it occurs in a frequency of greater than 25 per cent; when it is a subdominant it occurs in a frequency of 15 to 25 per cent. Gramineae pollen today occurs in frequency of 15 to 30 per cent when a dominant; 5 to 15 per cent when a subdominant; and less than 5 per cent when of less than subdominant importance.

While it must be granted that the basis for these conclusions is inconclusive (only six pollen samples being involved) the pattern of pollen-vegetation relationships expressed seems well evidenced from available data. It probably would be incorrect to infer that a Gramineae pollen frequency of 15 to 30 per cent necessarily should be interpreted as a floral association in which grass is the dominant member, but it at least seems reasonable to claim that such a Gramineae pollen frequency is very likely to be representative of a quite different floral association than one in which the Gramineae pollen frequency is less than 5 per cent.

As it serves our purposes to do so, I can see no reason why the principle of uniformity cannot be invoked as well for these more particularized pollen data from the Sapawe site area as for the pollen data gathered from general sources in the Southwest. In regard to the
AP frequency. Thus these surface samples can be utilized to illustrate the following relationships as occurring in the Sapawe region presently, and are henceforth assumed as having held true at the time of the occupation of the Sapawe site.

1) Woodland conditions are evidenced in the pollen record by AP frequencies of 60.0 per cent or greater.

2) Prairie (tree-less) conditions are evidenced by 35.0 per cent AP or less.

3) Artemisia pollen frequencies of 15.0 per cent or greater are illustrative of vegetation conditions distinct from those shown by pollen spectra containing less than 15.0 per cent Artemisia when AP frequencies are less than 60.0 per cent.

4) Gramineae pollen frequencies of 10.0 per cent or greater are illustrative of vegetation conditions distinct from those shown by pollen spectra containing less than 10.0 per cent Gramineae when AP frequencies are less than 60.0 per cent.

A fifth relationship, which I am rather arbitrarily assuming on the basis of my own evaluation of AP frequencies is:

5) AP frequencies between 40.0 and 60.0 per cent are illustrative of savanna conditions.

The Pollen Diagrams (Figs. 1-10)

Certain conventions have been used in the construction of these diagrams which should be explained. First, stratigraphic sequences.
AP frequency. Thus these surface samples can be utilized to illustrate the following relationships as occurring in the Sapawe region presently, and are henceforth assumed as having held true at the time of the occupation of the Sapawe site.

1) Woodland conditions are evidenced in the pollen record by AP frequencies of 60.0 per cent or greater.

2) Prairie (tree-less) conditions are evidenced by 35.0 per cent AP or less.

3) *Artemisia* pollen frequencies of 15.0 per cent or greater are illustrative of vegetation conditions distinct from those shown by pollen spectra containing less than 15.0 per cent *Artemisia* when AP frequencies are less than 60.0 per cent.

4) Gramineae pollen frequencies of 10.0 per cent or greater are illustrative of vegetation conditions distinct from those shown by pollen spectra containing less than 10.0 per cent Gramineae when AP frequencies are less than 60.0 per cent.

A fifth relationship, which I am rather arbitrarily assuming on the basis of my own evaluation of AP frequencies is:

5) AP frequencies between 40.0 and 60.0 per cent are illustrative of savanna conditions.

The Pollen Diagrams (Figs. 1-10)

Certain conventions have been used in the construction of these diagrams which should be explained. First, stratigraphic sequences
of respectable length have been illustrated as pollen profiles (Figs. 2-5) while other sample series have been illustrated as sets of pollen spectra. On the pollen profiles, sampling horizons which were investigated but failed to yield sufficient pollen for analysis are shown as horizontal lines. Second, the per cent calculations are based on an adjusted pollen sum equal to the number shown as N on the right hand side of the pollen spectrum involved; usually N=200. As this adjusted pollen sum excludes certain pollen taxa, not all of the pollen types shown for a spectrum were included in the usual 200-grain count. The number of grains of excluded pollen taxa observed was recorded, however, and the pollen statistics of the excluded taxa are also expressed as percentages of the pollen sum. These statistics are illustrated on the right side of the double bar of each pollen diagram. If the pollen sum of the included taxa was 200 grains, and the number of pine pollen grains was 65, the pine pollen frequency would be 32.5 per cent. There might also have been 65 grains of *Zea* pollen, an excluded taxon, observed and this would similarly be expressed on the diagram as 32.5 per cent. However, the total frequency of all included taxa must equal 100.0 per cent, while the total frequency of all excluded taxa may equal any positive number. Thus 450 grains of *Zea* might have been observed during the observation of 200 pollen grains of the included taxa. In such a case the *Zea* frequency would be 225 per cent.

It should be noted when observing the diagrams that each diagram is equipped with its own series of horizontal scales. The Compositae
pollen scale on one diagram is not necessarily equivalent to the Com-
positae pollen scale on another diagram, for example, and this must
be taken into account when evaluating the relative widths of the Com-
positae spectrum in different samples. Pollen statistics which are
consistently lower than 2.5 per cent on a given diagram are shown
as crosses.

The goal of the analysis of any particular sample was 200 grains
of the included taxa, but for some samples this could not be achieved
because insufficient pollen could be extracted from the sample or
because it would take an inordinate amount of time to observe so
large a number of pollen grains. Pollen frequencies based on counts
of less than 200 grains are statistically suspect; happily they do not
account for a large proportion of the analyses obtained. The amount
of pollen yielded by a sample may be an important consideration,
since the samples processed were all of about the same volume. A
sample which yields a low count seems most likely to illustrate a sit-
uation in which little pollen was entrapped in the accumulation of a
given volume of sediment. This situation probably occurs most fre-
quently when deposition proceeds so rapidly that very little absolute
time is represented in a given sediment sample.

