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POLLEN PRODUCTION, TRANSPORT AND PRESERVATION: POTENTIALS AND LIMITATIONS IN ARCHAEOLOGICAL PALYNOLOGY

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ABSTRACT.—Within the past quarter century palynology has become an increasingly important component of archaeological research. Applications have included elucidation of site and room functions, ceremonial and medicinal practices, prehistoric diet and food preparation, correlative construction and chronologies, human modification of the local environment and the nature, magnitude and duration of climatic perturbations, particularly as related to human demography and subsistence strategies. Apprehension concerning the nature and magnitude of palynological bias related to human activities, particularly as reflected by the sources of pollen commonly employed in such studies, is justified but remained largely unexplored. Examination of pollen production, dispersal and preservation leads to the conclusion that once the probability and magnitude of limitations are assessed, they can often be obviated or even be exploited as new potential application of palynology in archaeology.

INTRODUCTION

Fossil pollen used in early studies of paleoecology was usually obtained from lacustrine sediments because of excellent preservation of pollen in such environments. It was through such studies that the potential of palynology to yield paleoecological and paleoethnobotanical data was recognized (Clark 1954; Deevy 1944; Dimbleby 1955; Faegri 1944; Godwin 1956; Iversen 1949; Jessen 1935, 1949; Sears 1937, 1952; Troels-Smith 1956, 1960).

Non-lacustrine sediments were considered unsuitable for palynology due to low pollen concentration and poor pollen preservation despite the demonstration by Sears (1937) of their actual potential in the American Southwest (Dimbleby 1957, 1961). Modified extraction procedures finally permitted a number of palynologists to recover adequately preserved pollen in suitable quantities from aeolian and alluvial sediments and extend the application of palynology into archaeological sites where often more precise temporal control was available than in non-archaeological environments (Anderson 1955; Leopold et al. 1963; Martin 1963; Martin and Byers 1965; Schoenwetter 1960, 1962; Sears 1952, 1961; Sears and Roosma 1961).

Within the last 20 years, palynology has become an important component of archaeological research. Applications have included the elucidation of site and room functions (Berlin et al. 1978; Hevly MS*a*, *b*; Hill and Hevly 1968), ceremonial and medicinal practices (Hevly 1964; MS*a*; Hill and Hevly 1968), prehistoric diet and food preparation (Halbirt MS*a*; Hevly 1964; Kelso 1970, 1976; Martin and Sharrock 1964; Ward 1975), correlative construction and chronologies (Hill and Hevly 1968; Ward 1975), human modification of the local environment (Martin and Byers 1965; Wyckoff 1977), and the nature, magnitude and duration of climatic perturbations particularly as related to demography and subsistence strategies (Bohrer 1972; Dickey 1971; Euler et al. 1979; Hevly et al. 1979; Schoenwetter and Dittert 1968; Schoenwetter and Eddy 1964; Ward 1975; Weber 1981; Zubrow 1971).

Increasing concern has developed about the potentials and limitations of these new applications in paleoethnobotany, particularly in regard to the production, transport and preservation of pollen (Bradfield 1973; Hevly 1964, 1968a; Bohrer 1972; Kelso 1976; Lyttle-Web 1978; Potter 1967; Solomon 1976). This concern is justified because the nature and magnitude of palynological bias related to human activities, particularly as reflected by the sources of pollen commonly employed in such studies, (e.g., room and ramada floors, human coprolites, trash deposits, burials and artifacts) has remained largely unexplored.

MATERIALS AND METHODS

In an attempt to provide at least partial answers to some of the expressed concerns, data from a number of sites in Arizona, Utah, and New Mexico have been re-examined. The samples providing these data were obtained from ground stone artifacts, mummies, human coprolites, various pits and cists, ceramic bowls, floors and midden deposits as well as modern and prehistoric soils outside the archaeological structures. The pollen data from these sites were obtained by standard extraction procedures (Gray 1965). Pollen was identified using standard illustrations, keys and a small reference collection (Faegri and Iversen 1975; Erdtman 1952; McAndrews et al. 1973; Kapp 1969; Martin and Drew 1969, 1970). When possible a count was made of the first 200 pollen grains encountered while mechanically scanning the slide in non-overlapping rows. Records were also obtained of the number of grains per aliquot of pollen rich residue scanned, pine pollen preservation and ratios of AP/NAP (tree pollen/non-tree pollen), pine/juniper, and large/small pine (mostly referable to ponderosa and pinyon pines respectively). The fossil data were compared to modern pollen samples obtained from the plant community in which the site was located.

DISCUSSION

Pollen Production.—Pollen is produced in vastly different numbers by different kinds of plants. Anemophilous (wind pollinated) plants usually produce large numbers (e.g. 500 million per shoot of *Cannabis*; 350 million per 10-year branch system of *Pinus*) of generally small, smooth non-sticky pollen, while zoophilous (animal pollinated) plants usually produce low numbers (100s to 1000s per year per inflorescence) of generally large, rough, sticky pollen (Faegri and Iversen 1975).

Production of pollen is influenced by both climatic, edaphic and biotic factors and consequently varies from stand to stand and from year to year within a stand (Faegri and Iversen 1975). Cone (both male and female) production in conifers, for example, closely parallels climate influenced growth, and even after the production and maturation of cones, both seed and pollen can be aborted by climatic factors such as relative available moisture (Daubenmire 1960; Leiberg et al. 1904; Lester 1967; Roeser 1942; Shoulders 1967).

Many of these factors are manifest as individual plant variations rather than stand characteristics and hence are not reflected by pollen data from soil samples which incorporate the accumulative pollen of many years or several decades (Faegri and Iversen 1975). To be manifest in the pollen record, the effect must extend to a major portion of the stand and the effect must be either frequent or of long duration, increasing or decreasing the density of the pollen producing population, its geographic area or the abundance of flowers. Ecological factors which meet these criteria may be limited to fire, climatic change, edaphic modification (e.g. volcanism and altered drainage patterns or water tables) and biotic exploitation, including disturbance by man and grazing by livestock or insects. Presented below are some data which provide evidence that these effects can be detected in the pollen records of archaeological sites.

