

THE ENVIRONMENT OF MIAMI WASH, GILA COUNTY, ARIZONA

A.D. 1100 TO 1400

by

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## PREFACE

This dissertation was proposed to investigate techniques used to interpret the relationship between a prehistoric culture and its environment. It was especially designed to examine the basic assumptions and hypotheses of one specific technique, pollen analysis.

It is hoped that conclusions formed in this research will: (1) encourage further environmental investigations in archaeological sites, (2) stimulate research into factors controlling deposition in archaeological sites, and (3) increase communication between archaeologists and environmental scientists.

I wish to thank my advisors, Dr. C. Vance Haynes, Jr., Dr. Arthur Jelinek, Dr. Richard Reeves, and especially Dr. Allen Solomon (Oak Ridge National Laboratories, Tennessee) and Professor Terah L. Smiley, co-directors of my dissertation, for their continued encouragement, criticism, and guidance. Thanks are also extended to Dr. David Doyel and Mr. Laurens Hammack (both of Arizona State Museum, Arizona), who initiated the project, for their interest and support. My thanks also are extended to Ms. Sharon Urban (Arizona State Museum, Arizona) who shared the field work under a hot Arizona summer sun.

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## ABSTRACT

Archaeological attempts to describe the cultural ecology of prehistoric cultures have often been of limited value because basic assumptions and hypotheses have not been examined. In this study, the validity of using palynology for cultural and environmental interpretation is tested in a number of archaeological sites in central Arizona. Pollen from floor samples and pollen samples from other artifactual contexts are compared with pollen from modern surface samples in order to determine whether pollen from plants introduced by people is found in predictable cultural associations. The validity of employing palynological techniques to interpret occupational and post-occupational environments is examined by comparing pollen from floor samples, from surface samples, and samples from stratigraphic columns in structural fill. Consideration is given to the tree-ring record and sediment size changes of samples from the stratigraphic columns as compared with the pollen record.

Definition of the present and past environments of the sites is aided by examination of the geology and floral resources of the area. The location of sites is examined with regard to natural resources including water and arable land, climate, available lithic sources, and other physical parameters. Plants collected in association with sites and transects across the Miami Wash and Pinal

Creek valleys are compared with the archaeological pollen data and with vegetal samples in order to discern possible climatic change.

This synthesis of palynological, dendrochronological, geological and botanical information supports the need for examination of the premises and assumptions of methods employed to interpret the relationship between prehistoric cultures and their environment. Before it is possible to define the ecology of a culture it is necessary to define its environment. The accuracy of this definition is dependent upon the use of techniques whose basic hypotheses and assumptions have been tested and verified.

## CHAPTER 1

### INTRODUCTION

Men are biological and cultural creatures; when studying historical or prehistorical people it is necessary to view them within their physical and biological environment as well as within their cultural environment. Steward (1955) calls this approach "cultural ecology." Ecological techniques have been applied to archaeological problems with varying degrees of success. Karl Butzer asks (1975): "The ecological approach to archaeology: are we really trying?" As the negative implication of the question suggests, Butzer feels that the combination of ecology and archaeology has not succeeded due to lack of communication and well-coordinated investigations.

Butzer's doubt appears justified. Ecology has been defined in various ways, all of which entail the study of the relationship of an organism with its physical and biological environment. It is in dealing with the environmental aspect that cultural ecology as applied to archaeology has failed. To understand the ecology of man it is necessary to define the environment in which he lived or is living, and in order to accurately define the environment it is necessary to examine the means by which that definition is reached.

Of the various methods available for study of the climatic and biotic environment, one which appears to have great potential for

use in archaeology is palynology. Pollen is ubiquitous and, for the most part, identifiable; it preserves well, it is easily sampled, and it is amenable to analysis. Based on the assumption/hypothesis that the wind blown pollen rain reflects the local or regional biotic environment, palynology has been used to interpret the vegetational environment and environmental changes, the climate and climatic changes reflected in the vegetational environment, and the dates of those climatic and environmental changes. This method has been applied to archaeological sites in the Southwest (Hill and Hevly 1968; Schoenwetter 1962, 1965) without examining the assumption/hypothesis that the pollen rain in a cultural context reflects the environment in an arid area. The prevalence of pollen analysis in archaeological sites in the arid Southwest suggests that this hypothesis should be tested before further interpretations of the pollen record are made.

This dissertation has three principal goals:

1. To test the validity of using palynology in archaeological sites in the arid Southwest for cultural and environmental interpretation.
2. To examine the modern geological and vegetal environment of the sites in order to compare and amplify the archaeological and palynological evidence.
3. To fulfill the ultimate purpose of any study involving environment and archaeology: the understanding of the ecology of the culture, i.e., the effect of people on the environment and of the environment on the people.

In examining the first goal and the methods used to achieve it, three questions must be answered: (1) why are palynological techniques being used, (2) how are they used, and (3) what hypotheses are formulated as a result?

