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SEEDS OF DISCONTENT: IMPLICATIONS OF A "POMPEII" ARCHAEOBOTANICAL ASSEMBLAGE FOR GRAND CANYON ANASAZI SUBSISTENCE MODELS

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ABSTRACT.—Models of Anasazi subsistence economies in the Grand Canyon region are summarized. These models are then evaluated with new archaeobotanical evidence from a completely excavated Pueblo II Anasazi site located south of Desert View. Results of palynological and flotation analyses indicate that Anasazi subsistence along the South Rim and in the Upper Basin to the south focused on the exploitation and use of undomesticated pinyon nuts and amaranth seeds. However, it is difficult to reconcile the archaeobotanical data with the settlement's inferred permanent mode of occupation. Several alternative explanations are discussed.

INTRODUCTION

As the scope of survey and excavation has expanded in recent years, Southwestern archaeologists have recovered relevant data to support increasingly detailed pictures of Anasazi subsistence economies (e.g., Gasser 1982; Ford 1984; Gumerman 1984). This is especially true in the Grand Canyon area (Fig. 1) where regional sample surveys, supplemented by excavations in certain cases, have been conducted along the North Rim, the South Rim, and within the Inner Canyon. These studies have revealed that variation in subsistence practices was related, not surprisingly, to where the Anasazi lived in the Grand Canyon (Euler 1967).

Recent excavation of a Pueblo II Anasazi site (AZ I:1:17 (ASM)—Site 17 hereinafter), located just south of Desert View (Fig. 1), disclosed a well-preserved assemblage of archaeobotanical remains. Because Site 17 had been consumed rapidly by a catastrophic fire (Sullivan 1986), it is convenient to refer to the site's contents as "Pompeii" assemblages since they represent inventories of plants and artifacts at the time the settlement was destroyed and abandoned (Schiffer 1985).

It is important to note that this is the only substantial archaeobotanical collection recovered systematically from an archaeological site in the vast area between the South Rim and the San Francisco Peaks near Flagstaff. Also, this was the first excavation of an Anasazi site on the South Rim since the Tusayan Ruin was dug in 1929 (Haury 1931). The purpose of this paper, then, is to examine how these new data affect current views of Anasazi subsistence in the Grand Canyon area.

GRAND CANYON ANASAZI SUBSISTENCE ECONOMIES

Reconstruction of Grand Canyon Anasazi subsistence has been attempted, interestingly enough, only relatively recently. Based on fieldwork and pollen analyses conducted in the late 1960s and early 1970s (no flotation procedures were used then),

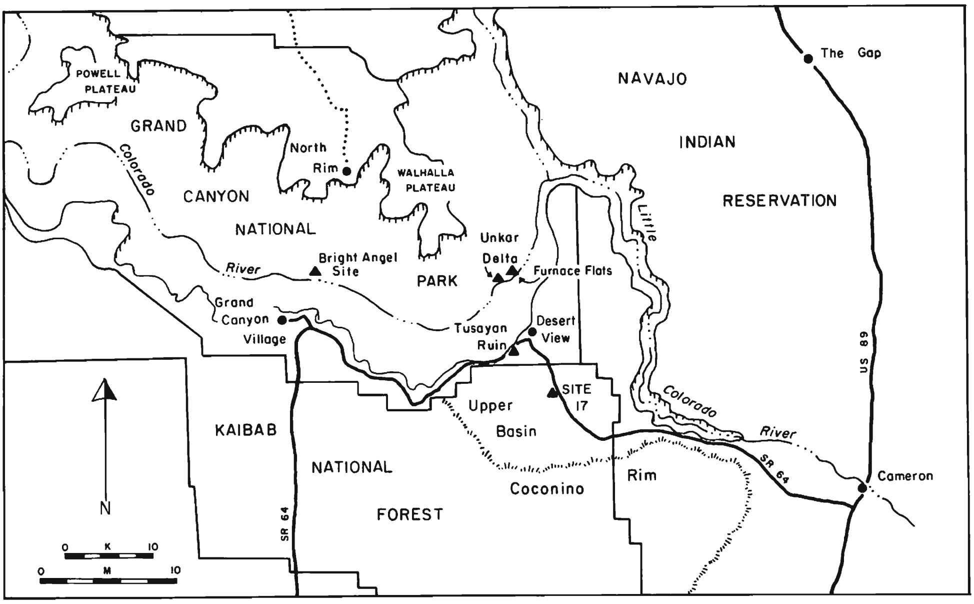

FIG. 1.—Important locations and archaeological sites in the Grand Canyon area.

Schwartz and his colleagues have posited that permanently occupied settlements (some with kivas—see Schwartz *et al.* 1979) along the Colorado River were linked with warm-season agricultural farmsteads located on the North Rim (Schwartz *et al.* 1981:6). In terms of economic organization, they argue that between A.D. 1050 and 1100, Anasazi groups were only "partially agricultural" (Schwartz *et al.* 1980:48, 175-176). Excavations at Unkar Delta (Fig. 1) produced small amounts of corn, bean, and squash pollen and relatively high frequencies of Mormon tea, cheno-am, and cactus pollen (Schwartz *et al.* 1980:179-180). Given the temperature and precipitation regimes of the Inner Canyon, it may have been possible to double-crop there (Jones 1986a:331).

Between A.D. 1100 and 1150, there appears to have been a substantial shift in economic organization. During this period of occupation on Unkar Delta, there is "indisputable evidence of agriculture" (Schwartz *et al.* 1980:185-187) in the form of terraces and check dams as well as corn, bean, and squash pollen from rooms and behind terrace alignments. However, no direct evidence was found regarding the use of wild plants (Schwartz *et al.* 1980:187).

On the North Rim, economic organization appears to have been less complex (Schwartz *et al.* 1981:39-40). Between A.D. 1050 and 1150, settlements "functioned as summer farmsteads used for temporary shelter and storage of crops by people whose winter homes were elsewhere" (Schwartz *et al.* 1981:57), presumably in the Inner Canyon (see also Jones 1986b:437).

Based on their surveys on Powell Plateau and along the South Rim, Effland *et al.* (1981) have reconstructed a rather different pattern of Anasazi resource exploitation. In view of the substantially lower frequencies of soil and water control features in these areas, Effland *et al.* (1981:41) concluded that "domesticates accounted for only a relatively small amount of the diet for these people. Products obtained from hunting and gathering provided the bulk of the subsistence base." However, the comparatively numerous one-room and two-room sites found in the Upper Basin, a subarea of the eastern South Rim (Fig. 1), led them to infer that it may have been a location of rather extensive agricultural production under the assumption that these small sites were the remains of field houses (see also Rice *et al.* 1980:24). Effland *et al.* (1981:44) also argue that in order to exploit the rich floral and faunal resources of the South Rim, especially the eastern South Rim, "an annual seasonal settlement round" was necessary.