Citadel Sink is located in Wupatki National Monument on the northern edge of the Sunset Crater ash fall area. Sediment and pollen analysis permits detection of various environmental modifications known to have occurred there: eleventh century volcanic eruption, an eleventh-thirteenth century rise and fall of prehistoric agricultural population and the twentieth century grazing and juniper chaining (Fig. 1). The aboreal pollen (AP) is composed of 2 principal types, *Pinus* and *Juniperus*. Pine does not occur locally and its pollen is therefore a long distance transport type. High proportion of pine pollen therefore reflect poor local pollen production, while low pine proportions reflect good local pollen production (Solomon 1976). Pine proportions (relative to locally occurring juniper) do increase twice in the pollen record (during the eleventh and twentieth centuries) at times atypical for such phenomena in the Colorado Plateau pollen chronology (Euler et al. 1979). Disruption of the local juniper population (which results in higher pine proportions in

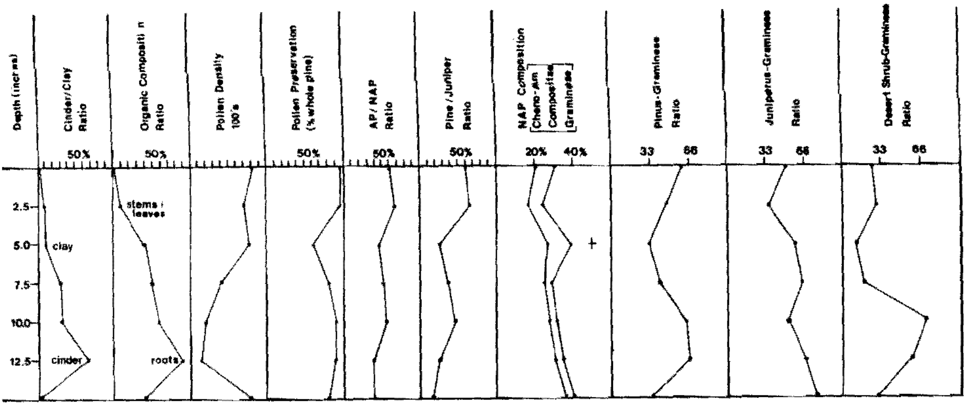


FIG. 1.—Sediment and pollen from Citadel Sink, Wupatki National Monument, reflecting the disturbances associated with volcanism, prehistoric agriculture and modern juniper chaining and cattle grazing (Hevly, Schley, and Barry MS). The abrupt increase of cinder at a depth of 31.75 cm resulted from the eruption of Sunset Crater about A.D. 1066 (Colton 1962). The cinder contains little pollen, few stem and leaf fragments, but abundant roots, indicating that it is an original air fall rather than being secondarily deposited. The deposition of cinder initially favored the growth of desert shrubs, but increasing proportions of Gramineae pollen suggest a progressively more grassland-like environment. The change in pollen preservation, increased relative abundance of Compositae and the occurrence of corn pollen at a depth of 12.7 cm probably reflects prehistoric agriculture. The changes in pine-juniper, pine-grass and juniper-grass ratios in the upper 6.35 cm probably reflect twentieth century floristic modifications associated with chaining of juniper and grazing of livestock.

pine-juniper ratios) in the twentieth century is probably due to local chaining operations. The eleventh century disruption of juniper is not likely to have been the direct result of damage from volcanic eruption considering the 22.5 km distance to the crater and the relatively shallow deposit of ash in the study area. Instead, the disruption of juniper is more likely to reflect the cutting of juniper for construction purposes by the prehistoric inhabitants whose local population underwent explosive growth at this time due perhaps in part to displacement of neighboring farmers from their former homesteads recently covered by lava and cinder (Berlin et al. 1978; Hevly et al. 1979; Pilles 1977).

While juniper recovered from this disruption, other plant types did not fair so well due to the permanently altered edaphic condition of this site. In particular, members of the Cheno-Am group (Chenopodiaceae-*Amaranthus*) diminished in relative abundance as grasses became more abundant. A second modification of the floristic composition of this site (increased proportions of Compositae) appears to occur coincident with cultivation and probably reflects disturbance not unlike that detected at the nearby prehistoric cornfield where also the effect of man's activity has persisted to the present (Berlin et al. 1978). The diminished proportions of Gramineae pollen in the latest twentieth century (surface) level could likewise reflect man's activity, in this case grazing by domestic livestock which has resulted in a local deterioration of rangeland.

While the above examples appear to reflect change of pollen production due to generally persistant changes of the floristic community resulting from volcanic eruption or disturbance by man, it is also possible to have changed pollen production with very little, if any, change of the local plant community. For example, the proportion of pine in a pine-juniper ratio (where both pine and juniper co-occur) parallels as expected the average moisture controlled growth trends of nearby trees but at a rate that is too fast to accommodate changed floristic composition involving establishment and growth of trees to sufficient maturity for cone production (Fig. 2a).

The significance of the local environment relative to pollen production and transport is also manifest in the arboreal pollen proportions, particularly those of pine composition.

When local growing conditions were favorable, locally produced pinyon pine pollen exhibits high proportions in the fossil pine data (Fig. 2b). However, when local growing conditions were not favorable, a larger proportion of yellow pine pollen transported a number of km from nearby mountains becomes the predominate pine type. Likewise, the local community of weedy annuals is comprised of species which flourish and flower successionally, different taxa predominating from year to year in response to seasonal changes of temperature and moisture availability (Hevly and Renner In Press; McDougall 1967; Solomon and Hays 1972). Persistant changes of their proportions over many decades, like those of pine-juniper ratio, probably reflect altered climatic conditions, such as seasonal distribution of moisture or succession within the local plant community coincident with abandonment and altered edaphic conditions. Incidentally it should be noted that the species composition of the flora of some areas of northern Arizona as well as the phenology of these plants is such that the seasonal indicator roles of Cheno-Ams and Compositae as described by Schoenwetter (1962), Martin (1963), Solomon and Hayes (1972) for southern Arizona are reversed in northern Arizona (Hevly and Renner In Press).