The Relative Chronology

There are two methods by which a relative chronology of the
pollen samples collected in association with the artifactual materials
can be developed. The stratigraphic positioning of the pollen spectra
can be invoked as the dominant tool for developing such a chronology,
Feet below datum

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---

Fig. 4
SAVANNA

WOODLAND

SAVANNA

Prairieland

Kiva 3 floor

Kiva 3, floor

Room AA3

Room AA2

Room AA1

Room AA2

Room AA1

Room AW1

Room AW1

Room AW1

Room AW1
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**Fig 6**
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Fig. 7
Fig. 9
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**Fig 10**
and there are a reasonable number of instances of stratigraphic superposition in the pollen series. The series of samples collected in the area of Room GNI (Fig. 2), the series from the fills of Kivas 1 (Fig. 3) and 4 (Fig. 4), and instances of superimposed samples from Plazas B (Fig. 6), D (Fig. 8) and C (Fig. 10), all assist in this regard. The variations in artifact content of the sedimentary horizons with which the samples are associated can also be utilized as a chronological tool. Particularly in the case of associated ceramics, it is possible to recognize artifact differentiations which can be relatively dated by reference to the general stratigraphic situation at this site, and to known stratigraphic ordering at other sites. The ceramics also can be related to hypotheses of ceramic developmental sequences tested in the area through other excavations.

The ceramic complex which can be considered oldest at Sapawe (group I) is associated with the floors of rooms A91, BW2, EW2, CS2, CS4, and the subfloor horizon of room GN3 (of those sherd collections which are associated with pollen samples). Two of these spectra (CS2 and GN3) illustrate the presence of a prairie condition; the others evidence a savanna condition. While none of these particular spectra have a stratigraphic relationship to other pollen spectra analyzed, the occurrence of an ancient savanna condition is shown by the stratigraphic relationship of subfloor samples from the B and D plazas (Figs. 5 and 7). Subfloor samples at rooms BW9, BW6, BW1, BWII, DE14, and DE04 were collected from three inches to twelve inches below the floor and so are probably quite respectably old in the site's history. These all contain pollen spectra illustrative
of savanna conditions, and they also contain pollen of maize, beeweed, cacti and/or squash. It would thus seem that they verify the existence of an early savanna during the period of occupation at the site. Unfortunately, there were no sherds associated with these subfloor pollen samples.

The next oldest ceramics (groups 2 and 2-3) are associated with pollen spectra from the floor of room DE05, and the upper floor of room GN2. Both of these pollen spectra indicate the presence of woodland conditions. Other pollen spectra which illustrate the woodland condition (floors of AN4, A44, DE2, DE03, DE04, and the level 0 to 2 inches below plaza level at GN1) are associated with ceramics of group 3. The occurrence of a sample indicating woodland conditions (floor of DE04) superimposed on one illustrating savanna conditions (subfloor of DE04) constitutes additional proof of the earlier existence of a savanna and the later existence of a woodland at the site. It seems reasonable to assume that the sequence of events recorded in the samples is that of a movement of vegetation down the elevational gradient through time; thus the prairie condition associated with group 1 ceramics was earliest; the savanna condition associated with group 1 ceramics and observed in subfloor samples followed it; and the woodland condition associated with ceramics of groups 2, 2-3, and 3 came later in relative sequence.

As prairie and savanna vegetation patterns are also evidenced later in the Sapawe sequence, I am distinguishing members of the entire series by their relative order. Thus the most ancient vegetation condition is hereafter called the first prairie, and it is followed by the
first savanna and the woodland.

The stratigraphic superposition of samples at GNI (Fig. 2) clearly shows that above the woodland horizon there are a series of samples illustrative of savanna conditions. These samples cover the 2 inch to 8 inch levels above the plaza floor. Unfortunately, the sherd lots associated with these pollen samples lumped the 8 inch level with sherd from higher levels and the 2 to 4 inch level with sherd from lower levels, so no good ceramic dating is available for this part of the GNI series. Since the woodland pollen spectra are associated with ceramics of groups 2, 2-3, and 3, we might expect that there would be pollen spectra of this second savanna condition associated with sherd of groups 3, 3-4 and, possibly, 4. This is the case; savanna pollen spectra from the floors of rooms BW1, BW5, CS1, CS3 and DE0 are associated with group 3 ceramics, savanna pollen spectra from the floors of rooms BW9, BW10, BW14, and DE06 are associated with group 3-4 ceramics, and savanna pollen spectra from the floors of rooms AW1, A55, F21 and BW5 are associated with group 4 ceramics. But there is also an association [floor of room F69] of a savanna pollen spectrum with a group 5 ceramic complex. On the basis of this evidence it would appear that the second savanna condition followed the woodland condition and persisted until the end of the occupation at the site. This conclusion is not in accord with other stratigraphic pollen or ceramic-pollen association data at the site.

Stratigraphically above the second savanna horizon at GNI (Fig. 2), and at the base of the kiva profiles (Figs. 3 and 4), there are pollen
spectra indicative of the existence of a second prairie condition. On the floor of Kiva 1, and in the lowest sampled level at Kiva 4 (probably the floor), these spectra are associated with ceramics of group 4. Pollen spectra indicating prairie conditions are also associated with group 4 ceramics on the floors of rooms GN4, GW3, GW6 and GW04 and the prairie pollen spectrum of the upper floor of DE14--associated with group 4 ceramics--is superimposed on the savanna pollen spectrum of the lower floor of DE14. Pollen spectra indicating prairie conditions are also associated with group 3-4 ceramics on the floors of rooms A46, A52, DE3, DN1, GS2, and Kiva 3.

A group 5 ceramic association with pollen indicating a prairie condition is also recognized from the floor of room A33.

If a relative chronology of pollen horizons (based on stratigraphy) and a relative chronology of ceramic groups (based on stratigraphy and a reasonable hypothesis of cultural development) are both true, then there is some error in these dates. The second savanna horizon could not possibly span the period encompassed by ceramic groups 3, 3-4, 4 and 5 if it is entirely earlier than the second prairie horizon which spans the period encompassed by ceramic groups 3-4, 4 and 5.