BACKGROUND FOR SUBSISTENCE: ENVIRONMENT AND RESOURCES OF THE EASTERN SOUTH RIM AND THE UPPER BASIN

The Upper Basin occupies the area between the South Rim of the Grand Canyon and the northern tip of the Coconino Plateau (Fig. 1; Strahler 1944; Babenroth and Strahler 1945). Elevation in the basin varies from 7200 feet (2195 m) at Desert View to 6000 feet (1829 m) at the base of the Coconino Rim. Today, the area receives between 14 and 18 inches (355-457 mm) of precipitation annually (Sellers and Hill 1972:240; also Metzger 1961). At least 148 days may elapse between frosts, which is substantially greater than the 101 days that were needed to grow corn on the North Rim (Schwartz *et al.* 1981:20; also Jones 1986b).

The vegetation of the eastern South Rim and the Upper Basin is dominated by a dense pinyon-juniper forest (Merkle 1952). Here, stone and wood for lithic technology and architecture were easily procured (Rand 1965; also Fogg 1965). Large and small game (especially deer, rabbits, and wood rats) were relatively abundant as were edible and nonedible plant products—pinyon nuts, juniper and amaranth seeds, pitch, yucca fiber, and sagebrush bark (see especially Schellbach 1933; McHenry 1934). Given the resources of the eastern South Rim and the Upper Basin, how do current subsistence models for the Grand Canyon Anasazi fare in view of excavated data from Site 17?

SAMPLING FOR SUBSISTENCE AT SITE 17

Excavations at Site 17 revealed the remains of a small Anasazi settlement (Fig. 2) that was occupied between A.D. 1049 and 1064 based on a tight clustering of 34 tree-ring dates (Fig. 3; Sullivan 1986:152-154). Architecturally, the site is composed of a semi-subterranean masonry structure (Structure 1) built in A.D. 1049 (remodelled in A.D. 1057) and three log-walled timber and brush structures (Structure 4 was built in A.D. 1056; Structures 2 and 3 were built in A.D. 1058; see Fig. 4). Extensive trenching and extramural stripping uncovered an area where ceramic vessels were made and fired (F-8 and F-38 in Fig. 2). No other exterior features that date to the main occupation of the site were found. As mentioned, during occupation this small settlement was destroyed catastrophically by fire. Fortunately, from an archaeobotanical point of view, the heavy roofs composed of timbers, poles, brush, and earth collapsed directly upon the occupied floors below, thereby producing a "Pompeii" assemblage of *in situ* botanical remains (Table 1) and artifact arrays.

All deposits, with the exception of backhoe trench spoil, were sifted through .25 inch (6.4 mm) mesh screens. This resulted in the recovery of three charred macrobotanical specimens from the floor of the masonry structure: two small 8-row corn cobs (Harinoso de Ocho: C. Miksicek, pers. comm.; cf. Cutler and Blake 1980) and a whorl of processed yucca *(Y. baccata)* fiber. All other archaeobotanical specimens were found in 17 flotation samples and 5 pollen samples taken from a variety of primary depositional contexts throughout the site (Fig. 2; cf. Toll 1984:244). Interestingly, no faunal remains that date to the main occupation of the settlement were recovered.

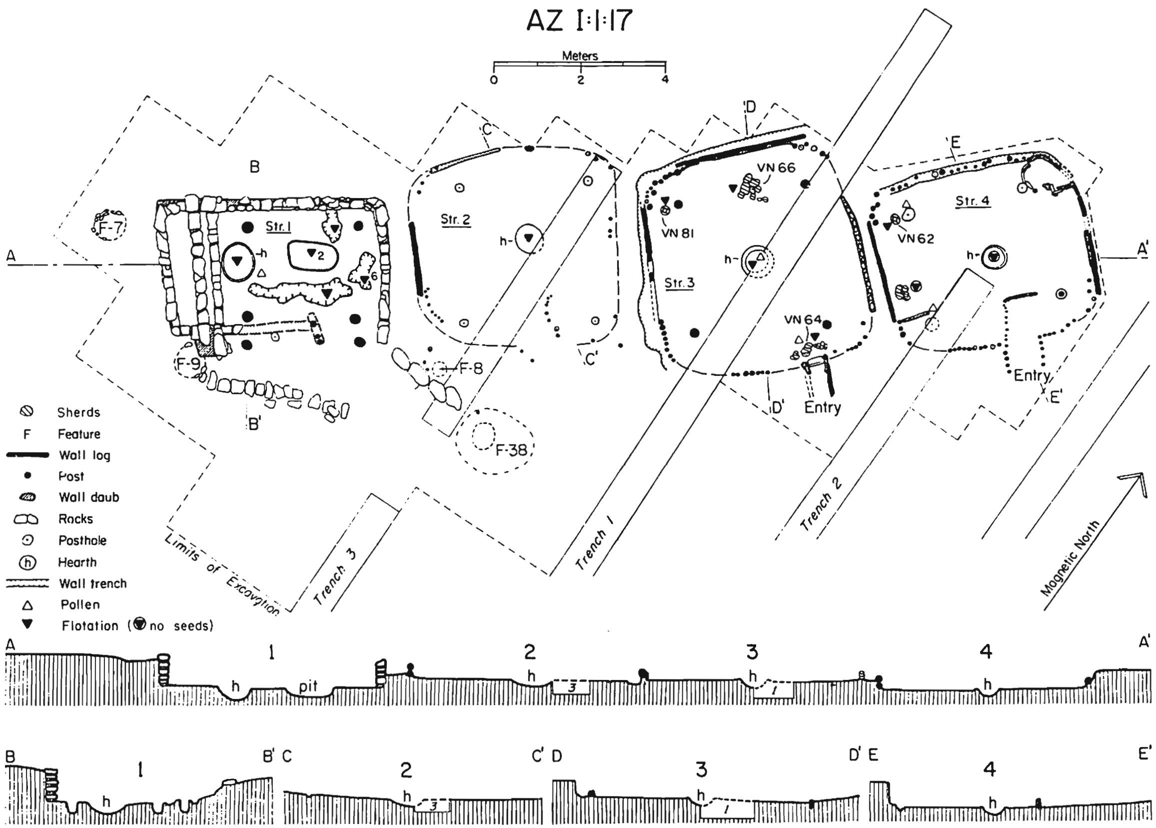

FIG. 2.—Map of Site 17 (AZ I:1:17 (ASM)) showing locations of pollen samples (open triangles) and flotation samples (filled triangles) plus other significant features of the site. The three ticket features in Structure 1 are unlined pits. The unticked feature in Structure 1 that is not labelled with a (h) is a clay-lined pit. All hearths (h) are clay-lined.