In final analysis, changes in pollen production do occur in response to physical (e.g. edaphic or climatic) and biotic modification of the environment. Such alterations may be essentially permanent (e.g., deposition of volcanic cinder or depletion of soil minerals through cropping); however, most are short term resulting from such phenomena as climatic perturbations, fire, and biotic exploitation. Distinction of the particular ecological factor(s) responsible for the observed nature, magnitude and duration of palynological

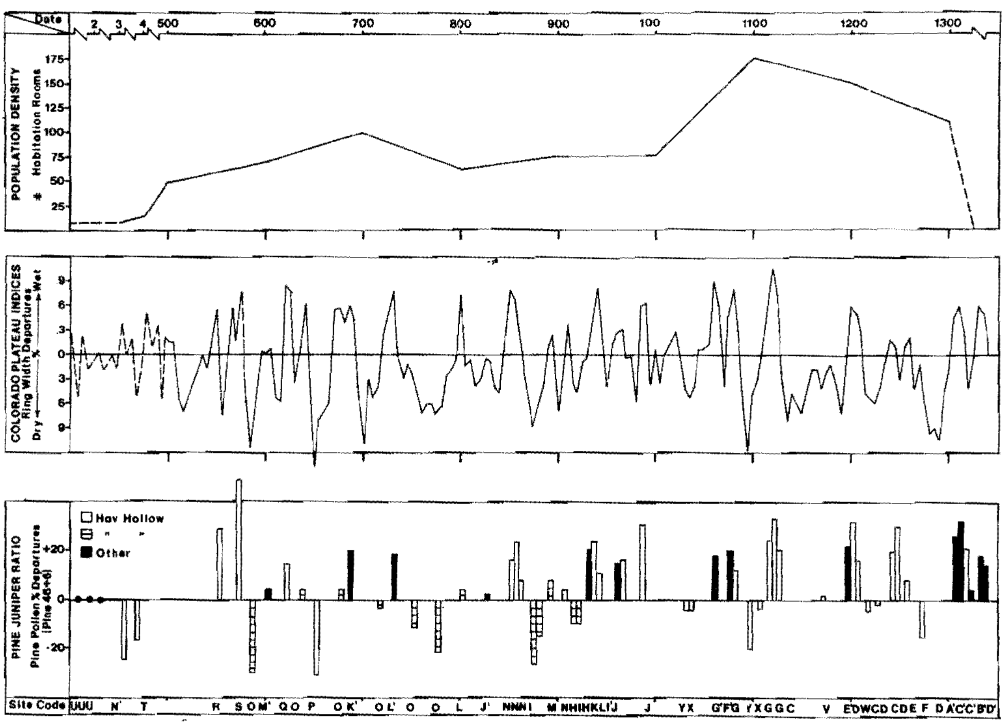
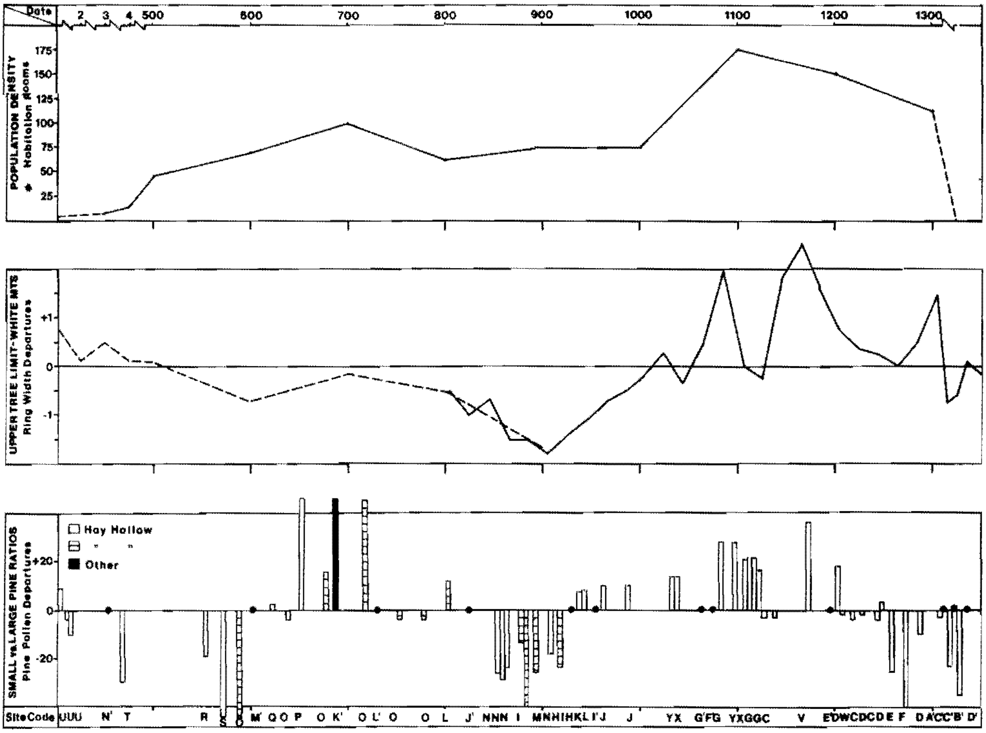


FIG. 2.—Comparisons of the demographic record and pollen records from Hay Hollow Valley (Bohrer 1972; Dickey 1971; Hevly 1964; Ward 1975) with tree-ring records from the Colorado Plateau (Fritts 1965) and the White Mountains of California (Lamarch 1974). Each site code letter reflects a different site (identical letters reflect different rooms of the same site.)

2a. Departures of pine pollen proportions from the modern mean in pine-juniper ratios probably reflect relative pollen production of these 2 genera locally, pine proportions declining during drought episodes as demonstrated in a study of historic pollen (Hevly et al. 1980).



2b. Departures of small pine proportions from the modern mean of small-large pine pollen ratios in the study area probably reflect local versus regional production of pine pollen and long-term trends of effective moisture.

change(s) in the fossil pollen record can often be accomplished by evaluation of additional biological, geological, and archaeological data. Such analysis permits more accurate paleoenvironmental reconstruction in which the relative effects of climatic perturbations, fire, biotic impacts by man and insects, as well as volcanism can be derived (Hevly et al. 1979).

Pollen Transport and Deposition.—The majority of pollen does not travel far from the plant producing it. Even in wind pollinated taxa most of the pollen falls immediately beneath the canopy (Silen 1962; Wright 1953). Nevertheless, wind transported pollen travels further (10s-100s km vs. 10s of cm to 100s of m)than insect transported pollen which appears in very low concentration in soil samples from open situations, being recovered most frequently in close proximity to the plant producing it or where it may on occasion have been dropped by insects transporting it. In archaeological sites or caves entomophilous pollen can be more abundant than in modern soils (Fig. 3a) and is most likely to have been introduced there by man or rodents (Briuer 1977; Hevly 1970; Hevly et al. 1979; Kelso 1970, 1976; Lyttle-Web 1978).

