A POLLEN STUDY OF THE ABIQUIU RESERVOIR

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Introduction

The sediment samples submitted for pollen study provide a body of information pertinent to two quite different research problems of archaeological relevance. The first of these is the palynological evidence of economic activities carried out at the sampled locations. The sediments sampled incorporate artifacts of the Historic Spanish, Navajo and Archaic occupational horizons of the Abiquiu Reservoir District. As the cultural patterns of these occupational intervals are distinct, it was expected that the pollen records of each would reflect distinctive variations in the utilization of vegetational resources resulting from distinctions in economic activity. This expectation was partially confirmed, but not in the fashion one would be led to anticipate on the basis of either ethnographic-historic or prior palynological evidence.

The second research problem is that of intra- and inter-site chronological relationships. At the most intensively sampled locus, AR33, there occur a series of hearths and floors associated with masonry nogans. Palynological records, functioning as indices of biostratigraphic horizons, allow identification of three temporal horizons in the occupancy of the site and recognition of which of the sampled provenience units are temporal correlates. The temporal relationship of Navajo provenience units at other sites relative to the occupation horizons of AR33 is also evaluable palynologically.

Though the research problem dealing with economics occupied most of the effort of investigation, and is of primary archaeological interest, the chronology problem is given precedence in this report. Partly, this is a function of the character of the data pertinent to problem

	ADJ AP %	PICEA	P. EDULIS	P. POND.	PINUS 1/3	TOTAL PINUS	JUNIPERUS	QUERCUS	ALNUS	JULGANS	BETULA	ULMUS	POPULUS	SALIX	CHENOPODIN	ARTIMESIA	AMBROSIEAE	TUBULIFLORAE	LIGULIFLORAE	GRAMINEAE	EPHEDRA N	EPHEDRA T	SARCOBATUS	YUCCA	ERIOGONUM	CACTACEAE	ELEAGNUS	TOTAL
AR403-A-1-1	80.	2	124	8	19	138	19	1					1		20	13	3	2	1	4			1					2
AR403-A-3-1	59.6		76	4	28	89	23	3					1		43	16	12	12		3	3						7	213
AR403-A-4-1	73.8	1	80	8	36	100	37	6				1			21	13	12	8		5	2	2					5	163
AR403-A-5-1	58.6		62	1	34	74	40	2	2	1	8				54	12	11	7		5	1		3	1			2	224
AR403-A-6-3	81.9		96	4	32	111	25	9							8	8		7		5							26	203
AR403-A-7-2	-														1													1
AR403-A-8-1	65.0		43	2	36	57	70	3			4				43	13	3	10										207
AR33-B-3-1-3	73.0	2	114	3		117	25	2			2				40	6	8	3		2	1			1				210
AR33-B-3-2-3	40.0		34	1	4	36	44						1	1	96	14	22	6		4								224
AR33-B-3-3-1	77.5		131	1	10	135	17	3							33	5	4	3		4								204
AR33-D-2-1	57.5		74	1	13	79	31	5							55	18	7	6		4								207
AR33-D-3-5	78.0		109	10	7	121	34	1							20	8	10	13		3								210
AR33-S-1-2	63.5		80	3	20	90	37								33	18	11	7		12		1				1		211
AR33-S-2-4	77.0		116	5	11	125	28	1							26	9	15	5		5								215
AR33-CC-1-2	73.0		119	2	20	124	22								34	9	13	7		4				1		1		215
AR33-H-2-2	65.5	1	76	5	10	84	44	2							40	12	7	4		11	2							207
AR33-V-1-3	72.5	3	111	5	14	121	17	4							25	23	5	2		2		3						205
AR33-M-1-1	78.5	1	108	1	36	120	35	1							29	11	19	1		1	1							219
AR33-U-1-3	87.0	1	154	4	3	159	12	2							19	4		1		1		1						200
AR32-A-0-2	88.5		156	7	2	164	19	4							14		2	1										204
AR32-A-2-1	89.5	1	141	14		155	20	3							17		4	6										206
AR32-C-2-2	-		1			1																						2
AR162-A-1-1	-																											-
AR162-A-1-4	-		1				3													2								6
AR572-1-1-4	63.5		119	2		121	5	1							68	1	4	4										204
AR527-1-2-6	64.5		94	3	55	115	12	2							58	8	3	1		4								203
AR527-1-3-8	-		5				3								2													10
AR212-1-1-3	85.5		156	5		161	10								22	3	2	5										203
AR212-7-1-13	83.0	2	144	7		151	12	1							20	8	3	6										203
AR212-7-1-14	86.0		159	5		164	8								20	5	3	3										203
AR212-1-1-5	81.0		77	2		79	5	1							14	4	1	6										110
AR100-4-0-3	80.5		128	2	7	132	27	2							20	14	8	4			1							208
AR254 F.S.3	92.0		178	2		180	3	1							10	2		4										200
AR53 F.S.1	87.3		155	12		167	10	1							22		5	3										209