In Europe and North America palynology has been used to interpret the environment of sites and to date postglacial time periods, some of which are based on hypothesized environmental changes caused by man (Davis 1961; Frey 1955; Godwin 1944; Keef, Wymer, and Dimbleby 1965; Mehringer 1967; Smith 1970; Turner 1970). In the Southwest United States it has been used for intra- and inter-site dating (Hill and Hevly 1968; Schoenwetter 1962, 1965; Schoenwetter and Eddy 1964), for studies of cultural plant use (Bryant 1974 a and b; Kelso 1971), and for defining the effect of man on the environment (Kelso no date; Martin and Byers 1965).

In this study the validity of the use of palynology in archaeological sites in the desert Southwest is tested in two contexts: (1) cultural usage of plants and (2) interpretation of the environment. Comparing samples from floors, burials, vessels, metates and manos, with modern surface samples should give information on the use or introduction of forage and food plants by man. The hypothesis is that pollen from plants used or introduced by man is present in a predictable cultural context, i.e., will be found on floors, in burials, vessels, metates and manos.

The use of pollen analysis to interpret environment and environmental and climatic changes and to derive dates from these

interpretations should be contrasted with its use in the interpretation of man's effect on his environment. If floor samples and samples collected from stratigraphic columns in sediment deposited on house floors record and reflect vegetation during occupation and after abandonment, then the following hypotheses can be tested: (1) man's effect on the vegetation in a site is so profound that the pollen rain in the site reflects this disturbance rather than the natural pollen rain and (2) pollen deposited on a floor after abandonment of that structure will not primarily reflect climatic change but rather other factors such as local deposition, erosion, continued occupation of the site, and plant succession.

Two techniques which are used in this study to examine these hypotheses are dendrochronology and stratigraphy. Dendrochronology is recognized as a major dating technique in the Southwest (Wilson 1975). Recent use of the computer by Fritts in the subdiscipline of dendroclimatology allows more precise interpretation of the climate of the past in areas where tree-ring records are plentiful (Bannister and Robinson 1975). In this study prehistoric and modern tree-ring records from nearby locations are compared with the archaeological and surface pollen records in order to interpret possible climatic changes.

Stratigraphic analysis is generally used to construct a relative chronology and to interpret changes in the environment of deposition and changes in climatic (Antevs 1955; Haynes 1964). Particle size analysis of the sediment is one means of observing depositional changes in the strata. Assuming that particle sizes



are affected by changes in effective precipitation, such changes are recorded in the same sediment that is collected for pollen samples. A sieve analysis of the sediments from stratigraphic columns is therefore compared with the pollen record.

The second goal is the description of the modern environment using geology and botany. The geological investigation included study of the topography, hydrology, and petrologic sources. As stated by Weide and Weide (1973) the study of topography and watershed systems is used for surveying and locational analysis. The location of sites is examined with regard to natural resources including water and arable land, climatic effects, and other physical parameters. The topography and hydrology was studied using maps and making field reconnaissance.

Information derived from these studies is synthesized with botanical and zoological data. A botanical survey is made in order to: (1) obtain knowledge of the variety of plants in the area, (2) compare local vegetational associations with the modern pollen rain, and (3) compare the modern plants with the fossil pollen and plant flotation study to determine possible changes in vegetation over time. In addition plant transects are compared with associated pollen samples.

The third goal involves the determination of the human ecology of these sites. At the present time such a goal is not truly realizable. The total relationship of an organism with its environment, as previously stated, is the ultimate purpose of ecological studies,

and should be the purpose of environmentalists working in archaeology. Up to the present time, however, no ecologist has succeeded in fully describing the ecology of an organism, large or small, simple or complex. This report, because of technical and theoretical limitations, is mainly concerned with an attempt to define a restricted part of the environment and to demonstrate how certain techniques can be used to test hypotheses involving man and his environment. My approach to this goal therefore only partially confronts Butzer's challenge concerning the ecological approach to archaeology.

My data were gathered during the highway salvage archaeological excavation of Salado sites located along Pinal Creek and Miami Wash in central Arizona. This set of sites offered the following advantages and opportunities:

1. A number of sites can give more comparative information than one or two sites.
2. The Pinal Creek-Miami Wash drainage is an area which is potentially a good source of vegetal and animal resources.
3. Preliminary surface and subsurface sampling indicated that pollen was well-preserved and plentiful.
4. The good communication with and cooperation of the archaeologists involved in this particular salvage project was also important. Meetings to discuss the purpose of the study, sampling techniques and proveniences, and mutual goals, were held before excavation started. Data collection began on the sites before excavation commenced and afterwards

I returned periodically for more collecting. In addition, the archaeologists allowed me access to the lithic materials and to the paleobotanical and paleozoological analyses necessary for the synthesis of environmental information.

This dissertation makes use of academic training and practical experience in a variety of subjects, such as geology, archaeology, climatology, and palynology. One of the skills this background has made possible is the synthesis of information from many fields and its integration into a more comprehensible whole. In order to succeed, the ecological approach to archaeology must be based on studies in various disciplines which, through increased communication and understanding, are combined so as to become more than the sum of their parts.