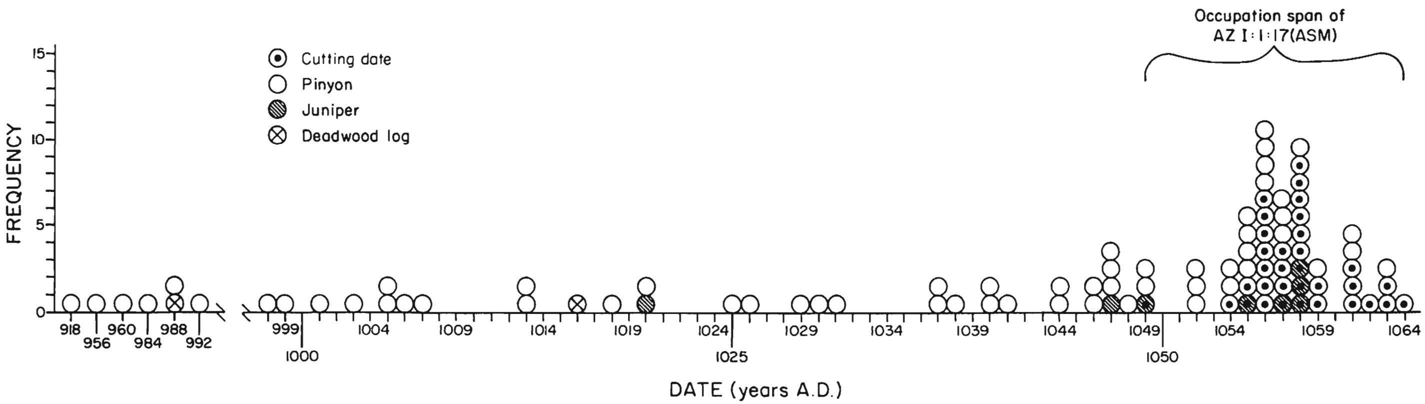

FIG. 3.—Histogram of cutting and noncutting tree-ring dates. Occupation span was determined by the range of cutting dates (A.D. 1049-1064).

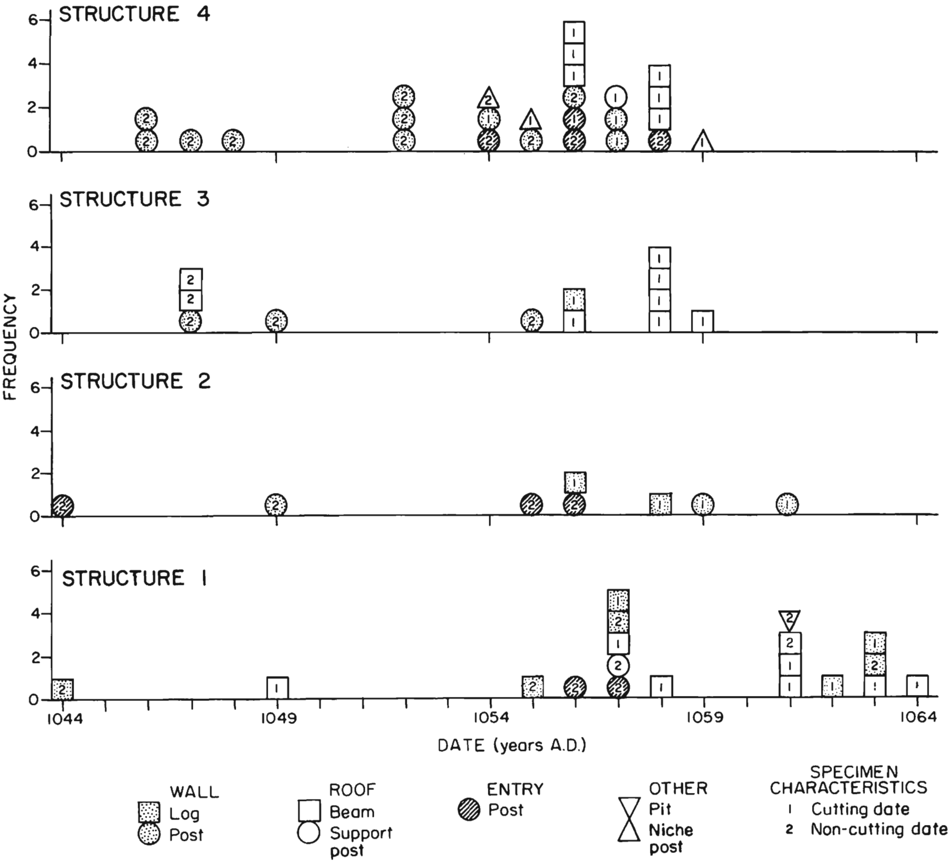

FIG. 4.—Histograms of cutting and noncutting tree-ring dates for all structures.

ARCHAEOBOTANICAL REMAINS FROM SITE 17

Palynological analysis revealed no domesticate pollen (Davis 1986:335). This is rather surprising since (a) five samples were from behavioral proveniences (one each from the floors of Structures 1 and 3, two from the floor of Structure 4, and one from the plastered hearth of Structure 3); (b) at least 200 grains were counted in each sample; and (c) as mentioned, corn macroremains had been recovered during excavation (cf. Bohrer 1981). These data suggest that domesticates, and corn in particular, were not processed in the settlement's structures (Davis 1986:335).

The composition of 17 flotation samples, broken down by taxon, structure, and provenience, is presented in Table 2 and represents a slight reworking of previously published data (for details on processing procedures, preservation, and contents of specific samples see Scott 1986). The information in Table 2 reflects the following collection and processing procedures. First, enough dirt was collected from the target provenience to fill one-half of a standard-sized #12 bag (ca. 4.7 liters). Second, depending on the size of the feature or vessel being sampled, the number of samples per provenience may have varied (see Table 2) as did, therefore, the quantity of soil floated (generally between 4

TABLE 1.—*Taxa identified in archaeobotanical samples from Site 17.*

TAXON	COMMON NAME
Amaranthus sp.	Amaranth (pigweed)
Chenopodium sp.	Chenopod (goosefoot)
Juniperus osteosperma (Torr.) Little	Juniper
LEGUMINOSEAE	Legume
Opuntia sp.	Cactus (prickly pear)
GRAMINEAE*	Grass
Pinus edulis Engelm.	Pinyon
Portulaca sp.	Purslane
Trifolium sp.**	Clover
Vitis sp.**	Grape
Zea mays	Corn

*Includes one *Oryzopsis* sp. seed and two unidentified grass seeds.

**Represented by a single seed (not included in subsequent analyses).

liters and 10 liters; Scott 1986:339). And third, due to the large volume of floated material "a minimum of 25 percent of each light fraction was examined" (Scott 1986:339).