Table I. Pollen Observed and Adjusted Arboreal Pollen Frequencies

resolution, since the chronology problem demands more attention to details of the palynological record. More significantly, the chronology problem has been granted priority because it provides a data framework pertinent to the resolution of the problem of paleoeconomic reconstruction.

As a matter of interest, it should be mentioned here that the samples submitted for pollen study were unusually productive of data. Of the 35 samples only five contained too little pollen to justify analysis and it is likely that four of those are referable to a single temporal interval. Three-quarters of the productive samples contained more than 1000 pollen grains per drop of extracted polliniferous fraction, and only one productive sample contained fewer than 350 grains per drop.

Chronology and Paleoenvironment

"Pollen dates" are produced through the application of principles of biostratigraphic analysis. Speaking very generally and simplistically, these may be reduced to two assumptions. The basic assumption is that any fossil assemblege reflects the evolutionary and adaptive (i.e. ecological) relationships of biota to those environmental conditions extant at the time of deposition of the assemblege. Significant distinctions in assembleges, then, reflect differences in such relationships likely to be the result of either temporal or spatial variations of paleoecology. This principle applies whether one utilizes fossil assembleges demonstrating the evolution of animal phyla (e.g. the "ages" of invertebrates, dinosaurs and mammals) or successional stages of vegetation. The second assumption is that for a given area of relatively small

geographic scale variations in adaptive relationships evidenced in the fossil record are more probably due to temporal than to spatial distinctions. The validity of this assumption is often documentable through experimental controls and application of the principle of uniformity. Where experimental controls are lacking, the assumption must be rejected or accepted on the grounds of logic and replicability of evidence.

The principles of biostratigraphic analysis are sound, but their application to fossil assembleges recovered from archaeological contexts is a matter of some debate. Human behavior is recognized by most scholars to be qualitatively, or at least quantitatively, distinct from that of other organisms as a result of the peculiarly significant influence of culturally conditioned learning patterns and value systems. A biological record associated with evidence of human activity, then, may be heavily influenced by culturally conditioned processes which occurred in prior times. The prospect that cultural processes may have effects on biota which mimic the effects of "natural" (i.e. non-human influenced) processes cannot be ignored. Further, the methodology of social science investigations and those of natural science investigations is based upon quite distinctive theoretical concerns and ontological propositions. If one must treat the fossil assemblege of an archaeological context as a "possible artifact" it is necessary to do so in a manner consistant with Anthropological method and theory, not in a manner consistant with the method and theory of geology or biology.

In the research discussed here, concern regarding applicability of the principles of biostratigraphic analysis focuses on the materials of the Navajo Horizon. Archaeological reconstructions of Archaic Horizon

economic patterns and subsistance stragies, based upon considerations of population size, tool functions and tool kit variability, present a fairly consistant picture of foraging exploitation of the biotic resources of inhabited areas. Though evidence may be cited which documents that Archaic horizon populations in the American Southwest cultivated maize, the weight of information available indicates that the economic patterns of all Archaic populations emphasized biotic resource exploitation rather than biotic resource manipulation, and that such exploitation tended to be strategically organized to harvest biological surpluses at a relatively low scale and level. Biological assembleges of this horizon associated with human activity patterns, then, are not expected to be influenced by--or illustrate the influence of--human behavioral effects upon the adaptational and evolutionary systems of interrelationship among the biota.