The majority of the pollen found in features with restricted openings (e.g., caves, shelters, fissures and man-made structures) is transported into such features primarily by wind but also by man and rodents. Pollen and sediment transport into such features should be slower than in open sites, but pollen will enter more freely than the larger and heavier inorganic sediment. Hence, if sediment accumulation is slow and a given sample reflects the accumulation of many decades or centuries, its pollen concentration should be high compared with that observed in open sites. These trends appear to be observable in the pollen concentration data available from Southwestern archaeological sites (Table 1). Continuously open sites such as rock fissures, caves and shelters have high pollen concentrations for individual samples, while man-made structures such as pithouses and

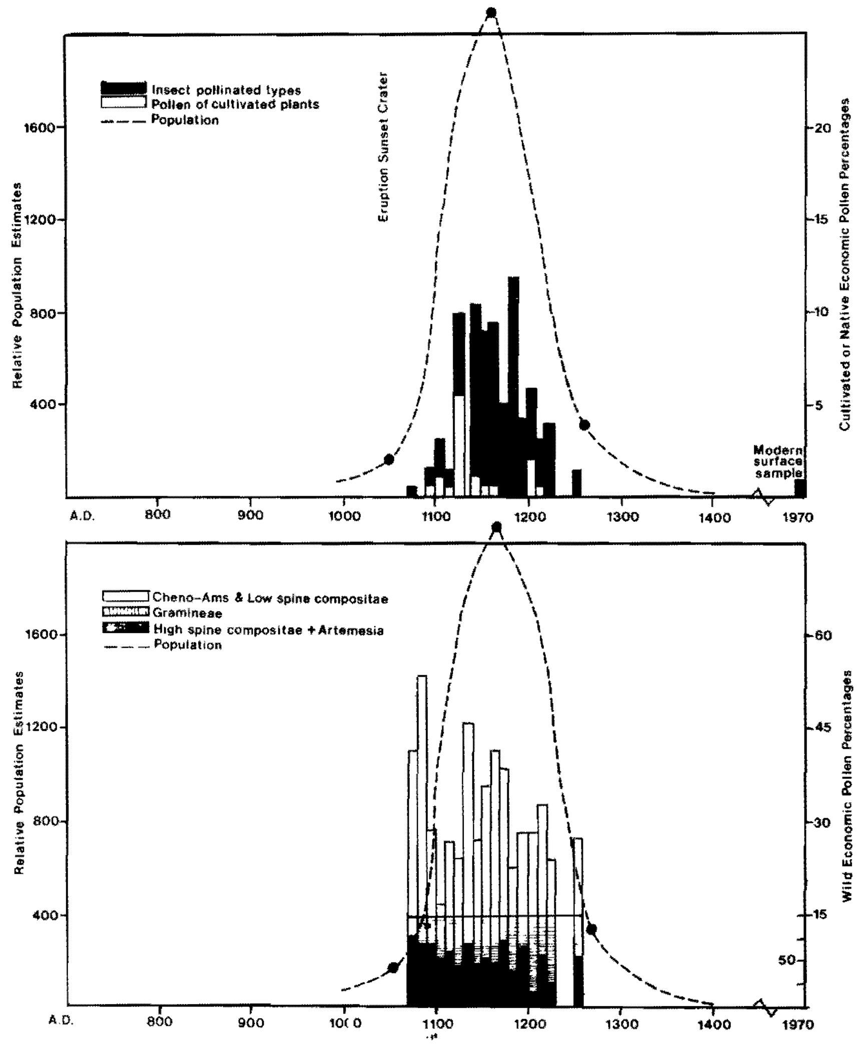


FIG. 3.—A comparison of prehistoric human demographic trends of the Flagstaff area (Colton 1962) with the proportion of non-arboreal pollen types from Elden Pueblo (Hevly et al. 1979).

3a. The rise and fall of human population at Elden Pueblo closely parallels the pollen records of cultivated plants and insect pollinated plants which both greatly exceed modern proportions. If the pollen of cultivated plants actually reflects the relative agricultural success of the local human community, some change of environment is suggested.

3b. Change in relative proportions of pollen from other largely annual non-arboreal taxa whose germination, seedling establishment and abundance are largely controlled by the seasonal distribution of moisture and temperature. The proportion of late-spring and early summer flowering Cheno-Am and Low-spine Compositae pollen in the total non-arboreal pollen sum is shown by the long, open bars. The proportion of Gramineae pollen (spring-summer flowering) to High-spine Compositae and *Artemesia* (late-summer and early-autumn flowering) is shown by the shorter bars and shorter scale at right. The data suggest replacement of Cheno-Ams and Compositae by Gramineae and could reflect secondary succession on the site, coincident with gradual abandonment and reduced disturbance; however, the data might also be interpreted to reflect a long-term trend of altered distribution of seasonal distribution of moisture. The latter interpretation could provide at least a partial explanation for the putative diminishment of agriculture inferred from pollen data of cultivated plants shown above.

pueblos with limited duration as a space within which to trap sediment have floor samples with more limited pollen content. Objects such as a small storage jar with a small hole open for centuries has accumulated a high concentration of pollen. Objects such as storage pits and cists open only for limited times during the occupation of the site and sealed for centuries by burial have low pollen concentrations. Comparison of contemporaneous fossil soils in an open situation with the pollen content of floor sediment of a pithouse or pueblo room and of storage pits or cists manifests a progressive reduction in pollen concentration. This phenomena is called attenuation and probably reflects progressively smaller target openings for pollen transport and also briefer periods for pollen deposition (original pollen content of soils on or in which man-made structures are built appears to be diminished by oxidation and mechanical breakage during construction (i.e. fossil soil, floors, cists, pit and subfloors in Table 1).

Since wind transported pollen can travel so far it might be anticipated that such pollen would enter structures with restricted apetures with great facility; however, contrary to expectations, different wind transported types appear to be transported differentially (Currier and Kapp 1974; Hevly 1970; Hevly et al. 1978; Tauber 1977). When the sediments of rock fissures are compared with outside soils, not only does the concentration of pollen change, but there is also an increase in the proportion of some wind pollinated types and decline in others (Fig. 4). The increase in pine pollen and decrease of other types is most noticeable in the Grand Falls Fissure, which has remained open for centuries collecting pollen. The magnitude of differential transport appears less in the structures occupied by man where pollen collected for more brief periods of time. Pine pollen is slightly under represented, while the NAP types, which were generally under represented in the fissure, are

TABLE 1.—*Pollen concentration and Preservation in Archaeological Sites. Preservation is expressed as the percentage of entire pine pollen. Concentration is expressed as mean numbers of grains per aliquot of pollen rich residue, numbers of grains per gram of extracted sediment and as numbers of grains counted while counting 150 grains from a known number of added exotic pollen* (Eucalyptus).