In order to develop settlement-wide economic interpretations of the data in Table 2, the following strategy was adopted. The 17 samples were separated into two major classes: (a) all floor features (i.e., unlined pits, clay-lined pits, and hearths) and floor contact vessels and (b) hearths and floor contact vessels only. By restricting analysis only to floor contact samples, the possibility of including material that originated from architectural debris and post-occupational processes was reduced considerably (Doebley 1981:182). Also, I assumed that the contents of all floor features and vessels might include the plants or plant parts that had been processed and stored prior to the destruction of the settlement as well as any low frequency residuals that might be indicative of long-term plant use (Minnis 1981:145). Similarly, by examining the contents of hearths and vessels only, it seemed reasonable to expect that information regarding patterns of daily plant use might be revealed (cf. Hally 1981:724).

The data in Table 2 were also broken down in terms of (a) all plant forms (i.e., charred and uncharred seeds and seed fragments, twigs, and needles) and (b) charred seeds and seed fragments only (Toll 1984:245). The purpose of this aspect of the analysis was to segregate those botanical remains that may have been food—seeds and seed fragments—from those that represented other types of plant use (Minnis 1981:147). For example, the juniper twigs and pinyon needles recovered from the hearths of Structures 1, 2, and 3 (see Table 2) undoubtedly are the remains of fuel or fire-starting tinder (Madsen 1986:31; also Phillips 1909:220). The charred and uncharred needles from the clay-lined and unlined pits in Structure 1 may have been roofing material or boughs used for bedding (Adams 1980:59-61; also McHenry 1934:265), while the 100+ charred needles from a small Black Mesa Black-on-white pitcher (VN 81) on the floor of Structure 3 most likely are the residue from a medicinal decoction (Lanner 1981:62; also Schellbach 1933:224). In contrast, the hundreds of pinyon nuts and fragments recovered from a broken jar on the floor of Structure 3 (VN 66) and an intact jar on the floor of Structure 4 (VN 62) clearly represent stored food (cf. Lanner 1981:71; Madsen 1986:31-34).

Table 2.—*Archaeobotanical specimens (seeds unless noted otherwise) recovered from floor pits, hearths, and vessels at Site 17 (from Scott 1986:342).*

	Structure 1				Structure 2	Structure 3				Structure 4	
	Lined Pit (n = 2)	Unlined Pits (n = 8)		Hearth	Hearth	Hearth	VN64	VN66	VN81	VN62	
	Charred	Charred	Uncharred	Charred	Charred	Charred	Charred	Charred	Charred	Charred	TOTAL
JUNIPER											
Seeds/fragments	6	2		3	2		1				14
Twigs	4	11	6	3							24
PINYON											
Seeds/fragments		4		2	1		1	100 + [b]		200 + [c]	308 +
Needles	40	62[a]		100 +	14	7	11		100 +		334 +
AMARANTH	48	34	1	250 +							333 +
CHENOPOD	22	90		10							122
LEGUME	1	8									9
CACTUS								2		2	4
GRASS		2	1								3
PURSLANE	1	1		1							3
CORN											
Kernels/fragments										4	4
Cob fragments				2							2
TOTAL	122	214	8	371 +	17	7	13	102 +	100 +	206 +	1160 +

a = includes 5 twigs; b = seeds only; c = seed fragments only; n = number of samples; VN = vessel number

ASPECTS OF ARCHAEOBOTANICAL ASSEMBLAGE QUANTIFICATION

Describing variability among archaeobotanical samples is a matter of considerable methodological discussion. Two measures dominate the literature. Relative abundance, which is the proportion of seeds of a specific taxon in a given assemblage, is frequently used as a gauge of prehistoric floral importance (Miksicek 1983). According to Minnis (1986:209), though, relative abundance monitors the magnitudes of past accidents of preservation. Thus, a small number of spills can seriously bias the representation of individual taxa in macrofloral assemblages (also Adams 1980:9). With regard to the data from Site 17, the "bias by accident" problem is controlled to a large extent because nuts stored in vessels are obviously not accidents of preservation (cf. Hally 1981:729-730). One problem with relative abundance, however, is that taxa proportions are not independent on one another, i.e., the proportion of a specific taxon is dependent on the proportions of others (Miksicek 1983:679-680). More importantly, perhaps, relative abundance does not take into account the spatial distribution of a particular taxon because samples are lumped when proportions are calculated.

Ubiquity, which refers to the percentage of samples that produced specimens of a specific taxon, "tends to measure the number of accidents that occurred, which may in turn be a measure, albeit imprecise, of the degree of processing and consequently of the use of that taxon" (Minnis 1986:210). However, ubiquity values may overrepresent specific taxa because the occurrence of a single seed or several hundred seeds in a given sample are analytically equivalent (Miksicek 1986). Thus, while ubiquity controls for spatial variation among macrofloral samples, it exaggerates differences in content diversity by inflating the importance of uncommon types (Minnis 1980:380).

Relative abundance and ubiquity measure different aspects of archaeobotanical assemblage variability. Fortunately, the advantages and disadvantages of each counterbalance one another. For this reason, relative abundance and ubiquity values were calculated for both groups of samples and types of plant remains.

PATTERNS OF PLANT USE AT SITE 17

When all floor features and vessels are considered (Table 3 and Fig. 5), it is clear that pinyon is relatively abundant and ubiquitous (cf. Gasser 1981:312). Furthermore, charred pinyon, amaranth, and chenopod seeds are all moderately abundant and ubiquitous suggesting that they were major components of the diet. It also is evident that corn remains were neither abundant nor ubiquitous (cf. Doebley 1981; Minnis 1986:212); neither were cactus, grass, purslane, and charred juniper seeds (cf. Bohrer 1973; Adams 1980:21-31). Thus, it is likely that this latter set of archaeobotanical remains, including perhaps the corn as well, may represent the remnants of an earlier plant use pattern (see Hally 1981:737-740).

This picture is refined by focusing only on the relative abundance and ubiquity of plant remains recovered from hearths and floor contact ceramics (Table 4). Because these samples are *in situ* materials (Miksicek 1986) from storage vessels (VNs 62, 64, 66, and 81) and hearths (in Structures 1, 2, and 3), they are a snapshot of the taxa that had been harvested and processed just prior to the destruction of Site 17. Based on the data depicted in Fig. 6, only pinyon, charred pinyon nuts, and charred amaranth seeds are relatively abundant; pinyon remains and charred pinyon nuts also are very ubiquitous whereas charred amaranth seeds are not (cf. Jones 1986c:267). These data are strong evidence for the proposition that pinyon nuts and, to a lesser extent, amaranth seeds, were the primary dietary staples when the settlement was consumed by fire (cf. Ford 1984:131).