Conversely, the economies of historic Spanish populations involved not only the manipulation of harvest potentials of introduced exotic organisms but also systematic disruption of adaptive interrelationships among native organisms. The latter was achieved in a number of fashions, the most prevalent of which were land clearance, disruption of ecological relationships through introduction of grazing animals and reduction of "varmint" competitors, and the selective export of large quantities of marketable local resources. Such behavior patterns would expectably leave their mark not only the biota of a locale but also that miniscule fraction thereof preserved as an assemblege of fossils. The degree to which the effect is evidenced in the fossil records of specific proveniences may be tested through examination of the fossil assembleges,

but one must assume the effect is recorded whether or not the evidence is easily identifiable.

The economics of Navajo life prior to the late 19th century, however, is not well understood as a result of either archaeological or historical study. Historical accounts stress either the behavior pattern of raiding (which may be considered as an activity organized for the purpose of extracting local and exotic resources as well as a political instrument) or the behavior patterns of pastoralism and subsistance agriculture. Archaeological study tends to stress the reconstruction of socio-political events affecting population distributions and assume that the economic significance of subsistance agriculture and pastoralism in the 18th and early 19th century was identical to ethnographic patterns of the late 19th century. Navajo Horizon pollen records, then, might reflect sufficient cultural influence that their value for biostratigraphic correlation is reduced significantly. But there is little by way of historical or archaeological evidence that can be used to determine if the possibility of such influence indeed is a probability.

In order to proceed with the analysis, I have taken the position that two sorts of Abiquiu Reservoir pollen records can be assumed to be uninfluenced by cultural activity despite the fact of their recovery from archaeological sites. One sample analyzed here derives from a stratum deposited subsequent to the Historic Spanish occupation of AR403. As a single sample, its pollen spectrum cannot be considered representative or diagnostic of ecological conditions obtaining at the time of deposition. However, I have assumed it may be legitimately accepted as a member of the population of surface pollen samples collected in the

Navajo Reservoir District (Schoenwetter and Eddy 1964) because of its minimal antiquity. I have also assumed that the pollen spectra obtained here in association with Archaic site occupations are not culturally influenced. This may be an error, but the assumption can be rationally defended on the basis of our comprehension of the economic patterns of the cultural systems employed on this horizon. Granting these assumptions, the similarities and differences between Modern and Archaic Horizon pollen spectra and those of the Historic Spanish and Navajo Horizons can be rationally assessed. Insofar as such similarities and differences may be interpreted in cultural terms, those characteristics have been considered in determining the potential of biostratigraphic analysis and development of chronological inferences.

The Modern Horizon

Sample AR403-A-1-1 is the only sample ever analyzed from the Abiquiu Reservoir District which may be referable to this horizon. Considered as a member of the population of surface samples examined in the vegetationally similar Navajo Reservoir District, it appears to document the occurence of a fairly dense woodland stand of pinyon and juniper in the adjusted arboreal pollen (AP) frequency value of 80.0%. This sample contains significantly less juniper pollen that the surface samples from the Navajo Reservoir, though the distinction is not evaluable in vegetational terms. Application of the pinyon: juniper pollen ratio criteria endorsed by Hilland Hevly (1968) would suggest that climatic conditions in the Abiquiu Reservoir District today favor the reproductive potential of pinyon over juniper relative to the Navajo Reservoir District at lower margins of the pigmy conifer woodland zone.

The Archaic Horizon

Three samples of Archaic Horizon context (AR254-1-1-3; AR100-4-0-3; AR527-1-2-6) and a series of probable Archaic context samples (AR212-1-1-3; AR212-1-1-5; AR212-7-1-14; AR212-7-1-13; AR53-1-1-1; AR527-1-1-4) provided palynological records. With the exception of the samples from AR527, all yielded pollen spectra which are statistically indistinguishable from the Modern Horizon population of pollen records as regards adjusted AP frequency. A plaeovegetation reconstruction of pinyon-juniper woodland is indicated. The significantly lower frequency values for juniper pollen even than the single modern horizon sample from AR403, coupled with Artemisia values which are also quite low, suggests this series may have been deposited during an interval of summer-dominant precipitation regime.