It will be noted that in the uppermost sample (11' 10" above plaza) of the stratigraphic series from GN1 (Fig. 2) and in one sample (3' 6" below datum) high in the stratigraphic series from Kiva 4 (Fig. 4) there is evidence of a third savanna horizon. If the floor samples
associated with group 4 and 5 ceramics which illustrate savanna conditions are of this third savanna horizon, rather than of the second savanna horizon, the contradictions in relative chronology almost disappear. Then the second savanna horizon would be associated with ceramics of groups 3 and 3-4, the second prairie horizon with ceramics of groups 3-4, 4 and 5, and the third savanna horizon with ceramics of groups 4 and 5.

To determine if this was the case, all of the prairie condition pollen spectra associated with group 4 ceramics were considered as one unit, and all of the savanna condition pollen spectra associated with group 4 ceramics as a second unit, and the sherd tabulations of the two units were compared. The sherd lot from the floor of room GW5 was excluded from consideration, since this was definitely a trash-filled room and therefore the sherd sample could well date much later than the pollen sample.

The percentages of time-diagnostic sherd types from the two units were sufficiently divergent to indicate that the two units did not belong to the same time horizon. The unit associated with prairie pollen spectra contained 6 per cent Biscuit A, 60 per cent Biscuit B, 25 per cent Biscuit-Sankawe, 6 per cent Sankawe, 4 per cent Potsuwil', and 0.5 per cent glaze ware sherds. The unit associated with savanna pollen spectra contained 12 per cent Biscuit A, 43 per cent Biscuit B, 6 per cent Biscuit-Sankawe, 35 per cent Sankawe, 4 per cent Potsuwil', and 0.5 per cent glaze ware sherds. The far higher proportion of Sankawe sherds in the unit associated with
associated with group 4 and 5 ceramics which illustrate savanna conditions are of this third savanna horizon, rather than of the second savanna horizon, the contradictions in relative chronology almost disappear. Then the second savanna horizon would be associated with ceramics of groups 3 and 3-4, the second prairie horizon with ceramics of groups 3-4, 4 and 5, and the third savanna horizon with ceramics of groups 4 and 5.

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TABLE II

Sherd counts by levels at Kiva 4
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**TABLE III**

Sherd counts by levels at GNI

1. Woodland
2. 2nd Sav.
3. 2nd Prarie
4. 3rd Sav.
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**TABLE IV**

Sherd counts by levels at Kiva 1
specific pollen spectra to positions in the pollen chronology, nothing more.

The present prairie condition evidenced in the surface sample from the site area (Fig. 1), and apparently also represented in the uppermost sample from Kiva 4 (Fig. 4), might be considered a third prairie horizon. However, from analysis of pollen spectra associated with Navajo Period materials (Schoenwetter and Eddy, 1964), which should date later than the period of occupation at Sapawe, I am suspicious that a series of vegetation patterns might be missing if the third prairie is considered as following directly after the third savanna horizon.

Table 1 lists the sherd counts, the ceramic group placement, and the pollen horizon placement for the various samples so far discussed. Tables II, III and IV list the same type of data for the stratigraphic sequences of Kiva 4, Kiva I and GNI. It will be noted immediately that in these last three tables, the correspondence between ceramic groups and pollen horizons is not as apparent as in the room floor samples of Table I.

This is almost to be expected. While a room floor is a single cultural horizon, the fill of a room, a plaza area, or a major depression such as a collapsed kiva or pithouse could conceivably contain materials from almost a horizon encompassed by the period of occupation of the site. Old and young potsherds drift into such proveniences together by washing from the surrounding surfaces, and intentional and unintentional deposition by the inhabitants. A roughly older- to-younger sequence of cultural material may be expected in
such proveniences, but examples of reversed stratigraphy in cultural material are not uncommon and may also be considered normal. The pollen content of such proveniences, however, is controlled only by the rate and nature of the deposition. Except for the pollen reflecting economic activities of the inhabitants, the pollen drifts into the deposit uncontrolled by cultural action. Therefore, unless the deposit is disturbed, the sequence of pollen variation is the sequence occurring through time. Thus the pollen content of such proveniences is expectably a better index to their chronology than the artifact content in many cases.

There were three pollen spectra from room floors (BS3, DE2, DEO13) which illustrated prairie conditions but had no sherds associated with them. I have arbitrarily assigned these to the second prairie horizon, since this seems to be the time of major occupation at the site and it is more probable that they are that age than any other. There were also a number of pollen spectra from room floors (A37, BS4, DE7, GW1) which evidenced savanna conditions and had no sherds associated. I have arbitrarily assigned these to the second savanna horizon.

The Absolute Chronology

There are two methods by which absolute dates may be applied to the vegetation horizons of the relative chronology. On the one hand, the absolute dates recognized for the ceramics associated with the various pollen horizons; on the other, there are comparisons of the Sapawe pollen horizons with those recognized by pollen analysis.
at other sites and dated at those sites by ceramic associations or other means of dating. Both methods have their limitations. In the case of the first method, questions of cultural lag between the sites so far investigated might be raised. In the case of the second method, questions as to the relationship of the timing of vegetational changes in one area to the timing of similar changes in another area might be raised. In both cases, one might well question the sensitivity of the ceramic dating by association with dendrological specimens.