## CHAPTER 2

### ENVIRONMENTAL DESCRIPTION OF SITES

#### Geographic Location

The nine sites studied are located in east central Arizona, north of the town of Miami and overlook the drainages of Miami Wash and Pinal Creek, Range 15 East, Township 1 North, Sections 4, 5, 9, and 16 of the Globe Quadrangle. Eight of the sites are within the realignment right-of-way of State Highway Project S-214-503 (Miami Wash Section), Miami, Arizona (Doyel 1974). The ninth site is outside the realignment area on land leased by the Inspiration Mining Company.

According to Sellers and Hill's (1974) description of the physical features of the state, the sites are located in a transition zone between the mountains and plateaus to the north and east and the deserts to the south and west. This is considered to be some of the most rugged terrain in Arizona (Martin and Plog 1973; Peterson 1962; Sellers and Hill 1974).

#### Physiography and Topography

The area is characterized topographically by moderate to steep hills cut by stream valleys, several of which have narrow floodplains (Fig. 1). The maximum relief in the sections in which the sites are located is circa 155 meters (500 feet). The highest point

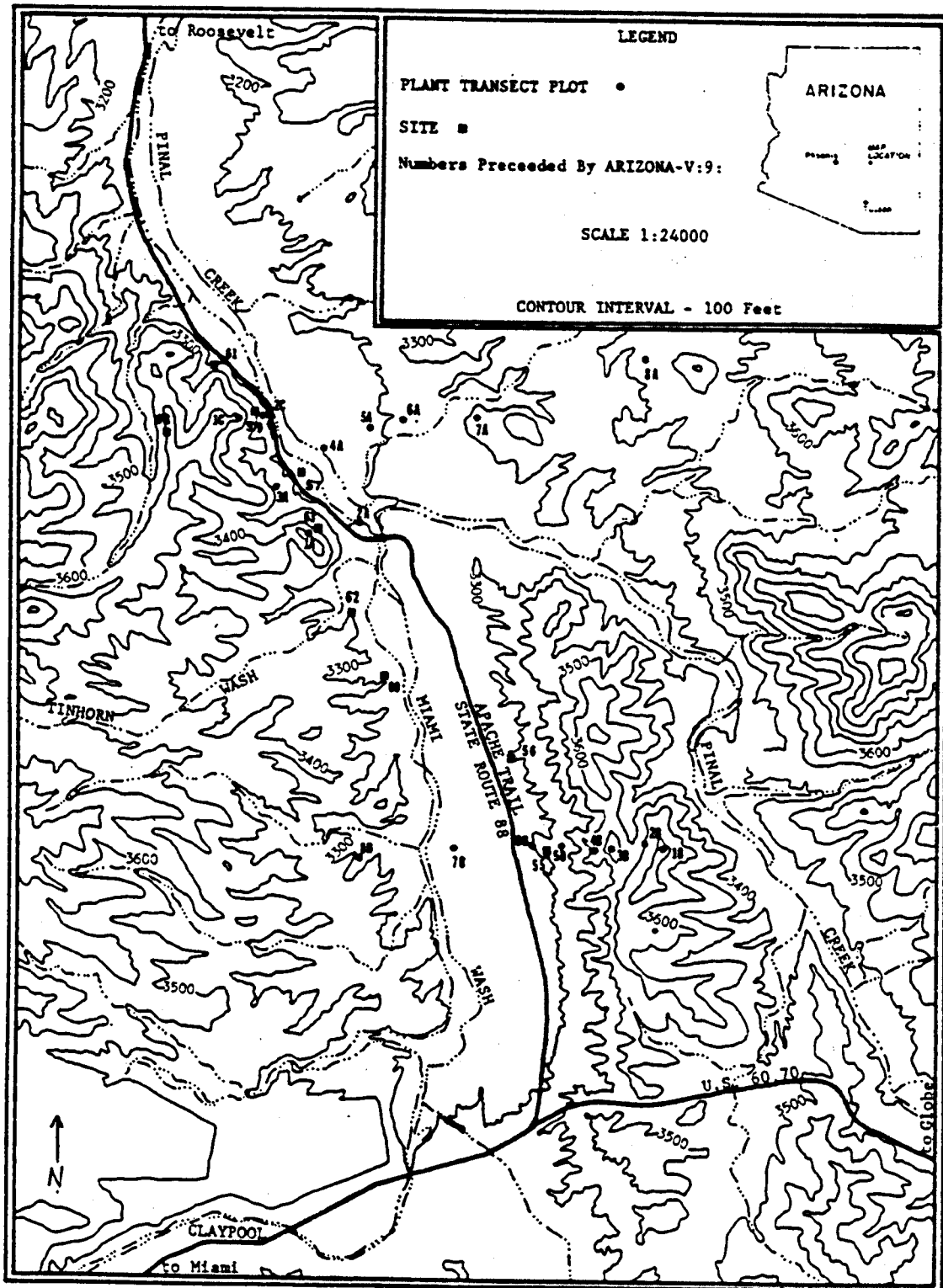
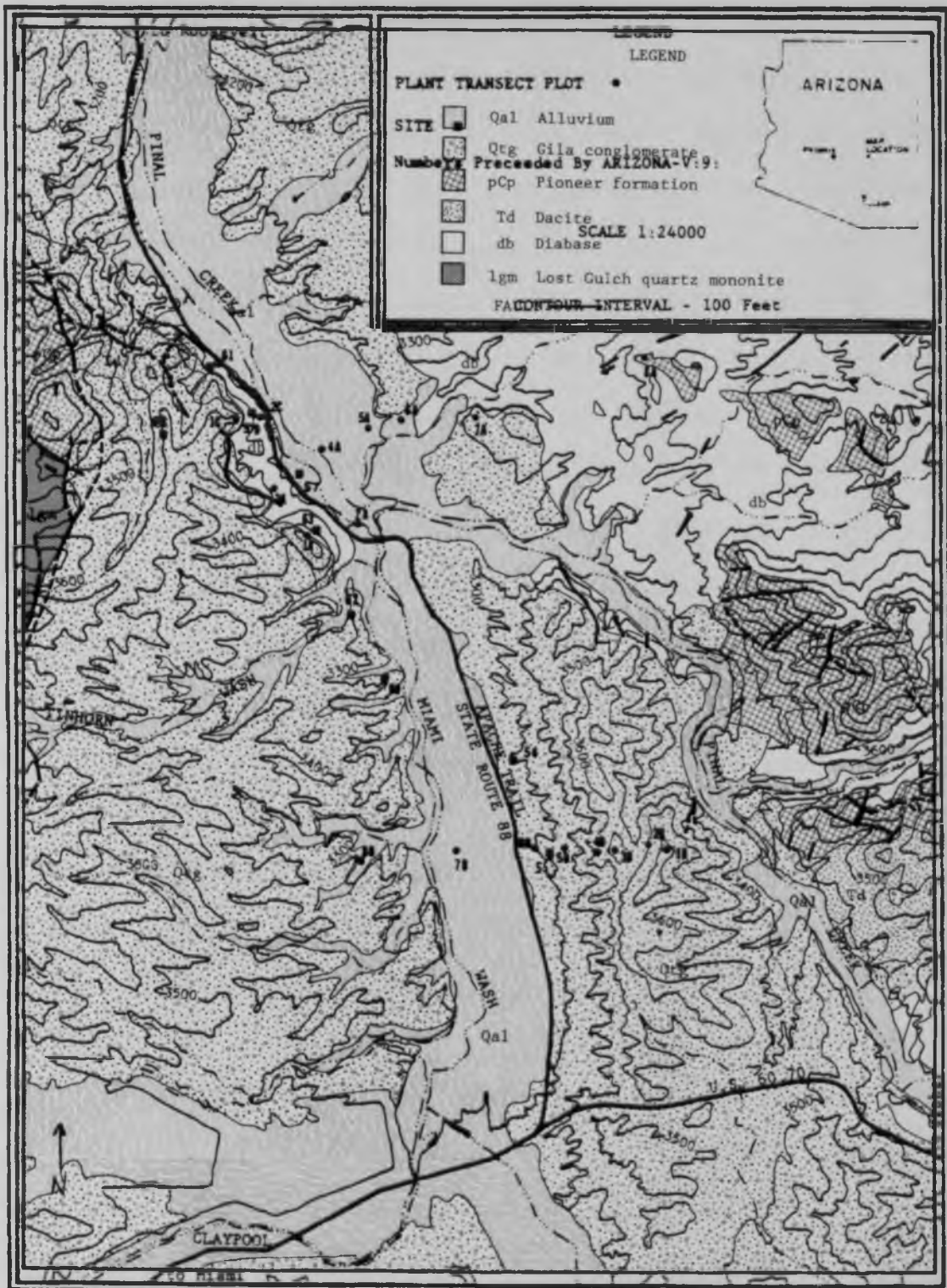