Variability in ecological conditions during the Archaic Horizon interval of occupation, however, is suggested by the palynological records from AR527-1 and that of Level 8 at AR403. Adjusted AP frequency values are lower in both samples collected from Feature 1 at AR527 (63.5 and 64.5%), though only one of the samples can be confidently relegated to the Archaic Horizon. The adjusted AP value of the possible Archaic Horizon sample from AR403 is also in this range (65%), through the ratio of pinyon: juniper pollen in this spectrum is markedly distinct.

If we grant the assumption that the Archaic Horizon pollen spectra are not culturally conditioned, two inferences emerge. First, their overwhelming similarity to each other and to the Modern Horizon samples strongly suggests that the adjusted AP frequency pollen statistic provides a legitimate basis for biostratigraphic corelation. Second, insofar as they

vary relative to that statistic it is far more likely that the variation is due to temporally than to spatially distributed factors.

Estimates of absolute age of the Archaic Horizon sediments analyzed cannot be secure on the basis of palynological evidence since the dated pollen chronology for the Colorado Plateau (Schoenwetter 1970) does not extend prior to 200 B.C. Certain patterns of ecological equivalence occur between the pollen records of this series and those of an unpublished pollen chronology from the Arroyo Cuervo area on the southern margin of the Colorado Plateau in New Mexico, however (Schoenwetter, n.d.). These suggest that with the exception of the samples from AR527 and Level 8 at AR403, the Archaic occupations of the sampled sites date between 3000 and 3500 B.P. The significantly higher values for Chenopodineae pollen recovered in the samples from feature 1 at AR527 could reflect local overpresentation of such plants or signify a segregate, drier, temporal horizon. If the latter is the case a date between 3500 and 4500 B.P. may be suggested. The samples collected from site AR162 did not yield sufficient pollen for analysis and in this manner are similar to the sample from Level 7 at AR403 and sample 527-1-1-3. Though negative evidence of this sort is not a logically adequate basis for inference, the hypothesis that all such samples date to the same temporal horizon shortly prior to that of the fill of feature 1 at AR527 may find verification as a result of radiocarbon or archaeomagnetic assays. The sample from Level 8 at AR403 is palynologically unique in the Archaic Horizon series as a result of high juniper pollen values. If representative of a paleoecological condition at all (which cannot be claimed on

the basis of a single sample from an archaeological context) it is probably older than the other samples submitted.

The Historic Spanish Horizon

The three samples attributable to Historic Spanish occupation derive from superimposed strata of a rockshelter deposit (AR403-A-4-1, -5-1 and -6-1) which were both capped by and overlay strata containing minimal evidence of human occupation. The deeper Level 7 did not provide adequate pollen for study; the capping layer (Level 3) and the occupation strata produced pollen records. Strata were defined in terms of color, texture and types of cultural debris. Level 6 is an occupational fill stratum; Level 4 is a stratum which is characterized by hearth features; and Level 5 (which intervenes in the sampled profile) contains possible hearth features and may be related to layer 4 on those grounds.

The pollen records of the samples of Levels 3, 4 and 6 (especially the latter) are locally overrepresented by pollen referable to Eleagnus. Oleaster is not native to the American Southwest; the species involved here is probably E. angustifolia (Russian olive), introduced from Eurasia as a cultigen. Pollen of Ulmus (elm), which is another exotic cultigen in the Southwest, also occurs in the Level 4 sample. The adjusted AP frequency values of the samples fall into two groups, represented by the samples of Levels 4 and 6 and the samples of Levels 3 and 5. The former group has AP values of the sort reflected by woodland samples in the modern series; the latter group contains significantly less tree pollen and significantly higher amounts of Chenopodineae pollen. As Levels 4 and 6 are definate occupational levels, while Level 3 is probably not a

cultural level and the archaeological evidence for Level 5 occupation is equivocal, it would appear that the palynological record provides evidence of reversed stratigraphy in this section of the rockshelter. At the point of collection of the pollen samples it seems likely that Level 5 actually references a time interval subsequent to the occupation evidenced in Level 4, and one similar ecologically to Level 3.