While it seems important to attempt to date the units of the Sapawe relative chronology as precisely as present evidence will allow, a word of caution should be interjected in order that the reader recognize the relationships generally being considered. In this regard by the author, I am as yet rather unconvinced that the precision of dating allowed by the evidence well reflects the accuracy of the dates involved. Precision is possible because of the association of precise tree-ring dates with ceramics of known types, but the life-spans of these ceramic types are not known with great accuracy and accurate dating relationships between a known ceramic type at one site and the same type at another is also a poorly investigated matter. In the past, archaeologists have been well content with fairly accurate dating on the order of one-half century for the time span of the last two millenia. There is some prospect that for certain periods and certain areas pollen-dating will allow much finer time divisions; perhaps on the order of five to ten years in specific cases, and twenty to thirty year periods in a number of cases. But since palynological horizons
can only be dated in absolute time through correlation with absolute
dating techniques, the pollen analyst is limited in his dating interpre-
tations by the limitations of the tools available for absolute dating. It
is my personal opinion that despite the precision of dating certain
ceramic types made possible by dendrochronology in the Southwest,
dates that are applicable to the pollen chronology by association with
dendrologically-dated ceramics still must be approached with a fair
measure of caution. I would advise the reader that in my own mind
any given absolute date is considered only as occurring somewhere
within the proper quarter-century. If a pollen horizon is dated at
A.D. 1380, then, I see the 1380 date as the most probable one
between 1375 and 1400.

There are three other palynological investigations with which this
one from Sapawe might be profitably compared. Hevly's (1964)
investigations in the Shumway area of Arizona contain spectra dated
only as sometime between A.D. 1300 and 1500. The pollen spectra
from excavations in the area of Cochiti pueblo (Schoenwetter, 1964)
and those from excavations at Picuris pueblo (Schoenwetter, n.d.; 1965)
cover the A.D. 1375 to 1400 period and are associated with
datable ceramics and the tree-ring records. The apparent correlation
of these three records with those from Sapawe is excellent.

\[\text{In all cases conditions indicating downslope vegetation movement and subsequent retreat are evidenced, though as the sites are at such different elevations the exact nature of the vegetation zones occurring in the series is somewhat distinctive. The preliminary ceramic dating at the Picuris site and the tree-ring dating at the Cochiti sites agree-}\]
It must be kept in mind that the palynological correlations have to be made between areas which now support somewhat different vegetation patterns, and the assumption must be granted that localized edaphic and geomorphological controls at each area preclude the possibility that exact correlations of pollen statistics can be made. What we search for are agreements at known points in time for these different points in space. The agreement is not so much that savanna vegetation occurs at each point in space at the same time, but that such changes in vegetation patterns as occur are in the same directions and occur at the same time in these disparate locations.

Ceramic Group 1 at Sepawe, correlative with the first prairie and first savanna horizons, is estimated to date no earlier than 1400 A.D. Ceramic Group 2, which appears to have become established before the shift from savanna to woodland conditions, and which declined before the end of the period of woodland vegetation pattern, is estimated to date from some time between 1400 and 1425 to some time before 1450. The environmental variation which allowed an increased density in tree coverage, then, dates after 1425 but before 1450 on the basis of estimates at Sepawe.

At Picuris, a change from a vegetation coverage pattern similar to that of the present to one of a denser pattern also occurs in the early 1400's. There the change is dated by associations with Rio Grande Glaze ceramics to have occurred at 1445. At Four-Mile Pueblo (Hevly, 1964) a pollen spectrum dated only as "late in the 1300-1500 range" yields identical pollen records to those obtained
at Picuris for the dates of 1425-1445. In the Cochiti area, pollen spectra dated associated with a bark tree-ring date of 1410 indicate conditions ecologically equivalent to those of the first prairie at Sepawe and the lessened tree density at Picuris date at 1425.

The woodland vegetation pattern in the Sepawe sequence is associated with ceramics of Ceramic Groups 2 and 3. The true age of this vegetation pattern is thus estimated to span the period from some time after 1425 to about 1475. At Picuris, very dense tree coverage is recognized in the pollen record of the middle 1400's and is dated as spanning the period 1445 to 1465.

At Cochiti, samples dating younger than 1410 but between 1400 and 1450 yield pollen statistics which are difficult to interpret because of a lack of surface sample data from the area. However, samples of this age from a recognizably different pattern than those known to be older than 1410 and that known to be as late as 1470. There is no reason to suspect that this "different pattern" is not ecologically correlative with the woodland horizon at Sepawe.

The second savanna, the second prairie, and the early third savanna horizons at Sepawe are associated with Group 4 ceramics and estimated to encompass the period 1475 to 1500. In the Picuris sequence a decline from dense vegetation to a pattern similar to the present is seen about 1465, and then a minor change to a slightly more dense pattern is noted about 1500.
At Cochiti the sample associated with a bark tree-ring date of 1469 yields indications of a lessened arboreal coverage; this parallels the situation observed between 1465 and 1500 at Picuris and the second prairie horizon at Sepawe.

A later part of the third savanna horizon at Sepawe is dated between 1500 and 1525 on the basis of an association with Group 5 ceramics at Sepawe. At Picuris, the slightly denser tree coverage initiated about 1500 is maintained through the date of 1525.

In effect, then, there is an amazingly close correspondence in the dating of changes in ecological conditions at Picuris, Cochiti and Sepawe during the 1400-1525 period. The nature of the changes in vegetation patterns at the various sites is somewhat different, but the directions of the changes, from less to more arboreal coverage, then to less again and finally to somewhat more, is precisely parallel. It is impossible to believe that this correspondence is due to chance, in my opinion.

Use of the dates available from Picuris for the pollen horizons involved yields more precise (but perhaps no more accurate) absolute dating estimates for the Sepawe sequence of events, as shown in Figure 11. Even if the absolute dates proposed are not precisely correct, they are evidently accurate within the range of error of a quarter century and most probably are correct within a range of error of a decade. Such age estimates are almost unprecedented in pollen work. European pollen dates are considered "correct" if they correlate with other dating techniques within a half millenium.
The implications of this dating indicate a very short span of time for the first and second prairie horizons, and allow some justification for the argument that they are only successional stages in the paleoecology of the area which should be ignored. Another interesting implication is that the oldest cultural horizon at Sapawe dates no earlier than 1425 A.D.
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2nd Savannah

3

1st Savannah

2

1st Prairie

1

Figure 11. Correlation of ceramic groups and pollen horizons from Sapawe with dated pollen horizons at Picuris.
In indicating that the maximal extent of downslope vegetation migration occurred in the last quarter of the 14th century and that vegetation zones had already retreated upslope again by A.D. 1410. At Picuris the preliminary ceramic dates on the vegetation unit correlative with the woodland at Sapawe is A.D. 1375. That which is correlative with the second or third prairie at Sapawe is dated at 1450. At Cochiti bark tree-ring dates associated with the period correlative with the second savanna horizon are A.D. 1410. By correlation with these dated pollen records, the first prairie and first savanna horizons at Sapawe would have to date before 1375; the woodland horizons at 1375; the second savanna beginning no later than 1410 and perhaps beginning earlier; the second prairie being in effect before 1450; and the third savanna beginning sometime after 1450 (since it does not occur in the other pollen sequences) and lasting to the end of the major occupation.