TABLE 3.—*Relative abundance and ubiquity of taxa recovered from all floor features and vessels at Site 17 (N = 1160 specimens from 17 samples).*

TAXON	RELATIVE ABUNDANCE All Parts	RELATIVE ABUNDANCE Charred Seeds and Fragments	UBIQUITY All Parts	UBIQUITY Charred Seeds and Fragments
Juniper	3.3	1.2	64.7	29.4
Pinyon	55.3	26.6	100.0	47.1
Amaranth	28.7	28.6	58.8	58.8
Chenopod	10.5	10.5	58.8	58.8
Legume	0.8	0.8	17.6	17.6
Cactus	0.3	0.3	11.8	11.8
Grass	0.3	0.2	17.6	11.8
Purslane	0.3	0.3	17.6	17.6
Corn	0.5	0.3	11.8	11.8

In addition, there may have been a slight difference in how these two taxa were treated. Because pinyon nuts are ubiquitous, relatively abundant, and occur in a variety of contexts and forms, it is likely that they were being processed, stored, and (in some cases) consumed throughout the settlement (Madsen 1986:31-34). On the other hand, the relatively abundant yet concentrated amaranth seeds in the hearth of Structure 1

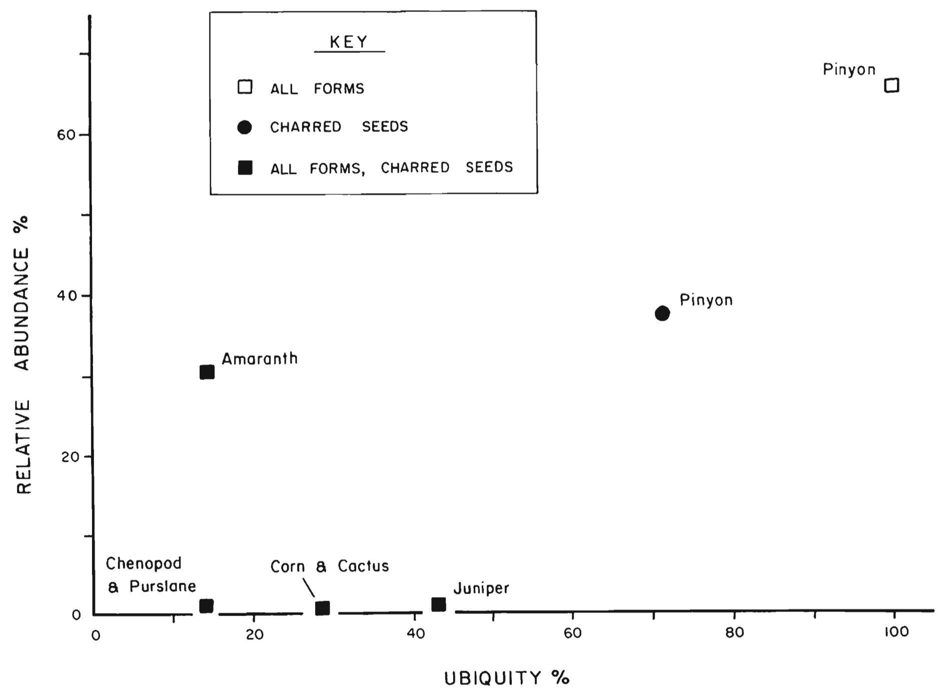

FIG. 5.—Plot of ubiquity and relative abundance values for all taxa recovered from all floor features (unlined pits, clay-lined pits, and hearths) and floor contact vessels.

may have been cooked as soon as they had been gathered and brought back to the settlement, rather than processed and stored for consumption at a later date (Adams 1980:59-60).

One clear fact emerges from these analyses. There is no way the data can be manipulated that would warrant any conclusion other than at the time of the settlement's destruction, its inhabitants were basically consumers of undomesticated seeds and nuts (primarily pinyon). Although corn kernels and cobs were found, their contexts of recovery and their forms (see Table 2) suggest that the consumption of maize was an inconsequential aspect of this Anasazi household's diet (cf. Gumerman 1984:84-85).

TABLE 4.—*Relative abundance and ubiquity of taxa recovered from hearths and vessels at Site 17 (N = 816 specimens from 7 samples).*

TAXON	RELATIVE ABUNDANCE All Parts	RELATIVE ABUNDANCE Charred Seeds and Fragments	UBIQUITY All Parts	UBIQUITY Charred Seeds and Fragments
Juniper	1.1	0.7	42.9	42.9
Pinyon	65.7	37.3	100.0	71.4
Amaranth	30.6	30.6	14.3	14.3
Chenopod	1.2	1.2	14.3	14.3
Legume	0.0	0.0	0.0	0.0
Cactus	0.5	0.5	28.6	28.6
Grass	0.0	0.0	0.0	0.0
Purslane	0.1	0.1	14.3	14.3
Corn	0.7	0.5	28.6	28.6

"POMPEII" ARCHAEOBOTANICAL ASSEMBLAGES: HOW REPRESENTATIVE?

The conclusion that the occupants of Site 17 were seed and nut eaters rather than corn consumers is based on a well-preserved archaeobotanical assemblage from a tightly-dated site. This "Pompeii" assemblage, however, represents the composition of the household larder on the day the settlement burned and thus presents two interpretive possibilities depending on how its representativeness is viewed (Hally 1981).

The assemblage from Site 17 is quite different than that of an Anasazi site—Furnace Flats—located in the eastern Inner Canyon (Jones 1986a; see Fig. 1). High ubiquity of corn remains and cheno-am seeds from Furnace Flats led the investigator to conclude that this small Pueblo II site was occupied during the late summer and that the "cultivation of corn provided a good portion of the total foodstuffs but was supplemented by wild and gathered foods, such as tree legumes, cacti, and chenopods" (Hutira 1986:289). In view of the Furnace Flats evidence, the assemblage from Site 17 may reflect plant use patterns associated with corn crop failure (cf. Bohrer 1975). This inference is based on the assumption that these people were maize agriculturalists (cf. Wagner *et al.* 1984:616) whose food production system had proved unreliable, thus necessitating extensive use of undomesticated plants (Doebley 1984:52). The corn kernels and cobs recovered at Site 17, then, may have come from previous corn crops that had been successfully grown and harvested, albeit at some distance from the settlement.