Provenience	Concentration aliquot	Pollen/ gram	150 Eucalyptus	Preservation	Spores/ aliquot
Feces (Sheep) 1	1094	41,572	547	98%	210
Feces (Human) 2	1050	53,200	315	99%	850
Mummy Alimentary Canal 3	1128-2198	43,050-55,650	—	100%	—
Grand Falls: 4					
Rock Fissure Floor	10,000	11,000	—	84%	17
Storage Jar	20,000	22,000	—	100%	513
Rock Springs Shelter 5	500-1500	506-1520	—	70-80%	—
Modern Soil 6	1061	1075	135	87%	275
Fossil Soil 7	2250	2280	—	75%	—
Pithouse Floor 7	332	336	—	69%	—
Pueblo Floor 7	658	666	—	66%	—
Hogan Floor 1	212	214	—	84%	300
Metate 1,7	227	—	—	—	—
Mono 1	127	—	—	—	—
Fire Pit 8	207	210	—	87%	—
Storage Pit 8	116	117	—	93%	—
Cist 8	50	50	—	90%	—
Subfloor 3	47	47	—	65%	—

1. Hevly et al. 1980; 2. Hevly and Hudgens MS; 3. Hevly MS*a*; 4. Hevly 1970; 5. Hevly et al. 1979; 6. Hevly unpubl. data; 7. Hevly 1964 and unpubl. data; 8. Hevly MS*b-d*.

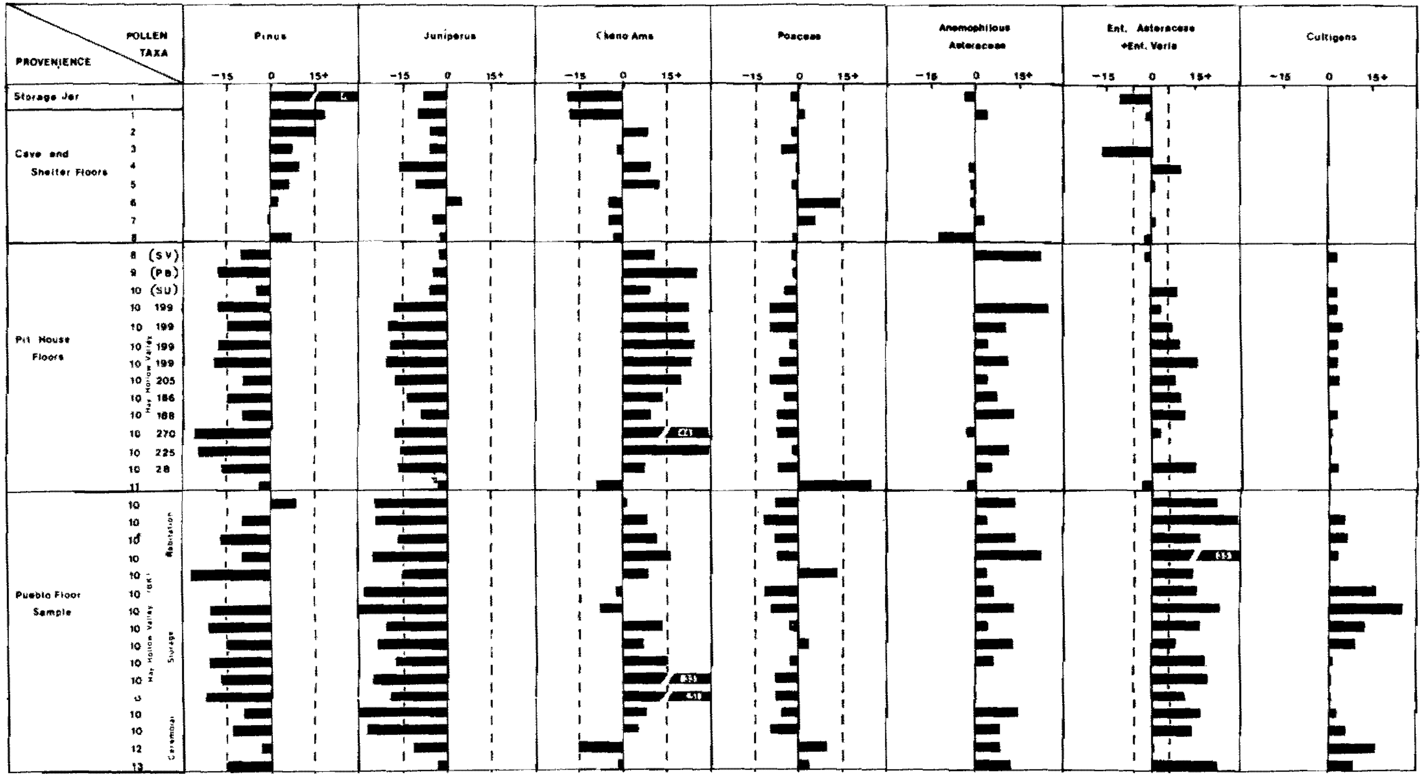
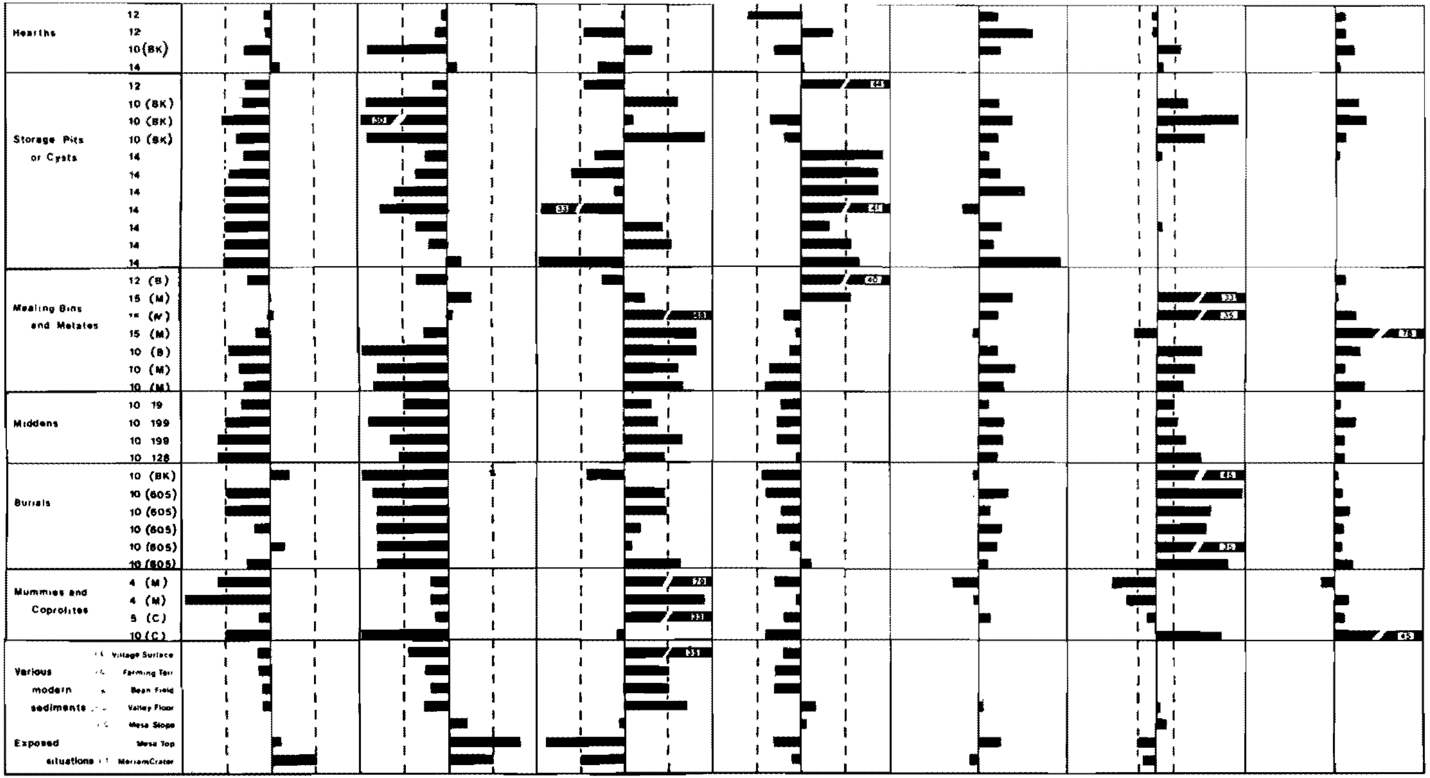