The dating afforded by the ceramic groups at Sapawe is somewhat at variance with that yielded by pollen correlations, but certainly not so much at variance as to discredit either type of dating control. Ceramic group 1, correlative with the first prairie and first savanna horizons, is estimated to date no earlier than 1400. Ceramic groups 2 and 3, which correlate with the woodland and early second savanna horizons, are estimated to span the 1425 to 1475 period. Group 4 ceramics, which are correlative with the later second savanna, the second prairie, and the early third savanna horizons, are estimated to begin about 1475 and end about 1500. Group 5 ceramics, associated
with both second prairie and third savanna pollen spectra, are dated 1500-1525.

Both of these dating techniques allow dates within the ranges of probable error expected, and such close agreement in absolute age is almost unprecedented in pollen work. European pollen dates are considered "correct" if they correlate with other dating techniques within a half millennium; here, there is correlation to less than half a century. Since even close dates are desirable, an attempt is made to develop the most precise dating of the pollen horizons and the ceramic groups possible, by integrating the age estimates based on both pollen correlation and ceramic group dating. It is expected that these estimates will be quickly and often revised.

The ceramic dating appears to allow more accuracy for the third savanna horizon. By correlation with other pollen horizons it dates only "after 1480", but since it is associated with group 5 ceramics it would seem to date at least 1480 to 1525, and perhaps it continues beyond 1525 in absolute time. Group 4 ceramics are associated with both the third savanna and the second prairie pollen horizons. The assignment of only the 25 years between 1475 and 1500 seems a little short to accommodate the necessary vegetation change, but it is possible. Within 25 years, juniper savannas are known to have invaded prairies in the Southwest; perhaps a 25 year span could well accommodate the retreat of a savanna from a prairie.

Fully 25 per cent of the shard lots associated with pollen spectra are of the 3-4 ceramic group. If a reliable number of shard lots has
been examined, this would indicate that the 3-4 group extended over a reasonably long period of time. If an estimate of 35 years is not excessive, this would indicate that the shift from the second savanna to the second prairie horizons took place in this span of time—probably between 1440 and 1475.

According to the tree-ring dates associated with pollen spectra at Cochiti, the shift from woodland to first savanna conditions took place by 1410. If the ceramic group dates are correct, the woodland conditions were not yet begun by 1400, and as they are associated with ceramic group 2 and 3 sherd lots they must lie somewhere within the 1425-1440 period. These data must remain in conflict, but it is probable that the tree-ring dates at Cochiti may be somewhat inaccurate in dating associated pollen spectra. The pollen could have been deposited on the room floors some years after the roof beams were cut. On the other hand, ceramic group 2 might begin somewhat earlier than 1425. There are only sherd lots of ceramic group 2, and these contain 16 and 17 sherd of time-diagnostic types each. With more sherd lots of this group more intrusive might be found which would help with the dating of the group.

It is likely that group 3 ceramics date 1420 to 1440, group 2-3 dates 1410 to 1420, and group 2 dates 1400 to 1410. Then the woodland to first savanna shift would date between 1420 and 1440. This dating, however, would necessitate that group 1 ceramics dated before 1400. The pollen correlation of the woodland horizon is to a horizon at Fincurts tentatively dated as 1375, and to one at Cochiti known only to be "before 1410." Thus ceramic group 1 need not
date much before 1400. It could date 1365 to 1400 and still be long enough to encompass the first prairie and first savanna pollen horizons.

Thus the diagram below is proposed as a reasonable dating of the pollen horizons and ceramic groups at Sapawe. The dates are reasonable, but probably more precise than defensible by present standards of accuracy.

Cultural Ecology of the Sapawe Site

The problems of cultural ecology are two-fold. On the one hand, one needs reconstruction of ecological conditions and, on the other, one needs reconstruction of cultural patterns. The relationship between the two is the cultural ecology. Until the analysis of artifactual materials from the site is complete, and perhaps not even then, the reconstruction of cultural patterns at Sapawe can only be accomplished on a very general level. Some points, however, can be attacked from available data.

It is known that the site of Sapawe was settled under certain ecological conditions, developed in size under later ones, and was abandoned after still later ones. It is also known that the occupants of Sapawe were agriculturists, and so it seems reasonable to put the question: how might the known variations in ecological conditions at Sapawe have affected the agricultural potential of the site area. As a corollary question we may ask: can an explanation for the original occupation and the later abandonment of the site be found in the paleoecological analysis.
Pollen analysis reveals only the patterns of vegetation change through time. It does not reveal the causes for such changes as can be recognized to have occurred. But when a number of techniques of paleoecological inquiry are applied to a specific time horizon the causes generally can be worked out, and in the case of the 1350-1550 time horizon there are a number of pieces of the puzzle available. The patterns of vegetation zone movement in the Southwest are generally recognized today to be functions of the amount of "effective moisture" -- the water available to the plants' roots. Effective moisture is not a direct correlate of total annual rainfall, since when and how the moisture becomes available to the plants is as important a variable as the total precipitation value. Geological evidence has been accumulated, however, to allow some measure of rainfall periodicity so that the pollen record can be interpreted more adequately. Recently, dendroclimatological studies have been undertaken which attempt to plot variations in total annual rainfall for the western states by decades, and these also assist in interpretation. Unfortunately these dendroclimatological studies are presently in an early stage of development and are only available for the 1500 to 1940 period (Fritts, Smith and Holmes, 1964).