We must assume that the pollen records of Levels 4 and 6 are culturally influenced, and the occurence of exotic cultigen pollen provides support for that position. However, the adjusted AP values of the samples of those two levels are not significantly distinct nor is there any other statistically significant difference between the pollen spectra not accounted for by local overrepresentations of cultigen or riparian tree pollen types (which are excluded in calculating adjusted AP values). Considered in light of the distinction that exists in both AP and Chenopodiineae values relative to the samples of Levels 3 and 5, it seems that cultural influence is restricted to the exotic cultigen pollen record in Levels 4 and 6. The adjusted AP values, then, may be argued to reflect ecological conditions uninfluenced directly by human behavior and thus relevant to intra-site biostratigraphic analysis. The relevance of adjusted AP values for inter-site correlation has already been documented by replicability amongst the Archaic Horizon samples.

The occurence of both elm and oleaster pollen in these records is more consistant with a 20th century date for the occupational strata than an 18th or 19th century date. The ecological situation suggested by the non-occupation interval pollen records of Levels 3 and 5 is of particular interest. Though the Chenopodiineae values are nigh they are

lower than those occurring on the Archaic Horizon in the records for AR527-1. Yet the adjusted AP values for Levels 3 and 5 are lower than those from AR527-1. Though plants which produce Chenopodiineae pollen tend to be disturbed ground pioneers, and we know that the economic activities of groups occupying the area during the Historic Spanish period created habitats to which such plants are adapted, the inference which is suggested by the record is that Chenopodiineae pollen values are not effective measures of culturally induced land surface disturbance. The higher Chenopodiineae values are associated with the non-occupational interval of the Horizon, not the occupational interval.

The Navajo Horizon

The Navajo Horizon of occupation is unequivocally represented only by the lower floor hearth sample from feature D at AR33 (AR33-D-2-1), since a superimposed floor of the Navajo Horizon sealed this sample from any post-Navajo occupation contamination. Though there are a number of other pollen records attributable to this horizon by virtue of associated artifacts, almost all derive from sediments which could have trapped pollen subsequent to occupational activity, such as hearth fill, hogan fill and floor surface deposits.

The matter is relevant because pollen grains are subject to destruction through burning. Pollen recovered from a sample of hearth fill deposit is thus far less likely to date to the time the hearth supported a fire than to a subsequent time when pollen rained from the atmosphere upon the remains of the extinguished fire and gradually downwashed into the hearth fill. Since almost all of the Navajo Horizon

hearth samples are of deposits buried less than 10 cm below the modern surface, the prospect of contamination by more recent pollen rain remains relatively high.

The presumption that all of the pollen records attributed to the Navajo Horizon by virtue of associated artifactual data are of this horizon, however, is somewhat more justified than not. There are twelve such equivocal records from AR32 and AR33. Five yeild AP values statistically indistinguishable from those of the unequivocally Navajo Horizon sample. Such replicability of data seems unlikely if different temporal horizons are involved. The remainder fall into two groups: a group of three samples (AR33-S-1-2, AR33-D-2-1 and AR33-H-2-2) which have significantly lower adjusted AP values, and a group (AR33-U-1-3, AR32-A-2-1 and AR32-A-0-2) which have significantly higher adjusted AP values. Two members of the first group were collected stratigraphically superimposed upon samples which produced pollen records indistinguishable from that of the unequivocally Navajo occupation interval, and it seems reasonable to consider this group of samples younger though not necessarily non-Navajo. Two of the second group of distinctive samples derive from a different site and it seems not unreasonable to assess this group as older, though also referent to the Navajo Horizon of occupation.

On the basis of distinctions in adjusted AP frequency value, then, the pollen records of the Navajo Horizon in the Abiquiu Reservoir which derive from masonry hogan associations appear to fall into a number of temporal groups. The earliest samples (adjusted AP = ± 85%) are associated with feature A at AR32 and feature U at AR33. The samples from the lower floor hearth of feature D and the hearths of features S, CC, V and

M at AR33 are of the second temporal group (adjusted AP = ± 75%). The hogan fill samples of AR33-B also belong to this series, though the sample of the 30 cm level (AR33-B-3-2-3) is overrepresented in Chenopodiineae pollen--probably the result of growth of pioneer plants upon collapsed roof and wall materials. The floor sample of feature I at site AR4 (Schoenwetter 1977) is also a member of this series, and the midden sample from feature L at AR4 may be.