FIG. 4.—Departures of fossil pollen proportions (%) in various proveniences from the proportions of pollen in contemporaneous soils. Departures exceeding 15% for wind pollinated and 5% for insect pollinated types are significant at 0.05 level.



1. Hevly 1970; 2. Hevly et al. 1979; 3.Hevly 1968b; 4. Hevly MS*a*; Hevly and Hudgens MS; 6. Briuer 1977; 7. Hevly MS*e*; 8. Hevly MS*a*; 9. Hevly and Rogge MS; 10. Hevly 1964; 11. Bohrer 1972; 12. Ward 1975; 13. Dickey 1971; 14. Hevly MS*c*; 15. Halbirt MS*b*; 16. Scott 1979; 17. Berlin et al. 1978.

frequently over-represented in the structures occupied by man, particularly when comparisons are made with modern rather than ancient soils (Fig. 4). Such over-representation reflects natural or human (Fig. 5) disturbance favoring growth of pioneer species at least in part (Diggs 1979; Gish 1979; Halbirt MS*a*; Scott 1979).

Macroscopic evidence from human feces and food storage and preparation features suggests that such pollen over-representation may also reflect the introduction of wild (or even encouraged or semi-cultivated) plant parts bearing pollen into the occupation areas (Bohrer 1972; Cutler 1964; Hevly MS*c*; Hill and Hevly 1968).

Recognition that the pollen record of archaeological sites is not identical to that of contemporaneous soils due to differential transport of pollen might seem a critical if not fatal blow to all attempts of paleoenvironmental reconstruction. However, selection of indicator species least affected by such differential transport and using samples from proveniences exhibiting minimal transport bias such as small sites may obviate such problems. Furthermore, when the general patterns of transport capability are recognized, various statistical procedures may be used to correct for over or under representation of particular types (Mosimann 1963).

Comparison of various man-occupied structures and non-archaeological sites permits recognition of general patterns in pollen transport and deposition, departures from which can be interpreted as changed modes of transport (Fig. 6). In archaeological contexts such changed modes of transport, which often are reflected by significant over-representation of particular types (Fig. 4), provides information regarding human activity (e.g., storage, food preparation and medicinal or ceremonial).

Pollen Preservation.—Different pollen types are not equally well preserved, being subject to chemical, mechanical, and biological degradation (Havinga 1971). It has been suggested that juniper pollen is less well preserved than pine pollen (Bradfield 1973; Potter 1967). This is contrary to experimental studies of relative pollen preservation and has not been substantiated in modern pollen studies of soils (Havinga 1971; Hevly 1968a). The explanation for these conflicting results may relate to the different seasons of pollen dispersal in pine (early summer) and juniper (early spring) and perhaps even to the nature of the depositional environment. If juniper pollen were to lie on an exposed soil surface for several months prior to burial by wind mixing of sediments or secondary transport into a cistern with the onset of summer rains shortly after the pollination of pine, it would be expected that differences of preservation might be manifest. If, on the other hand, juniper and pine pollen are both buried shortly after their wind transport and deposition, preservation would be about equal as found in the experimental studies. The problem is worthy of much further examination since no one has checked the relative preservation of pine and juniper in different depositional environments. Preliminary studies would suggest that differences might occur since pine pollen is not equally well preserved in wet vs. dry sediments of different plant communities (Fig. 7).

Preservation of pollen could be an important factor in fossil pollen studies of archaeological sites, since relative abundance of a pollen type such as pine appears to be negatively correlated with the percentage of broken grains in both modern and fossil samples (Fig. 7). Fortunately, the range of preservation found in modern and archaeological samples is about equal (except in samples from burned structures) despite the generally lower pollen concentrations of archaeological samples compared with that of modern soils from open environments (Table 1; Fig. 7).