At present the geological evidence accumulated in the Navajo Reservoir District (Schoenwetter and Eddy, 1964) would indicate that the vegetation movements seen in the Sapawe pollen chronology occurred during a period when winter rainfall accounted for a greater proportion of the total annual precipitation than it does at present. Thus winters
were generally longer and wetter, and the growing season for maize was shorter and possibly dryer. We can infer fairly confidently that the movement of vegetation units down the elevational gradient during this period was a consequence of increased winter rainfall, and movement upslope was a consequence of decreased winter rainfall. As yet, there is no absolute measures to which these increases and decreases may be compared. It is not known how many inches of rain are involved in an "increase" or a "decrease" nor do we know whether "increase" means more or less than present rainfall allotments.

Though we must operate within this limited framework of paleoclimatic reconstruction, there is sufficient information to allow us to recognize that the agricultural potentials of the Sapawe site area were of a higher order throughout the known period of occupation than they are today. Conditions being what they were, both the Recent Terrace (then undissected) and the first bench area received more winter rainfall than they now do, the soil was soaked to a reasonable depth, and the potential for germinating maize plants on such land was quite good. The lessened frequency of summer rains may have been such that the first bench could not catch enough rainfall to mature a crop, but the bottomlands of the El Rio, fed by permanent stream, very likely were sufficient in themselves to provide the economic basis of the site.6

6Though the growing season must have been shorter, then maize must have been available in the area. A genetically distinct variety must have been available from the abundance of Zea pollen that corn have been available.
Agricultural potentials of the site area probably were maximal during the savanna periods, when effective moisture values were high and much of the land area of the first bench was not covered by trees. During the woodland period, agricultural potential would have been somewhat less. Though moisture values were high there was less arable land because of greater tree cover. It is true that the land area of the first bench might have been cleared during the woodland period, thus making this the period of maximal agricultural potential, but since the woodland is evidenced in the site area it quite obviously was not cleared. The prairie horizons are indicative of lessened effective moisture values and thus would be periods of less agricultural potential than the savanna or woodland horizons.

These evaluations, of course, are offered on the assumption that irrigation was not practiced in the area of the site. If irrigation was practiced the general level of effective moisture to which the trees were responding might have little to do with the level of effective moisture to which the crops were responding. Also, it must be recognized that a horizon on which agricultural potential is greater or lesser might have very little to do with the amount of agriculture actually undertaken by the occupants of the site. If the population was small during periods when the agricultural potential was great, relatively little agriculture might have been practiced in actuality.

The evidence seems sufficient to allow the conclusion that at the time the Sapawe site area was first settled, during the first prairie
horizon, the agricultural potential of the area was minimal. With the advent of the first savanna, however, the agricultural potential of the site area became maximal and it remained high until the end of the second savanna horizon. Twenty-nine floor samples are recognized from this period of maximal potential. Occupation of the site was maintained through the period of the second prairie horizon, when the agricultural potential of the area was lessened. For the period immediately subsequent, that of the third savanna, a horizon of maximal agricultural potential can again be recognized. For this period there are three pollen spectra from room floors.

It is extremely tempting, on the basis of these conclusions, to develop the working hypothesis that the site of Sapawe was originally settled by a small group of people who were surviving as agriculturalists during a period when agricultural potential was at a low ebb. Subsequently, as agricultural potential in the area increased to a high level, a population explosion occurred in response to an increased availability of food. With time the agricultural potential of the area declined but the population size was not equally diminished; even when, near the end of the occupation, more food could be produced, the population was too large to be supported and effective abandonment of the site occurred.

The hypothesis is tempting only because it accommodates the presently available facts, and there are many, many facts which must be recognized as not yet available. The artificial materials are as yet substantially unanalyzed. Also, the hypothesis incorporates an environmentalist philosophy which, on the basis of ethnographic fact,
anthropologists should be quite hesitant in proposing. The number of assumptions which underly the hypothesis and which need much substantiation by evidence is fairly respectable. These include: (1) the assumption that a sufficient number of rooms have been subjected to pollen analysis to yield an index, however rough, to population size on any given pollen horizon; (2) the assumption that irrigation was not practiced, or if practiced was subject to the same environmental controls as dry farming but to a lesser degree; (3) the assumption that maize dominated the economy of the inhabitants of the Sapawe site; and (4) the assumption that in this case population size was primarily controlled by available food and thus disease, warfare or other cultural factors were not principally involved. These assumptions are all the addition to the primary one that the palynological record is a true indication of ancient environmental conditions.

However, there are positive factors apparent. The working hypothesis does accommodate the known facts, and seems to be at least a respectable first attempt at adequate explanation so long as its limitations are recognized. If acceptable, this hypothesis can also be viewed in the perspective of the broader archaeology and history of the Chama Valley area. The two ruins, Leafwater and Te'wel, on which work has been done most recently in this district (Wendorf, 1953), evidence longer occupations than Sapawe. Rooms containing respectable quantities of Santa Fe Black-on-White and Wyo Black-on-White denote occupations of the 13th century at the former sites, while evidence for occupation in the 14th century is minimal at Sapawe.
It might be expected that under the conditions of minimal agricultural potential evidenced on the first prairie horizon, sites in the area, such as Leafwater and Télewd, might have been unable to support the size of population that may have accrued over a period of a century. New small sites might then have been developed by a splintering process from old ones. Sapawe may originally have been such a community.