Fig. 1 Site map



in the quadrangle, circa 1525 meters (5160 feet), is an unnamed mountain northeast of Crash-up Mountain in the Globe Hills.

The drainages of Miami Wash and Pinal Creek are tributaries of the Salt River to the North. Along the stretch of Miami Wash where four of the sites are located, the floodplain is approximately 800 meters (0.5 miles) wide, with shallow terraces flanked by hills on either side. The slope of the hills varies from about 45 meters/kilometer (250 feet/mile) west of the wash to a maximum of 175 meters/kilometer (925 feet/mile) to the east. At the junction of Miami Wash and Pinal Creek the valley widens in places to circa 1200 meters (0.75 miles). Steep slopes, circa 190 meters/kilometer (1000 feet/mile), continue on the western side of Pinal Creek, but the eastern slopes decrease to circa 55 meters/kilometer (300 feet/mile) as they grade into the Globe Hills.

Though the wash and the creek are presently dry most of the year, Pinal Creek had, within the last twenty years, substantial underground flow (Peterson 1962). Some flow apparently still exists, since a spring, not identified on the topographic map, was found on the western side of Miami Wash near the sites. It is also possible that the lack of surface water in the drainages is a recent occurrence (within this century), since local informants say that their parents or grandparents recall both Pinal Creek and Miami Wash flowing much or all of the year in the area of the sites. The drop in the water table might be due to climatic change, but could also have been caused by increased use of ground water for mining and smelting operations.

## Geology

The geology of the Globe Quadrangle is complex and can best be reviewed in three parts: the rock types, the structure of the area, and the geologic history.

### Rock Types

Geologic column of igneous, metamorphic, and sedimentary rocks in the Globe Quadrangle and surrounding areas (Peterson 1962)

Igneous and metamorphic rocks:

| Age                    | Rock Type           | Description  |
|------------------------|---------------------|--|
| Quaternary             | Basalt              | Found as scattered small outcrops of olivine basalt flows over the Gila conglomerate.  |
| Tertiary (?)           | Dacite              | Light brownish gray, aphanitic with phenocrysts of feldspar, quartz and biotite. May be welded tuff.   |
|                        | Tuff                | Two members:<br>(1) White tuff, pyroclastic origin (ash and ashflows)<br>(2) Yellowish-gray, deposited in shallow bodies of water.                                   |
|                        | Perlite             | Black with vitreous luster and conchoidal fracture.  |
| Cretaceous or Tertiary | Diorite<br>Porphyry | Light gray to medium gray diorite emplaced as sills and dikes. Deeply weathered and extensively altered.   |
|                        | Diabase             | Dark gray or greenish gray diabase, with aphanitic to coarse-grained texture. Intruded into faulted areas as dikes and sills. Widespread, soft and easily weathered. |



|                                |                         |   |
|--------------------------------|-------------------------|---|
|                                | Lost Gulch<br>monzonite | Varies in texture and composition from porphyritic quartz monzonite with large orthoclase phenocrysts in a coarse-grained groundmass to quartz monzonite porphyry with orthoclase and plagioclase phenocrysts in a fine-grained groundmass. |
| Precambrian                    | Apache group<br>basalt  | Brownish gray to brownish black basalt which is highly altered and weathered. It may have been the result of multiple flows.  |
|                                | Ruin granite            | Coarse-grained porphyritic granite found in the north part of the quadrangle. Highly weathered.   |
|                                | Madera diorite          | Medium-grained granodiorite which appears bright gray. Intrusive into the Pinal schist.   |
|                                | Pinal schist            | "...wide range of gradational varieties..." (Peterson 1962:8). Correlates in age with the Yavapai series in central Arizona and the Vishnu schist in the Grand Canyon.  |
| Sedimentary rocks              |                         |   |
| Quaternary                     | Alluvium and<br>talus   | Localized deposits of soil, gravel, slope wash, and talus. The composition of the sediment varies according to the source rock.   |
| Tertiary and<br>Quaternary     | Gila conglom-<br>erate  | Formed as coalescing alluvial fans. The composition, which depends on the source and the degree of transportation, varies from unsorted, unconsolidated rubble to well-stratified, well sorted deposits of sand and pebbles.                |
| Carboniferous<br>Pennsylvanian | Naco lime-<br>stone     | Red shale base overlain by thin interbedded layers of gray marl and calcareous shale. Is fossiliferous with macrofossils and fusulinids.  |

|               |                           |  |
|---------------|---------------------------|--|
| Mississippian | Escabrosa limestone       | Massive gray fossiliferous limestone base topped by bedded limestone with shaley lenses.   |
| Devonian      | Martin limestone          | Has five major members: (1) a basal conglomerate of reworked material derived from local sources, (2) a lower limestone which varies from dolomitic limestone to layers of sandstone and conglomerate, (3) a middle layer of gray to brown crossbedded quartzite; (4) a medium to thick bedded upper limestone with fossils of brachiopods and corals, and (5) an upper deposit of very thin bedded (paper) shale. |
| Cambrian      | Troy quartzite            | Grades from a basal conglomerate derived from the Pioneer formation, the Barnes conglomerate and the Dripping Spring quartzite, to a sandstone of variable composition, typically brownish-gray medium- to coarse-grained sandstone or quartzite.  |
| Precambrian   | Mescal limestone          | Found as small faulted blocks of variable composition; includes crystalline and siliceous limestone, cherty limestone and limestone with fossil algae.   |
|               | Dripping Spring quartzite | Two members: (1) a lower one which varies from a light-gray to light-brownish gray coarse- to medium-grained quartzite, and (2) an upper member which is a thin-bedded fissile arenaceous shale.   |
| Apache group  |                           |  |
|               | Barnes conglomerate       | Of uniform texture with "smooth, well-rounded, ellipsoidal pebbles in a matrix of coarse arkosic sand so firmly cemented by silica that fractures generally cut through pebbles and matrix alike" (Peterson 1962:15).  |

|                      |   |
|----------------------|---|
| Pioneer formation    | A fine- to medium-grained arkosic quartzite   |
| Scanlon conglomerate | A thin conglomerate composed of reworked local material with fragments of white vein quartz and schist. |