The sample from the upper floor of feature O and the hearth sample from feature H at AR33 are members of a younger temporal group (adjusted AP = ± 60%). The sample of culturally sterile deposit superimposed upon the hearth level of feature S at AR33 probably belongs to this series also.

Interestingly, six pollen records from AR4 fall into this group (feature BB floor, feature E hearth, feature B exterior hearth and feature D midden) as do the fill samples collected from AR32 B (Schoenwetter and Rankin 1977). Other pollen records from AR4, representing feature D floor, feature C floor and the fill of feature G3, appear to represent a fourth temporal group (adjusted AP = ± 30%) younger than any of the pollen records from AR32 or AR33.

The paleoenvironmental trend of the series is one of increasing aridity through the Navajo occupation. Initially, the pigmy conifer woodland seems to have been slightly denser, or supportive of larger trees, than normally occurs today. As time progressed during the horizon of masonry hogan occupation the arboreal canopy thinned. Yucca and prickley pear were established as common floristic elements by the end of the period.

mental trend of the sort evidenced palynologically dates 1840-1905 A.D. The "wet" years identified by wide rings during the 1825-1840 interval are followed by normal width rings until the "drought" years evidenced by narrow rings in the 1891-1905 period. But there is no necessary correlation between tree-ring and palynological indices of moisture since the factors constraining ring width and those constraining pollen production, dispersal and preservation are not identical. If one assumes that the "missing years" of the Picuris pollen sequence resulted from the existance of a dry interval not recorded in the tree-ring sequence, an alternative argument can be developed that the Abiquiu pollen sequence of the Navaho Horizon dates from a time just after A.D. 1650 to 1750 or 1775. Though this alternative depends upon an assumption based on negative evidence, it is not necessarily unlikely and may be more consistant with the information provided by the artifactual record and forms of chronometric dating.

Land Use and Economic Activities

Two procedures were employed to allow palynological identification of resource utilization. In the expectation that pollen of cultigens might occur in very low frequency, most samples were scanned to allow observation of 1000 pollen grains. Maize and squash pollen, the anticipated cultigens of the Archaic and Navajo Horizons, and pollen of Eurasian cereals, are large and easily identifiable in this way. The second procedure involved comparison of pollen values of the Historic Spanish Horizon which might be reasonably interpreted as indices of land clearance or livestock grazing against those of other horizons.

The absolute antiquity of these pollen records can only be estimated through comparison with those of dated locations, and at present most Navajo Horizon pollen records (Schoenwetter and Eddy 1964, Schoenwetter 1965) are dated either imprecisely (e.g. post 1706 AD) or relatively (e.g. Gobernador Phase). The record from Picuris pueblo referable to the A.D. 1600-1800 horizon indicates an interval of wetter conditions than occur today (bracketed between dates of 1600 and 1650) followed by one of environmental conditions similar to today's which lasted through the mid 18th century. However, the pollen samples most likely to date 1750-1800 A.D. in the Picuris series yielded no data.

The Gobernador Phase pollen record of the Navajo Reservoir pollen chronology (estimated to date 1700-1775) indicates conditions such as presently occur, but the 8 pollen samples involved do not necessarily span the entire temporal interval of the phase. Pollen records assigned to the Dinetah Phase of the Navajo Reservoir chronology document an interval of wetter conditions. This may be a reflection of the same 17th century wet phase represented at Picuris and in the tree-ring records (Fritz 1965) of 1611-20 and 1626-36, but absolute dates assigned to the Dinetah Phase (A.D. 1550-1700) are recognizably equivocal. Thus, the Navajo Horizon paleoenviromental trend from conditions as wet as those of the modern situation to drier conditions evidenced at Abiquiu Reservoir is not replicated in other extant data nor does the tree-ring record indicate the likely occurence of relatively warm-dry climatic conditions between 1600 and 1800 A.D.