Again accepting the hypothesis, there is little reason to suspect that the population-food supply relationship would not hold true at other sites in the region. Given conditions of maximal and high agricultural potential until the middle decades of the 16th century, most sites would have undergone explosions. With the return of minimal conditions for agricultural potential, population pressure became a factor which had not been previously important. In the 14th century, fragmentation of sites was effective because small numbers of people were involved; in the 16th century most of the usable arable land would already have been under cultivation to accommodate the large population. Fragmentation of the sites would thus not effect a respectable change in the economics of any individual group during the 16th century. The answer to such a problem is obvious; that is, reduce the population in the area under pressure. Migration to an occupied, or more fertile, area was a humane possible solution; warfare or similar activities was an inhumane one. From present evidence, the former solution was the one found acceptable.

From the viewpoint of the broader perspective, we might also ask if environmental conditions be invoked in explanation of the
First, they allow more accurate placement of room units at the site in different points in time. Any given room unit might contain too few potsherds on its floor to allow accurate dating. But room floors which have been dated by pollen content to one horizon can be considered as a group and all of their pottery combined as a sample of the ceramics of that horizon. The statistics of ceramic types recognized from this sample can then be applied to determine the relative dates for rooms where no pollen analysis was accomplished. Some rooms, of course, will not be datable because there are no distinguishing ceramic features, and other rooms will not be datable to one horizon but may be definitely excluded from certain horizons. The technique should apply equally well to other categories of artifacts than ceramics (point types, scraper types, etc.) if a sufficiently large number of such artifacts are available to yield reasonably reliable statistics. Having more accurate time placement of rooms allows the archaeologist a number of otherwise difficult interpretations. Mapping of the site by periods, definition of developmental ceramic and artifact sequences, and well-evidenced "conjunctive approach" analyses then become possible.

Second, the archaeologist can approach the problems of meaning and function of artifact classes in relation to environmental and population conditions. It might be expected, for example, that woodworking tools would be most in evidence at the site during the period of woodland and savanna conditions and less in evidence during periods of prairie conditions. The amount of culinary pottery would be expected
to increase during periods of higher population, but this may or may not be the case for decorated pottery. The types of culinary pottery may be related to occurring environmental conditions if certain pottery types were used for wild products which were more or less abundant at different times. Styles of house and kiva construction might be related to postulated population size variations. The proportion of storage rooms to habitation rooms would be expected to increase during periods of economic plenty as contrasted to periods of poverty. Objects of ceremonial significance might be expected to be more numerous during periods of higher population. If this were not the case, the possibility is raised of a small, specialized, priesthood rather than a general participation in ceremonial officiation by the larger group of adults. Objects indistinguishable as toys might be recovered in greater quantity on some horizons than others, indicating that a larger proportion of the population were children at those times.

The possibilities and ramifications of the possibilities produce a never-ending list; each conclusion demonstrated leads to another whole list of possibilities that might be investigated. There are, of course, practical limitations fostered by the amount of data available, for the vast majority of the site remains unexcavated, and there are limitations to the time and energy that the archaeologist is willing or able to expend on this site. There is also the practical consideration that anthropology, in its present state of development, is principally a comparative science. While many cultural patterns might be
demonstrated at the Sapawe site, those which have no value in allowing comparisons to be made between this site and others have little immediate relevance. Some day, of course, such patterns might be recognized as quite valuable and it may be worthwhile to suggest the possibility of their occurrence at Sapawe for the anthropologists of the future. But experience will illustrate that in most instances where an attempt has been made in the archaeological literature to provide interpretations for future generations, these interpretations have been failures because of an inability to predict accurately which problems will be investigated in the future and which will not. Re-analysis of the raw data seems more often the way that succeeding generations of scientists find older data useful for new problems. Thus it seems far more worthwhile to invest one's energies in accurate presentation of raw data than problems of no immediate comparative relevance.

The Vegetation Units as Resources.

The wild plants of the Southwest form a valuable resource of raw materials for food, medicines, architecture, tools, dyestuffs and other items of manufacture to the modern native. Presumably these resources were even more valuable before the white man's goods became available. To properly evaluate the potentials of the vegetation units, more of their ecology must be explained than the number and density of trees, as has so far been done. The identification of the dominant species involved, and the reconstruction of the species nature of the plant assemblages, need also to be reconstructed.
This task is an exceedingly difficult one to attempt on the basis of the palynological evidence available. First, the plant associations occurring today in the Southwest (any of which might be expected on the horizon under discussion) are numerous, highly varied, and poorly studied by ecologists. As the greater majority of recognizable modern plant associations have not been investigated in terms of their modern pollen rains, there are no emprical controls by which the pollen spectra of the ancient horizons may be evaluated. Second, the vagaries of pollen fruition, dispersion, preservation and identification play as yet poorly defined roles in the question of reconstruction of plant species assemblages. Third, as the method of pollen analysis is basically a statistical one, the techniques are ordinarily devised for elucidation of data pertinent to a particular problem. The techniques utilized in this study were designed to yield information on vegetation structure, and therefore the statistics derived may not be well suited, or at all suited, to the problem of vegetation composition.

But looking again to the surface samples as empirical controls—so small a sample as they may be for these purposes—a few specific similarities can be noted between them and the more ancient pollen horizons. Under present conditions, *Artemisia* pollen occurs in frequencies greater than 15 per cent when it is a dominant or subdominant member of the floral association. On the second prairie horizon 13 of 17 samples also have *Artemisia* in a frequency of 15 per cent or more. There is no particular reason to suspect that the sagebrush
dominant, or subdominant, floral associations of the second prairie horizon were different in species composition than those now observed. In terms of grass pollen, (the principle being that grass frequencies greater than 10 per cent are indicative of more grass) of the 17 samples 10 show relatively high quantities of grass. Nine of these 10 are associated with greater than 15 per cent Artemisia pollen, indicating that the floral assemblage of the second prairie similar to that of the sagebrush-grass association now found at the foot of the first bench and the back of the Recent Terrace.