### Geological Structure (Peterson 1962)

The Globe Quadrangle consists of three major structural blocks: the Globe Hills block, the Globe Valley block, and the Inspiration block. The Globe Hills block comprises the northeastern half of the Globe quadrangle. Its boundary, the Pinal Creek fault zone, follows the course of Pinal Creek from the north edge of the quadrangle south to the junction of Pinal Creek and Miami Wash. In this area the fault is covered by recent alluvium and its exact location is uncertain; it apparently follows the trend of Pinal Creek to the southeast. The Globe Valley block is a graben bounded by the Pinal Creek fault zone on the east and the Miami fault on the west. A trace of the Miami fault follows the contact of the Quaternary deposits with the Tertiary and Cretaceous crystalline rocks in the western quarter of the quadrangle (Peterson 1954). The inspiration block is bounded on the east by the Miami fault and extends beyond the boundaries of the quadrangle in the other directions.

### Geological History (Peterson 1962)

Early Precambrian. The oldest known rock, the Pinal schist, was formed from deposits of clastic sediment derived from an unknown source. The Mazatzal revolution ended deposition when southeast-northwest

compression formed a northeast trending mountain range which became a divide between the northern and southern sedimentary basis in Arizona from the late Precambrian period into the Paleozoic. During this tectonic episode the clastic sediments were metamorphosed into the Pinal schist and intruded by granitic rocks (Madera diorite and Ruin granite). At the end of the Mazatzal revolution the topography consisted of rugged mountains with folded and faulted blocks. Deep weathering and extensive erosion followed, leaving unconsolidated sediments mantling the bedrock.

In the Late Precambrian the sea advanced, depositing the various members of the Apache group. The Scanlan conglomerate and Pioneer formation were formed during the initial advance of the sea. Subsequent elevation of the land and retreat of the sea resulted in increased erosion and consequent deposition of the Barnes conglomerate. The basal layer of the Dripping Spring quartzite was formed during subsidence and readvance of the sea. This sandstone was buried by the subsequent deposition of fine-grained sandstone and shales, followed by Mescal limestone, as the sea continued to advance.

A new period of uplift accompanied by basaltic extrusions but with no apparent folding or faulting produced an erosional disconformity which removed most of the Mescal limestone.

Paleozoic. During the Mid-Cambrian period the land subsided and the sea advanced. The Troy quartzite, derived from the reworked Mescal limestone and Barnes conglomerate, was deposited. The absence of rocks dating from the Late Cambrian, the Ordovician, the Silurian,

and the Early to Mid-Devonian periods made geologic history subsequent to the Mid-Devonian difficult to interpret. In addition, there is no evidence of folding or faulting. Heavy erosion of the Troy quartzite indicates that the area was above sea level at least part, if not most, of that time.

During the late Devonian and early Mississippian the sea advanced, depositing first the Martin and then the Escabrosa limestones. In the Late Mississippian some erosion occurred, but by the Pennsylvanian period the area was again covered by shallow seas. During this period frequent changes in depositional conditions must have occurred to produce the alternating limestone and shale layers of the Naco limestone.

From the Upper Precambrian to the Pennsylvanian, there is no evidence of complex structural movements. Disconformities are the result of regional uplift and subsidence.

Mesozoic and Cenozoic. No lithologic evidence of the Permian, the Triassic, the Jurassic, and the Early to Mid-Cretaceous periods exist in the Globe Quadrangle. Any rocks which were formed during this time must have been completely eroded. In the Late Cretaceous(?) igneous bodies, including the Lost Gulch quartz monzonite and the diabase, were intruded into the area. This igneous activity was accompanied by faulting, producing fracture zones which became channels for hydrothermal mineralizing solutions in later times.

These intrusions were followed by uplift and broad folding of the sedimentary strata over the crystalline rocks to form an anticlinal arch, the Pinal Mountain elevation. This movement was

accompanied by faulting on the north side of the range. Intrusions of Schultze granite and diorite porphyrys into the fault zone and along the margins of the uplift were followed by copper metallization of the fracture zones.

During the Mesozoic era erosion of the area produced detritus which accumulated in the low areas to form the Whitetail conglomerate. The erosion was interrupted by two major stages of volcanic eruption. The first stage consisted of repeated ejections of tuff, rhyolite and perlite glass interspersed with short periods of erosion. Then, the second, more extensive, eruptive phase began. First, pumaceous material was ejected; this was followed by dacite flows and ejection of bombs and lapilli, which formed a massive sheet.

At the end of the major volcanic activity, large scale faulting occurred at intervals into the Pleistocene. Recent sedimentary formations--Gila conglomerate and alluvium--are the result of erosion of local rocks. This erosion was accompanied by some minor volcanic activity which produced flows of olivine basalt.

The sites are, for the most part, located on terraces along Miami Wash composed of Gila conglomerate. The topography formed on the Gila conglomerate is (Peterson 1962:5):

...characteristic of that formed in the destruction of a gently sloping plain of a nearly homogeneous rock. The surface is intricately dissected by a uniform, dendritic pattern of arroyos separated by smooth rounded ridges and spurs. The lower reaches of the main channels have broad gravelly beds of nearly uniform gradient.