If one utilizes the tree-ring record reconstruction of dry-warm and wet-cool intervals as a basis of correlation, the only paleoenviron-

The only cultigen pollen observed in the Historic Spanish Horizon samples was that of oleaster and elm. Observation of 4000 pollen grains revealed no cereal or maize pollen, nor even other rare local plants that may have been resources for food or fodder. To my astonishment, with the exception of one pollen grain of maize recovered from the feature D floor sample at AR4, none of the Navajo Horizon sediment samples contain pollen of cultigens. The number of Navajo Horizon pollen grains scanned (13,350) is without doubt adequate to allow the conclusion that cultivar pollen grains are not members of the population. There is virtually no evidence that cultivated plants were locally grown. A very poorly preserved palynomorph which might be referible to maize, and another which might be referable to an old world cereal, were recovered in samples AR33-D-2-1 and AR33-5-1 respectively. But these identifications are highly improbable as the microfossils observed lack diagnostic morphological attributes and may, actually, be spores and not pollen at all.

The samples from AR4 and AR32-B, which were analyzed in 1977 and 1978, were not subject to scans of large numbers of pollen gains. Thus there is some possibility that maize and other cultigen pollen may occur in low frequency values on the next to youngest as well as the youngest interval of masonry hogan occupation. But the statistical probability of significant evidence of cultigens at any interval of this occupation is very, very low. At its maximum, cultigen pollen presently occurs at a frequency value of 1 pollen grain in 300 during the youngest interval of occupation. It's occurrence on the next youngest interval must be less than 1 pollen grain in 4000. The evidence before us provides fairly strong indication that the Abiquiu Reservoir District was not an area in

which crops were grown during the Navajo Horizon of occupation. There is also no evidence of the cultivation of food crops during the Historic Spanish Horizon, though this is not reliable as a basis of argument. Only four Historic Spanish Horizon pollen records exist and only two of them reliably relate to occupational intervals. Since all the Historic Spanish Horizon records derive from a single site, generalization is inappropriate.

None of the ten Archaic horizon samples (involving observation of 5280 pollen grains from five sites) document the occurrence of cultigen pollen. Apparently, even though some Archaic Horizon populations of the American Southwest cultivated maize those represented in the Abiquiu Reservoir did not do so in this district.

A number of pollen analysts attribute the occurrence of high values of Chenopodineae pollen in samples of archaeological context to culturally-induced landscape disturbance (e.g. Bohrer 1966,1970). As discussed above, the evidence of the Historic Spanish Horizon pollen records does not support this inference in the Abiquiu Reservoir. Comparing the modern, non-occupation Spanish Horizon and occupation Spanish Horizon pollen records against each other, however, yields some interesting and potentially significant information on this issue.

The Modern Horizon pollen records of woodland habitats in the Navajo Reservoir and Abiquiu Reservoir districts yield AP: Artemisia pollen ratios averaging about 9:1 (range = 16:1 to 4:1). The non-occupation interval Spanish Horizon samples (N = 2) yield AP: Artemisia ratio values of 11:1, while those of the occupation interval (N = 2) yield ratio values of 14:1. High AP: Artemisia pollen ratios are

expectable for the Historic Spanish Horizon as a result of either of two behavioral practices: clearing sagebrush-dominated land for cultivation or sagebrush browsing by introduced sheep and/or goats. The Historic Spanish Horizon pollen spectra provide no basis for inference regarding which of these behaviors is more likely to account for the higher proportions of tree pollen, unfortunately, or if both are probable.

Pollen records of the Navajo Horizon, however, also yield high AP: Artemisia values and in those cases the palynological record strongly indicates that land-clearance for purposes of cultivation was not practiced. From earliest to latest, the intervals of Navajo Horizon occupation average AP: Artemisia ratio values of 13:0.2, 14:0.8, 50:0.2 and 32.6:0. Because of low sample numbers these pollen statistics are not reliable as quantitative reflections of disruptions of the ecological relationships we observe today as "normal" in modern surface samples. That is, we may have no statistical confidence in an inference that the Navajo Horizon records of Albiquiu Reservoir illustrate overgrazing beteen 3 and 30 times greater than is evident today in Navajo Reservoir. But the qualitative value of these pollen statistics as indices of overgrazing is reasonably appreciable. If the modern relationship between AP and Artemisia pollen production results from a lessening of agricultural and/or pastoral activities since the Historic Spanish Horizon, it seems probable that such ecological disruption was significantly pronounced during the later intervals of Navajo Horizon occupation. The most probable cause in that case is overgrazing by sheep and/or goats.