There are also some curious differences between the modern surface samples and the fossil ones. In the modern woodland sample juniper pollen accounts for 50 per cent of the pollen spectrum, but in ancient samples of woodland it never accounts for more than 4 per cent. In the modern samples ponderosa pine pollen never accounts for more than 7 per cent, but in seven out of the ten of the ancient woodland samples it accounts for at least 7 per cent. Oak pollen is present in the modern woodland sample, but absent in eight of the ten ancient samples of woodland. Ficca pollen is found in nine of the 10 ancient samples of woodland, and Pseudostuga pollen is found in one of them, but neither taxon is found associated with the modern woodland sample. Juniper and oak are the more xeric trees, and their pollen is found in greater frequency in the modern samples; spruce, Douglas fir and ponderosa pine are the more mesic, higher elevation, trees and their pollen is found in greater frequency in the ancient woodland samples. It would thus appear that the ancient woodland was of a different composition than the present one, with more of
the higher elevation species. However, it is not presently possible to define the actual compositional nature of the ancient woodland. There may have been a large number of the higher elevation trees or a small number. It can only be determined that the woodland was not like that near the site at present.

As there are no control surface samples on the savanna condition at Sapawe (indeed there is relatively little savanna presently occurring for some distance from Sapawe) it is difficult to evaluate samples attributed to savanna on the ancient horizons. If high occurrences of juniper and oak pollen are indicative of more xeric savannas, and high occurrences of spruce, fir, and ponderosa pollen are indicative more mesic savannas, neither the first nor second savannas are clearly either xeric or mesic. On the first savanna horizon there is relatively more spruce, but relatively less ponderosa and fir pollen. On the second savanna horizon there is relatively more oak, but relatively less juniper pollen. Both savannas seem to constitute one or more types of floral association now unrecognized in the Sapawe area (where xeric juniper savannas are occasional), and possibly rare today in the Southwest.

Thus it would seem from limited evidence that the plant resources available to the occupants of Sapawe during the second prairie period were like those available today in the area, and probably were the same ones exploited by the Tewa (Harrington, et. al, 1916) and the Navajo (Elmore, 1944) of the region. On the earlier horizons the vegetation associations seem to have been different than those of the present day in the area, but exactly how different cannot be concluded
It seems unlikely that any plant resource now obtainable was completely absent during the first savanna, woodland, and second savanna horizons, but more xeric species may have been in lesser quantity. On the other hand, more mesic species -- particularly Douglas fir, true fir, spruce and ponderosa pine -- were far more available than they are at present.

In the matter of plants of economic value, the pollen record itself may be approached as an index of utilization of both cultivated and wild taxa. Zea, is totally a cultivated plant. It no longer exists in its wild form anywhere except possibly in a geneticist's laboratory, and probably never existed in the wild state north of central Mexico. The genus Cucurbita contains both wild and cultivated species. While wild species are quite common in the Southwest they are insect pollinated plants and their pollen has never been observed in modern surface samples. Yet Cucurbita pollen is very common in pollen samples from archaeological sites, almost invariably associated with Zea pollen. It thus seems most likely that fossil Cucurbita pollen from archaeological sites is of plants which were gathered or cultivated for food by the occupants of the sites. Like Cucurbita, wild species of Cleome and Opuntia are common on the southwestern landscape and their pollen is found under "normal" conditions but always in very low frequency. In archaeological samples the pollen of Cleome is quite abundant on certain horizons, and that of the Opuntias is not infrequently encountered. Cleome serrulata, and flowers and fruits of both Cylindropuntia and Platyopuntia cacti, are known to have been valuable food resources for southwestern Indian groups in the near distant past. There is every reason to expect that at the time of the
occupation of Sapawe these plants served similar purposes and their pollen is probably a reflection of the food habits of the occupants. In the case of Cleome, another factor may also be involved. Cleome is a plentiful, and much utilized, source of organic pigment for pottery decoration. Its occurrence in the archaeological pollen record in quantity (greater than 2.5%) is almost invariably associated with pottery that has been decorated with organic, or organic-based, pigments. It thus is probable that some quantity of the Cleome pollen observed was incorporated into the sediments around the site when the plant was gathered as a paint source.

The differentiation between Cucurbita moschata and C. pepo on the pollen diagrams does not indicate that the indentification of the pollen is accurate to species. There are two types of Cucurbita pollen; C. moschata and a few other species have pollen of the one type and C. pepo and a few other species have pollen of the other type (Awasthi, 1962).

Hevly (1964) has suggested that Malvaceae pollen from archaeological sites -- almost invariably of a morphology similar to the pollen to Spharalcea, the globe mallow -- should be considered as an economic plant since it is quite rare in surface samples but common in samples from archaeological sites. In the present study Malvaceae pollen has not been considered an indication of economic activity, though it well might be.

All of the above types are recognized by Martin and Sharrock (1964) from human local samples collected in the Glen Canyon area.
as being economic indicator pollen types, except for *Cylindropuntia*
pollen which was absent in their samples. *Cylindropuntia* species
do not grow in the Glen Canyon area at present. They also recog-
nized *Populus* pollen as an economic type, since it occurred in great
frequency in one fecal sample.

The amount of pollen of these economic plants is probably not
a reliable index to the intensity with which they were gathered or
cultivated. The pollen of *Cylindropuntia*, for example, probably finds
its way into the archaeological sediments through the vagaries of the
way the fruits were culturally handled. Assuming that the fruit was
used for food, first being peeled to remove the spines, the pollen
clinging to the rind would be discarded onto the most available trash
heap, would be dropped onto the ground, would cling to the fingers
and the implement used for peeling, or would be ingested and excreted
later in the dung of the eater. Since any one cactus fruit rind might
contain any number of pollen grains, it is impossible to evaluate the
differences in frequency of such a pollen type through time in the
sediment samples. The amount of economic pollen recovered from
room floors, however, is quite a bit less than the amount recovered
from the kiva fill samples or the stratigraphic series from GN1, ex-
cept for the between floors fill sample from Room GN2. Very high
frequencies of economic pollen may denote trash midden sediments.
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