Archaeologically and physiographically the Globe-Miami area is related to the Tonto Basin, circa 48 kilometers (30 miles) to the

north. Their geological relationship, if any, is unknown. Available archaeological reports for the Tonto Basin (Steen 1962; Haas 1971) include little geological data. In addition, I was unable to find any geological information on the Tonto Basin area in a library search which included United States Geological Survey and Arizona Geological Survey literature. It is therefore highly desirable that subsequent archaeological excavations in the Tonto Basin should include geological investigations.

### Climate

No weather station is located in either Miami Wash or Pinal Creek, but records (Sellers and Hill 1974) are available for both Miami and Globe, Arizona, located, respectively, 5.7 kilometers (3.5 miles) southwest and 5.8 kilometers (3.6 miles) southeast of the southern-most site. Miami, which is 1085 meters (3560 feet) above mean sea level, has two seasonal maxima of precipitation--winter and mid- to late summer. Late spring is very dry. The predominant seasonal rainfall occurs in July and August, when there are short, heavy rains associated with a high pressure zone over the Gulf of Mexico. Rains in the winter are normally gentler and longer, but also less regular than the summer rains. The average precipitation in Miami from 1931 to 1972 was 45.85 centimeters (18.05 inches). The summers are warm, though not nearly as hot and withering as those in the Sonoran desert near Tucson, circa 130 kilometers (80 miles) to the south. The daily mean temperatures top 26.7°C (80°F) only in

July and August. Winter days are mild, with maximum mean temperatures ranging from circa 12.8°C (55°F) to greater than 21°C (70°F). Minimal nighttime winter temperatures may fall near or below freezing. The record high of 43°C (110°F) was recorded in July, 1958, and the record low of -13°C (8°F) in January, 1962. The growing season, which extends from the latter part of March to mid- to late November, averages about 245 days.

Globe, at nearly the same elevation as Miami--1802 meters (3550 feet) above sea level--has a similar climate. The average yearly precipitation is 39.82 centimeters (15.53 inches), occurring, as at Miami, in two peak periods--during July and August and December and January. Precipitation is, like that in the desert, erratic. Since 1930, monthly rainfall has exceeded 20.32 centimeters (8 inches) three times--in August, 1963, and in December, 1965 and 1967--while less than 22.86 centimeters (9 inches) fell during the entire year of 1948. The normal winter snowfall is 5 centimeters (2 inches); however, extremes of 28 centimeters (11 inches) were recorded in February, 1939, and December, 1967, and 61 centimeters (24 inches) were estimated for January, 1937. Average maximum daily temperatures in the winter vary from 10 to 16°C (50 to 60°F). A record low temperature of -12.77°C (9°F) was recorded in both 1968 and 1971. Though temperatures from April through October may exceed 32°C (90°F), the hottest months are normally June, July, and August. A record high of 45°C (113°F) was recorded in July, 1970. The length of the growing season averages 228 days, extending from the first week in April to the middle of November.



The climate of the sites is probably very similar to that of Miami and Globe. The towns and five of the sites are located on the same geological formation--Gila conglomerate--so the lithologic effect, which includes insolation and albedo, is essentially the same. Four of the sites are on a local outcropping of diabase which is surrounded by the conglomerate. The microclimate of an area is affected by the underlying lithology. For example, dark rocks absorb sunlight and emit heat, raising the air temperature above them. Lighter colored rocks reflect sunlight. The major physiographic difference between the towns and the sites is that Globe and Miami are on north-facing slopes, while the sites are primarily on east- and west-facing slopes in a north-south trending valley. It would therefore be expected that daytime temperatures at the sites would be warmer in both summer and winter. However, cold air drainage down the valley may cause cooler temperatures at night. This drainage may also cause shorter growing seasons than in Miami and Globe.

### Vegetation

The vegetation reflects the transitional nature of the environment. The flora consists of components of five of Lowe's (1964) plant communities: the Lower Sonoran Desert, the Desert- and Plains-Grassland, the Chaparral, the Evergreen Woodland, and the Riparian environment. Plants common both to Lowe's five communities and to the area of the sites are:

1. Lower Sonoran Desert. blue paloverde (Cercidium floridum), crucifixion thorn (Canotia holocantha), jojoba (Simmondsia

- chinensis), and various species of cactus such as hedgehog (Echinocereus), barrel (Ferocactus), cholla (Opuntia) and prickly pear (Opuntia).
2. Desert- and Plains-Grassland. sotol (Dasyllirion wheeleri), beargrass (Nolina), and grasses such as three-awn (Aristida), fescue (Festuca), brome (Bromus) and others
  3. Chaparral. live scrub oak (Quercus turbinella), mountain mahogany (Cercocarpus betuloides), brickellbush (Brickellia), barberry (Berberia), and squawbush (Rhus trilobata)
  4. Evergreen woodland. juniper (Juniperus)
  5. Riparian. mesquite (Prosopis juliflora), cottonwood (Populus freemontii), and willow (Salix)