This inference must be qualified by recognition that almost all of the palynological record of the later intervals of Navajo Horizon

occupation derive from AR4. It is quite possible that relatively intense grazing occurred in the area of this site, but was not characteristic of the temporal interval.

It is also of interest to note that the presumed Dinetah and Gobernador Phase pollen records of the Navajo Reservoir series yield average AP: Artemisia values of 8.8:1 and 7.5:1, respectively, and are thus lower than those of the Navajo Horizon of the Abiquiu Reservoir series. These data may be taken as support of the inference that the Abiquiu series is younger, reflecting a time when pastoral activities were more significant in Navajo economy. However, this must be balanced by recognition that local cultivation of maize is evidenced palynologically for the Navajo Horizon in the Navajo Reservoir District and contra-indicated for the Abiquiu Reservoir District. Thus the lower AP: Artemisia ratios in the former area may be a function of spatially differentiated land use rather than a temporal index.

Summary

The pollen records of the Abiquiu Reservoir District may be interpreted in paleoenvironmental, chronological and behavioral terms. The modern pattern of pigmy conifer woodland vegetation which occurs at the sampled locations seems to have been that encountered by all populations inhabiting the area. Relatively drier, and presumably warmer, climatic conditions than occur today are indicated for an interval during the Historic Spanish occupation, the late intervals of Navajo Horizon occupation, and one of the two intervals of Archaic Horizon occupation.

The pollen record of the single Historic Spanish Horizon site sampled is more consistant with a post-A.D. 1900 date than any other because of the occurrence of pollen of exotic ornamental flora. The record of the Navajo Horizon is consistant with both pollen and tree-ring data relegated to the A.D. 1825-1840 period, but an alternate dating of A.D. 1650-1750 is also credible. On palynological grounds alone the more recent dating seems more likely, but the true antiquity of the masonry hogan structures and associated external hearths and middens should be determined on a wider body of evidence. The palynological records of the Archaic Horizon cannot be securely dated by correlation with independently dated records from the Colorado Plateau. Correspondences which exist between them and records from the Arroyo Cuervo District of central New Mexico suggest dates in the range of 3000-4500 B.P., but this remains an hypothesis which should be tested independently.

One of the most interesting results of the research has been development of a body of evidence suggesting that the Abiqui Reservoir District was not an area subject to significant agricultural usage during Historic Spanish, Navajo or Archaic horizons of occupancy. Sheep and goat pastoral activities are reasonably well evidenced palynologically for both Navajo and Historic Spanish occupation periods, however, with the apparent maximum of pastoralism occuring during the later intervals of usage of masonry hogan architecture. On palynological grounds, the masonry hogan settlements may be functionally diagnosed as winter encampments in which the principle economic activities seem to have been relevant to sheep and goat pastoralism.

Ethnic identification of the inhabitants of the masonry hogans is a matter of some anthropological relevance and archaeological interest. The palynological data provides only very indirect evidence, but the pollen record is not consistant with ethnohistoric accounts of intensive Navajo pastoralism unless the 19th century dating is accepted. The 17th century Cocoyes inhabitants of the area are recorded as farmers. However the political history of Navajo, Apache and Spanish interactions (Schroder 1963) suggests that Navajo settlement in the Abiquiu Reservoir District during the first half of the 19th century is not at all likely. If the ethnic identification is accurate and the masonry hogans were occupied by Navajo in the late 17th-mid 18th centuries, it would appear that the Navajo had very rapidly developed a strong subsistance-settlement committment to pastoral activities. If the mid 19th century dates for masonry hogan occupation are confirmed, it seems ethnic characterization of the population as Ute may be preferable.

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