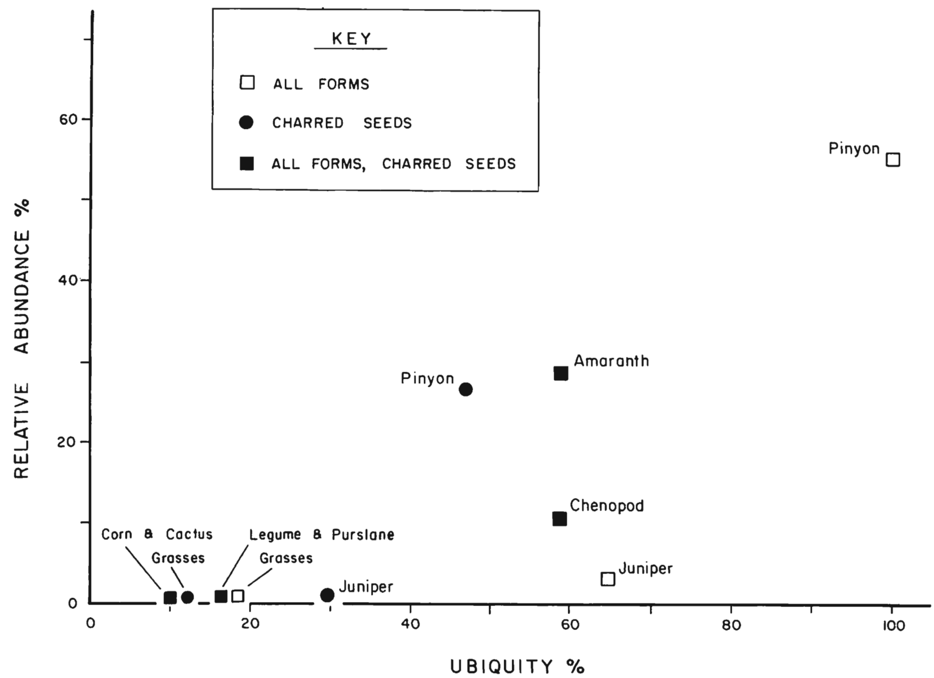

FIG. 6.—Plot of ubiquity and relative abundance values for all taxa recovered from hearths and floor contact vessels.

The other alternative is that corn agriculture was never a major component of Anasazi subsistence along the eastern South Rim and, therefore, the floral assemblage from Site 17 is representative of the yearly plant use pattern (see Gasser 1982:46 ff.). A consideration of the availability of corn, amaranth, and pinyon provides some support for this possibility. As a warm season annual, amaranth may be procured between June and September (Bye 1981:110-114; also Adams 1980:21). Pinyon nuts, however, are not ready for harvesting until the beginning of October (Martin 1973:1450; Madsen 1986:29). In terms of scheduling, therefore, the harvesting periods of amaranth and pinyon do not overlap. Each, however, overlaps with corn which is harvestable in late summer and early fall (Minnis 1985:316, 330). If corn had been available, then it is reasonable to expect that some of it would have been collected along with the amaranth (or vice versa—see especially Winter and Hogan 1986:119-121, 123, 138). Thus, the absence of corn pollen very well may mean that corn was not grown in the vicinity of the settlement and that, in addition, even if corn had been introduced to the settlement in a processed form, it was never an important element of the diet (cf. Gasser 1981:312).

SEEDS OF DISCONTENT: DISCUSSION

The extensive collection of undomesticated plant remains recovered from Site 17 presents a problem in archaeobotanical interpretation. Based on current thinking about Anasazi subsistence (e.g., Gasser 1982; Gumerman 1984; Wagner *et al.* 1984), it is difficult to reconcile the seed and nut remains with other aspects of Site 17. For example, the following characteristics suggest a perennial (e.g., Schwartz *et al.* 1980:67-74;

also Gumerman 1984:90) rather than a seasonal (e.g., Schwartz *et al.* 1981:45, 52-57; also Epstein and Schwartz 1951:83-85) occupational mode:

(a) annual repair and rebuilding events (based on clusters of tree-ring dates; see Fig. 4);

(b) summer tree-cutting activity (all tree-ring samples, with three exceptions, have incomplete terminal growth rings: J. S. Dean, pers. comm.);

(c) bedrock floors (Structures 1 and 4) and plaster floors (Structures 2 and 3);

(d) a wide range of moderately large-sized rooms (11.5 - 22.6 square meters);

(e) postholes sunk 35-50 cm into bedrock;

(f) clay-lined hearths in each structure; and

(g) functionally-specific room (grinding stones were found only in Structure 4; Structure 1 was probably a foul-weather living room (its semi-subterranean walls were clay-lined) and Structure 3 a fair-weather living room).

Thus, if Site 17 represents the remains of a permanently occupied habitation site, then (a) subsistence was based primarily on nuts and seeds (e.g., Martin 1973:1449-1450; also Madsen 1982) or (b) nuts and seeds were simply backup foods when domesticates were unavailable (Lentz 1984:198-199). Unfortunately, even though the entire site was excavated and all contents screened, there are presently no available archaeological or archaeobotanical data that can eliminate either possibility. Clearly, the near absence of corn, a domesticated dietary staple that generally is associated with habitation sites in the Grand Canyon area and elsewhere throughout Anasazi country (e.g., Toll 1984), is most unexpected.

ANASAZI SUBSISTENCE ECONOMY IN THE GRAND CANYON AREA: SUMMARY AND CONCLUSIONS

A reanalysis of archaeobotanical data from Site 17 provides a foundation for evaluating current subsistence economy models for the Grand Canyon Anasazi. First, many of the one-room archaeological sites—which Site 17 appeared to be prior to excavation—along the South Rim and in the Upper Basin may not have been related to agricultural production. Thus, previous archaeological surveys that interpreted these sites as the remains of fieldhouses may have exaggerated the importance of prehistoric agriculture in the area. Based on current evidence, farming in the Inner Canyon and on the North Rim probably exceeded that of the eastern South Rim and the Upper Basin (cf. Effland *et al.* 1981:40).

Second, it appears that small, well-built settlements may have been occupied (for various spans of time) by autonomous households that made pottery and subsisted mainly on undomesticated nuts and seeds (cf. Rice *et al.* 1980:58). This rather unconventional interpretation of an Anasazi habitation site (cf. Gumerman 1984:142-144) implies that, overall, there was substantially more variation in land-use, settlement, and subsistence patterns along the South Rim and in the Upper Basin than previous workers have suggested on the basis of survey data alone (e.g., Effland *et al.* 1981; also Euler and Chandler 1978).

Finally, there appear to be striking differences between the North Rim and the South Rim in terms of economic organization. The economic pattern of the North Rim/Inner Canyon Anasazi can best be described as a system structured on both delayed returns (e.g., food production and environmental manipulation) and immediate returns (e.g., collecting and encounter hunting—Woodburn 1980:98-99), although given the evidence presented above, there may have been somewhat more of an emphasis on delayed or indirect resource procurement (see Bailey 1981:7). Furthermore, the presence of kivas at many Inner Canyon sites may indicate a concern with activity scheduling and with past and future events, features often associated with societies whose economic systems are not based exclusively on immediate returns (Woodburn 1980:97-98, 107).

In contrast, Anasazi economic organization on the South Rim and in the Upper Basin was based largely on a system of immediate returns through direct resource exploitation. Such patterns are especially useful in broad spectrum environments like the Upper Basin (Bailey 1981:6). The lack of evidence of kivas along the South Rim (Rice *et al.* 1980:22), until late in the occupational sequence (Haury 1931; Bannister *et al.* 1968:11), fits well with Woodburn's immediate return model.