The variability of pollen preservation might also seem a fatal blow to environmental reconstruction; however, the types critical for environmental reconstruction appear to be about equally well preserved. Preservation of pollen in different depositional situations is also variable, but archaeological sites, particularly in grassland or woodland situations, seem to provide best preservation. In fact pollen often provides the only record of plants whose macroscopic record is totally lacking in archaeological context having been decomposed by bacteria or fungi, eaten by animals or destroyed by fire (Bohrer 1972; Schoenwetter 1962; Hevly 1964, 1968b, MS*c*; Martin and Byers 1965).

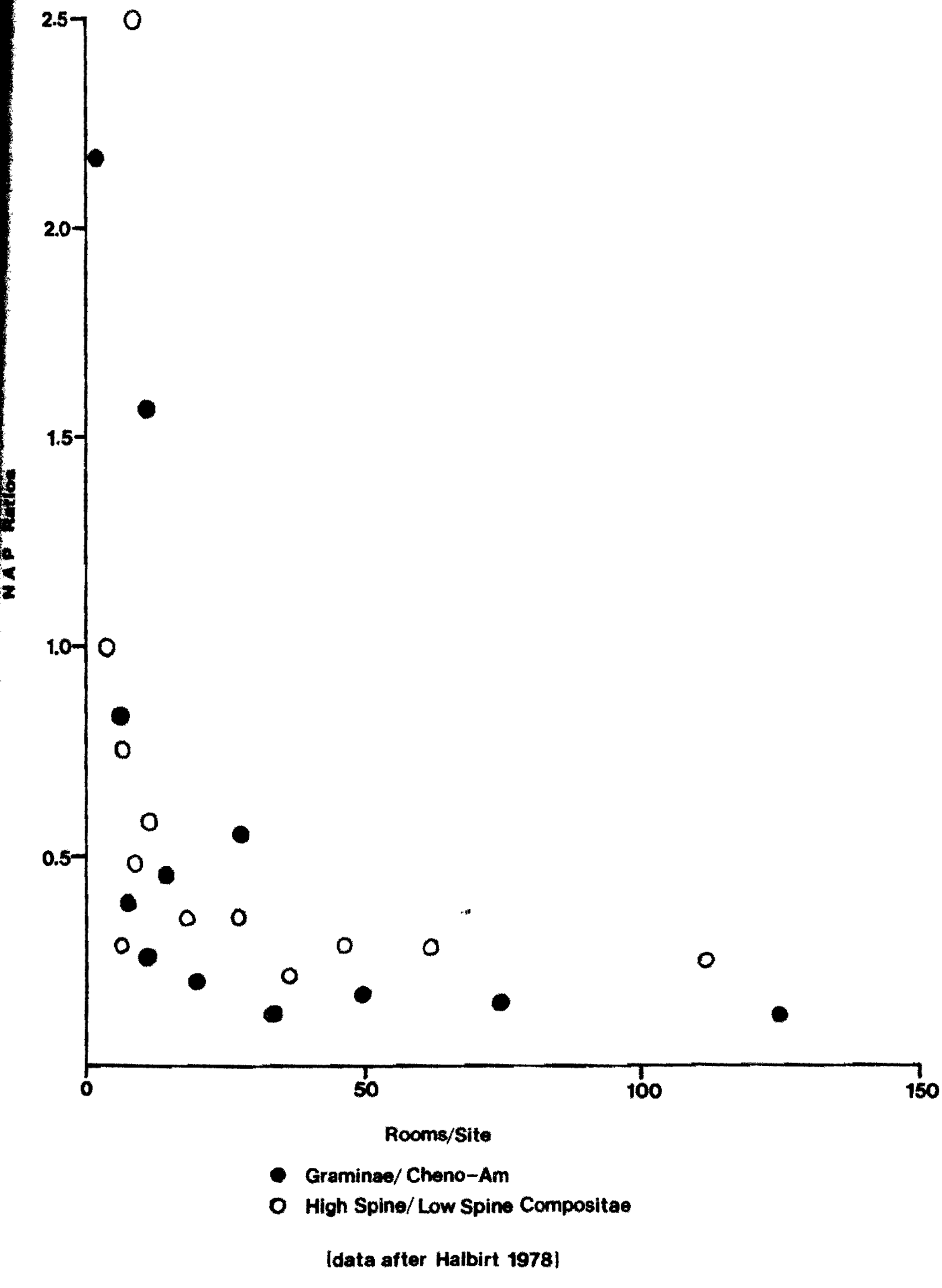


FIG. 5.—A comparison of non-arboreal pollen ratios with the size of archaeological sites (rooms/site). Smaller sites are characterized by higher proportions of Gramineae and High-spine Compositae pollen, while larger sites are characterized by higher proportions of Cheno-Am and Low-spine Compositae pollen. The latter plants are characteristic pioneer plants favored by disturbance.

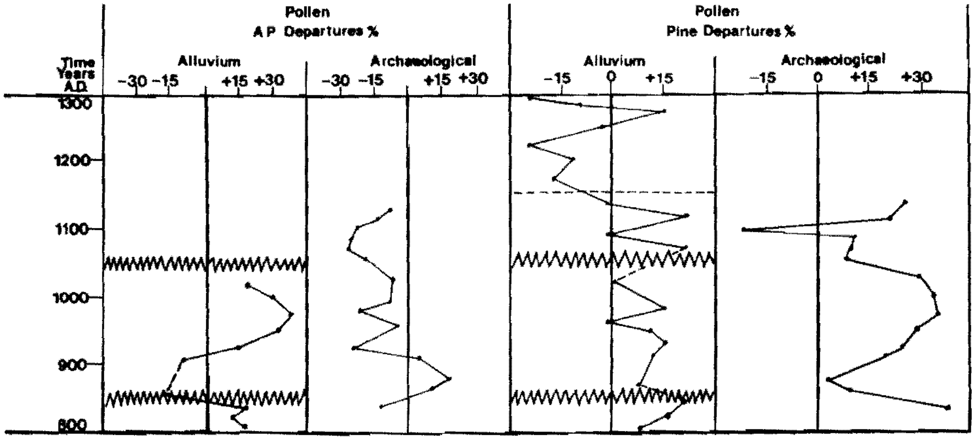


FIG. 6.—Comparisons of the arboreal pollen data from alluvial and archaeological proveniences in the same locality (Black Mesa, Hevly, unpubl. data). Unadjusted departures of arboreal pollen from the modern mean of the study area are negatively correlated between alluvial and archaeological sites, reflecting perhaps the differences of mode of pollen transport into such environments. Departures of pine in pine-juniper ratios from the modern mean of the study area exhibit generally parallel trends. The few differences which can be noted probably reflect ambiguities introduced by sampling intervals. The data suggest that pine-juniper ratios can reasonably be substituted for AP/NAP ratios in environmental reconstructions if the latter ratio is biased, for example by NAP over-representation.