A major lesson from Site 17 is that the emerging picture of robust variation in Grand Canyon Anasazi subsistence practices must be balanced by a consideration of the many factors—cultural and noncultural—that affect the composition of archaeobotanical assemblages (Bohrer 1986:36-38). For the future, archaeological research in the Grand Canyon area (cf. Euler 1974; also Schwartz *et al.* 1980:177) must concentrate on obtaining comparative botanical material from excavated sites. It is crucial to determine, for example, whether the "Pompeii" assemblage from Site 17 is simply a well-preserved, though seasonally skewed, archaeobotanical sample that reflects autumnal plant use strategies necessitated by an inadequate corn harvest (or perhaps outright crop failure). If this possibility can be eliminated by the excavation of sites that date to the same occupational horizon, then the South Rim and the Upper Basin may have been occupied by Anasazi who survived, in fact, largely by eating undomesticated nuts and seeds.

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LITERATURE CITED

ADAMS, KAREN R. 1980. Pollen, Parched Seeds and Prehistory: A Pilot Investigation of Prehistoric Plant Remains from Salmon Ruin, a Chacoan Pueblo in Northwestern New Mexico. Eastern New Mexico Univ. Contributions in Anthrop. No. 9.

BABENROTH, DONALD L. and ARTHUR N. STRAHLER. 1945. Geomorphology and structure of the East Kaibab Monocline, Arizona and Utah. Bull. Geo. Soc. of America 56:107-150.

BAILEY, G. N. 1981. Concepts of resource exploitation: continuity and discontinuity in paleoeconomy. World Arch. 13:1-15.

BANNISTER, BRYANT, JEFFREY S. DEAN and WILLIAM J. ROBINSON. 1968. Tree-Ring Dates from Arizona C-D: Eastern Grand Canyon-Tsegi Canyon-Kayenta Area. Lab. Tree-Ring Research, Univ. Arizona, Tucson.

BOHRER, VORSILA L. 1973. Ethnobotany of Point of Pines Ruin, Arizona W:10:50. Econ. Botany 27:423-437.

__________. 1975. The prehistoric and historic role of the cool-season grasses in the Southwest. Econ. Botany 29:199-107.

__________. 1981. Methods for recognizing cultural activity from pollen at archaeological sites. Kiva 46:135-142.

LITERATURE CITED (continued)

__________. 1986. Guideposts in ethnobotany. J. Ethnobiol. 6:27-43.

BYE, ROBERT A., JR. 1981. Quelites—ethnoecology of edible greens—past, present, and future. J. Ethnobiol. 1:109-123.

CUTLER, HUGH C. and LEONARD W. BLAKE. 1980. Plant materials from Grand Canyon sites. Pp. 209-212 *in* Archaeology of the Grand Canyon: Unkar Delta (by Douglas W. Schwartz, Richard C. Chapman, and Jane Kepp). School of American Research Press, Santa Fe.

DAVIS, OWEN K. 1986. Pollen analysis from AZ I:1:17(ASM). Pp. 333-338 *in* Prehistory of the Upper Basin, Coconino County, Arizona (by Alan P. Sullivan, III). Arizona State Museum Archaeological Series No. 167.

DOEBLEY, JOHN F. 1981. Plant remains recovered by flotation from trash at Salmon Ruin, New Mexico. Kiva 46:169-187.

__________. 1984. "Seeds" of wild grasses: a major food of Southwestern Indians. Econ. Botany 38:52-64.

EFFLAND, RICHARD W., A. TRINKLE JONES and ROBERT C. EULER. 1981. The Archaeology of Powell Plateau: Regional Interaction at Grand Canyon. Grand Canyon Natural History Association Monograph No. 3.

EPSTEIN, JEREMIAH F. and DOUGLAS W. SCHWARTZ. 1951. Structures. Pp. 55-86 *in* The Cohonina Culture of Northwestern Arizona (John C. McGregor, ed.). Univ. Illinois Press, Urbana.

EULER, ROBERT C. 1967. The canyon dwellers. American West 4:22-27, 67-71.

__________. 1974. Future archaeological research in Grand Canyon. Plateau 46:139-148.

__________ and SUSAN M. CHANDLER. 1978. Aspects of prehistoric settlement patterns in Grand Canyon. Pp. 73-86 *in* Investigations of the Southwestern Anthropological Research Group (Robert C. Euler and George J. Gumerman, eds.). Mus. No. Ariz., Flagstaff.

FOGG, GEORGE G. 1965. The pinyon pines and man. Econ. Botany 20:103-105.

FORD, RICHARD I. 1984. Ecological consequences of early agriculture in the Southwest. Pp. 127-138 *in* Papers on the Archaeology of Black Mesa, Arizona, Volume II (Stephen Plog and Shirley Powell, eds.). So. Ill. Univ. Press, Carbondale.

GASSER, ROBERT E. 1981. Flotation analysis. Pp. 309-319 *in* Prehistory of the St. Johns Area, East-central Arizona: The TEP St. Johns Project (by Deborah A. Westfall). Arizona State Museum Archaeological Series No. 153.

__________. 1982. Anasazi diet. Pp. 8-95 *in* The Coronado Project Archaeological Investigations, The Specialists' Volume: Biocultural Analyses (Robert E. Gasser, comp.). MNA Research Paper No. 23. Mus. N. Ariz., Flagstaff.

GUMERMAN, GEORGE J. 1984. A View from Black Mesa: The Changing Face of Archaeology. Univ. Arizona Press, Tucson.

HALLY, DAVID J. 1981. Plant preservation and the content of paleobotanical samples: a case study. Amer. Ant. 46:723-742.

HAURY, EMIL W. 1931. Kivas of the Tusayan Ruin, Grand Canyon, Arizona. Medallion Papers No. 9. Gila Pueblo, Globe.

HUTIRA, JOHNA. 1986. Analysis of plants, pollen, and coprolites. Pp. 268-322 *in* A Cross Section of Grand Canyon Archeology: Excavations at Five Sites along the Colorado River (by Anne Trinkle Jones). Western Archeological and Conservation Center Pub. in Anthrop. No. 28.

JONES, ANNE TRINKLE. 1986a. A Cross Section of Grand Canyon Archeology: Excavations at Five Sites along the Colorado River. Western Archeological and Conservation Center Pub. in Anthrop. No. 28.

__________. 1986b. Agricultural systems at Grand Canyon: Walhalla Glades. Western Anasazi Reports 3:406-441.

__________. 1986c. Spatial and Temporal Variation in Grand Canyon Subsistence and Technology. Western Anasazi Reports 3:260-272.

LANNER, RONALD M. 1981. The Pinon Pine: A Natural and Cultural History. Univ. Nevada Press, Reno.