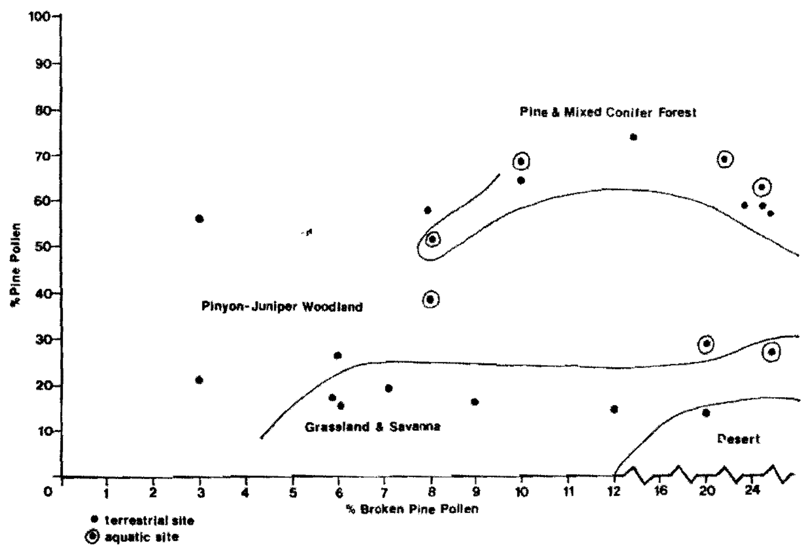
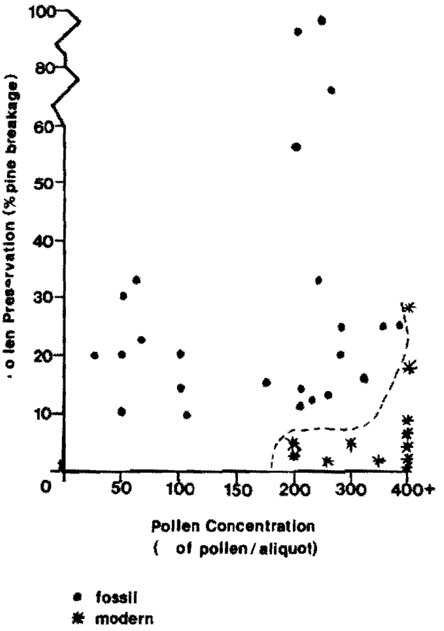
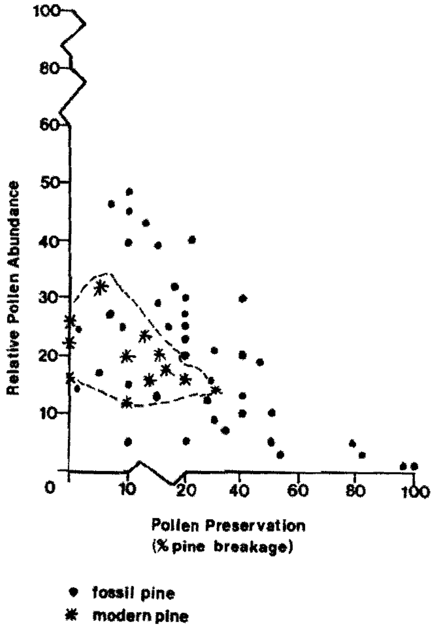


FIG. 7.—Preservation of pine pollen (data from Dickey 1971; Hevly 1964; Ward 1975).
7a. A comparison of the preservation of pine pollen with the percentage of pine recovered in different depositional environments within different plant communities. Generally, the proportion of pine increases as expected in the higher elevation conifer. However, pine proportions may also be high in depositional environments characterized by low plant cover and correspondingly low pollen production as compared with depositional environments characterized by high plant cover and correspondingly high pollen production (compare aquatic vs. terrestrial sites in grasslands and savanna). Preservation is approximately equal in aquatic and terrestrial sites within the pine and mixed conifer forests. Within the Pinyon-Juniper Woodland and Grassland or Savanna communities preservation was generally better than in the pine and mixed conifer forests except in aquatic sites.





7b. A comparison of pine pollen preservation and total pollen concentration. Pollen concentration is lower than in modern soil samples, however, the range of preservation is about the same except in burned sites where more than 50% of the pine pollen is broken.
7c. A comparison of the relative abundance of pine pollen and pine preservation. Generally the relative abundance of pine pollen diminishes as the breakage of pollen increases.

CONCLUSION

The pollen record contained in archaeological sites, like that of any other depositional environment, is influenced by such factors as pollen production, dispersal and preservation. Interpretation of fossil pollen data from archaeological sites for either behavioral or paleoenvironmental inferences requires elucidation of the significance of such factors relative to individual pollen types. Acquistion of such data is just now beginning in the Southwest; however, preliminary data now in hand clearly indicate trends of the potentials and limitations of archaeological palynology.

Changes in pollen production do occur in response to physical and biotic modification of the environment. Such alterations may be of very long duration, but most are short term, resulting from such phenomena as climatic perturbations, fire and biotic exploitation. Distinction of the particular ecological factor(s) responsible for the observed nature, magnitude and duration of the palynological change can often be accomplished.

The pollen record of archaeological sites is not identical to that of contemporaneous soils due to differences of mode of pollen transport into different depositional environments and even of differential capability of pollen to enter archaeological sites due to location, size and seasonality of openings. Comparisons of pollen taxa with other previously demonstrated sensitive environmental indicators reveals that some pollen types are useful for purposes of paleoecological reconstruction. Comparisons of pollen taxa within and without archaeological sites indicates that other pollen types are probably more useful as indicators of human behavior.

Different pollen types are not equally well preserved and the preservation of pollen in the archaeological record may not be assumed to be similar for all time periods. Experimental studies are badly needed in the American Southwest, but data which are at hand suggest the pollen types which appear to be of greatest utility for paleoenvironmental reconstruction are fortunately about equally well preserved. Thus, if preserved by incorporation in soil soon after dispersal, such pollen types should retain their utility as paleoecological indicators.

Thus, in final analysis, the potential limitations posed by improving understanding of pollen production, dispersal and preservation are real but not so limiting as to preclude reasonable inferences of human behavior and attempts of paleoenvironmental reconstructions.

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