LENTZ, DAVID L. 1984. Utah juniper *(Juniperus osteosperma)* cones and seeds from Salmon Ruin, New Mexico. J. Ethnobiol. 4:191-200.

MADSEN, DAVID B. 1982. Get it where the gettin's good: a variable model of Great

LITERATURE CITED (continued)

Basin subsistence and settlement based on data from the eastern Great Basin. Pp. 207-226 *in* Man and Environment in the Great Basin (David B. Madsen and James F. O'Connell, eds.). Soc. Amer. Arch. Papers No. 2.

__________. 1986. Great Basin nuts: a short treatise on the distribution, productivity, and prehistoric use of pinyon. Pp. 21-41 *in* Anthropology of the Desert West: Essays in Honor of Jesse D. Jennings (Carol J. Condie and Don D. Fowler, eds.). Univ. Utah Anthrop. Papers No. 110. Univ. Utah Press, Salt Lake City.

MARTIN, JOHN F. 1973. On the estimation of the sizes of local groups in a hunting-gathering environment. Amer. Anthro. 75:1448-1468.

McHENRY, DONALD E. 1934. Indian uses of juniper in the Grand Canyon region. Grand Canyon Nature Notes 9:261-271.

MERKLE, JOHN. 1952. An analysis of a pinyon-juniper community at Grand Canyon. Ecology 33:375-384.

METZGER, D. G. 1961. Geology in relation to availability of water along the South Rim, Grand Canyon National Park, Arizona. Geological Survey Water Supply Paper 1475-C.

MIKSICEK, CHARLES H. 1983. Archaeobotanical aspects of Las Fosas: a statistical approach to prehistoric plant remains. Pp. 671-700 *in* Hohokam Archaeology along the Salt-Gila Aqueduct (Lynn S. Teague and Patricia L. Crown, eds.). Arizona State Museum Archaeological Series No. 150 (vol. VI, parts V and VI).

__________. 1986. Formation processes of the archaeobotanical record. *In press* Advances in Archaeological Method and Theory (Michael B. Schiffer, ed.). Academic Press, New York.

MINNIS, PAUL E. 1980. Prehistoric puebloan food and fuel: the macroplant evidence from Dead Valley, Arizona. Pp. 371-388 *in* Prehistory in Dead Valley Arizona, east-central Arizona: the TG&E Springerville Report (David E. Doyel and Sharon S. Debowski, eds.). Arizona State Museum Archaeological Series No. 144.

__________. 1981. Seeds in archaeological sites: sources and some interpretive problems. Amer. Antiquity 46:143-152.

__________. 1985. Domesticating people and plants in the Greater Southwest. Pp. 309-339 *in* Prehistoric food production in North America (Richard I. Ford, ed.). Mus. of Anthrop. Univ. Michigan Anthropol. Papers No. 75.

__________. 1986. Macroplant remains. Pp. 205-218 *in* Short-Term Sedentism in the American Southwest: The Mimbres Valley Salado (Ben A. Nelson and Steven A. LeBlanc, eds.). Maxwell Mus. of Anthrop. and Univ. New Mexico Press, Albuquerque.

PHILLIPS, F. J. 1909. A study of pinon pine. Botanical Gazette 48:216-223.

RAND, PATRICIA J. 1965. Factors Related to the Distribution of Ponderosa and Pinyon Pines at Grand Canyon. Unpubl. Ph.D Dissert. (Botany), Duke Univ., Chapel Hill.

RICE, GLEN, RICK EFFLAND and LAURIE BLANK-ROPER. 1980. A Sample Survey of Tusayan Planning Unit 1, Kaibab National Forest, Arizona. Cultural Resources Report 33. USDA Forest Service, Southwestern Region, Albuquerque.

SCHELLBACH, LOUIS, III. 1933. Indian use of the pinyon pine in the Grand Canyon region. Grand Canyon Nature Notes 8: 217-227.

SCHIFFER, MICHAEL B. 1985. Is there a "Pompeii Premise" in archaeology? J. Anthro. Res. 41:18-41.

SCHWARTZ, DOUGLAS W., RICHARD C. CHAPMAN and JANE KEPP. 1980. Archaeology of the Grand Canyon: Unkar Delta. School of American Research Press, Santa Fe.

SCHWARTZ, DOUGLAS W., JANE KEPP and RICHARD C. CHAPMAN. 1981. Archaeology of the Grand Canyon: Walhalla Plateau. School of American Research Press, Santa Fe.

SCHWARTZ, DOUGLAS W., MICHAEL P. MARSHALL and JANE KEPP. 1979. Archaeology of the Grand Canyon: The Bright Angel Site. School of American Research Press, Santa Fe.

SCOTT, LINDA J. 1986. Analysis of selected macrofloral samples from AZ I:1:17(ASM). Pp. 339-346 *in* Prehistory of the Upper Basin, Coconino County, Arizona (by Alan P. Sullivan, III). Arizona State Museum Archaeological Series No. 167.

LITERATURE CITED (continued)

SELLERS, WILLIAM D. and RICHARD H. HILL. 1972. Arizona Climate. Univ. Arizona Press, Tucson.

STRAHLER, ARTHUR N. 1944. A guide to the East Kaibab Monocline in the Grand Canyon region. Plateau 17:1-13.

SULLIVAN, ALAN P., III. 1986. Occupational dynamics of a small Kayenta Anasazi settlement. Pp. 47-190 *in* The Prehistory of the Upper Basin, Coconino County, Arizona (by Alan P. Sullivan, III). Arizona State Museum Archaeological Series No. 167.

TOLL, MOLLIE S. 1984. Taxonomic diversity in flotation and macrobotanical assemblages from Chaco Canyon. Pp. 241-250 *in* Recent research on Chaco prehistory (W. James Judge and J. D. Schelberg, eds.). Reports of the Chaco Center No. 8. National Park Service, Albuquerque.

WAGNER, GAIL, TRISTINE SMART, RICHARD I. FORD and HEATHER TRIGG. 1984. Ethnobotanical recovery, 1982: summary of analysis and frequency tables. Pp. 613-632 *in* Excavations on Black Mesa, 1982: A descriptive report (Deborah L. Nichols and F. E. Smiley, eds.). So. Ill. Univ. at Carbondale, Center for Archaeological Investigations Research Paper No. 39.

WINTER, JOSEPH C. and PATRICK F. HOGAN. 1986. Plant Husbandry in the Great Basin and adjacent northern Colorado Plateau. Pp. 117-144 *in* Anthropology of the Desert West: Essays in honor of Jesse D. Jennings (Carol J. Condie and Don D. Fowler, eds.). Univ. of Utah Anthro. Papers No. 110. Univ. Utah Press, Salt Lake City.

WOODBURN, JAMES. 1980. Hunters and gatherers today and reconstruction of the past. Pp. 95-117 *in* Soviet and Western Anthropology (Ernest Gellner, ed.). Duckworth, London.