The plant associations within the site area vary, at times with relation to the topography, but other times for no immediately obvious reason. Generally, more mesic types of vegetation are found on the northwest-facing slopes. These include juniper (Juniperus), crucifixion thorn (Canotia holocantha), mountain mahogany (Cercocarpus betuloides), and scrub oak (Quercus), though all of these may be found in isolated instances on slopes facing other directions. Common plants on east- and southeast-facing slopes include catclaw (Acacia gregii), white thorn (A. constricta), cacti (Opuntia spp., Echinocereus, Ferocactus), sotol (Dasyllirion wheeleri), and blue paloverde (Cercidium floridum). One west-facing slope was dominated by wait-a-minute (Mimosa cf. biuncifera), though it was found only rarely in

other locations. Juniper (Juniperus) and crucifixion thorn (Canotia holocantha) were two other plants which occurred infrequently on the slopes. Cottonwood (Populus Freemontii), elderberry (Sambucus), willow (Salix), and cattail (Typha) were present, though not common, on the floodplains. Bosques dominated by mesquite (Prosopis) associated with nightshade (Solanum), catclaw (Acacia gregii), Haplopappus, and white thorn (Acacia constricta) were found in the broader valleys at the mouths of tributaries of Miami Wash and Pinal Creek.

As should be indicated by the review of the vegetation, it is difficult to describe the plants in the site area as belonging to any particular association or community. Associations are present--juniper and crucifixion thorn, acacias and mesquite--but even these are not consistent over the hills and valleys. The variations partially reflect the topography, but some occurrences, such as the Mimosa, must be related to other factors such as variation in soil composition.

### Fauna

According to Martin and Plog (1973), over fifty percent of the animal biomass within the transition zone consists of small rodents. (Substantiation for this statement was, however, not apparent.) These include (Lowe 1964): valley pocket gopher (Thomomys bottae), various types of pocket mice (Perognathus), and mice (Peromyscus). Larger mammals present are: rabbits (Lepus), cottontails (Sylvilagus), squirrels (Citellus), coyote (Canis latrans), bobcat (Lynx rufus), mule deer (Odocoileus hemionus), skunk (Mephitis),

and javelina (Pecari tajacu). Amphibians which might be present include spadefoot toads (Scaphiopus) and toads (Bufo). Both lizards and snakes were sighted in the field. Reptiles common to the area are: banded Geckos (Coleonyx variegatus), collared lizards (Crotaphytus collaris), chuckwalla (Sauromalus obesus) and other lizards, blind snakes (Leptotyphlops), garter snakes (Thamnophis), gopher snakes (Pituophis melanoleucus), and rattlesnakes (Crotalus).

As previously mentioned, springs in the area do not presently form ponds or lakes, and the washes and creeks are often dry. Informants indicate that Pinal Creek and Miami Wash were perennial in the past. Native fish in Arizona streams which might have been present in Miami Wash and Pinal Creek include (Lowe 1964): Gila trout (Salmo gilae), Colorado chub (Gila robusta), longfin dace (Agosia chrysogaster), spinedace (Meda fulgida), and suckers (Catostomus).

This area is well described by the phrase "transitional zone," as is indicated by the physiography, topography, geology, climate, flora, and fauna. The region comprises neither a dry, hot Basin and Range topography like that found to the south and west, nor a cool, high mountainous area like that to the north. The land has, instead, microenvironments common to both areas which offer a wide variety of vegetal and animal resources to those living in the area today and to those who lived there in the past. It is thus not surprising that there is abundant evidence of prehistoric man inhabiting this area for hundreds of years.

## CHAPTER 3

### ARCHAEOLOGICAL BACKGROUND AND SITE DESCRIPTIONS<sup>1</sup>

The nine sites excavated within the transitional environment show evidence of habitation by two prehistoric cultures--the Hohokam from circa A.D. 700 or 750 to 1150, and the Salado from circa A.D. 1200 to 1400 or 1450. In addition, the Miami cultural phase, dating circa A.D. 1150 to 1200, appears to Doyel (1976a) to form a transition between the Hohokam and the Salado. Continuous or intermittent occupation of an area for hundreds of years implies the presence of some factor or factors which are attractive to the occupants. In order to develop a basis for understanding the relationship of these cultures to their environment, it is necessary first, to review what is known of the cultures in other areas and then, to examine the evidence from the sites themselves.

#### The Hohokam

The Pima and Papago, who are possible descendents of the Hohokam, referred to them as "the ancient ones," "those who have vanished" (Wormington 1947) or less romantically, "those who are all

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1. This is a summary of the archaeology. For a fuller treatment, see Doyel 1976a.

used up" (Haury 1976). The Hohokam lived on the floodplains of the desert rivers and in the interior of the Sonoran desert for over a thousand years (Haury 1967). They practiced irrigation agriculture where perennial streams made it possible and subsistence collecting and limited farming where water was scarce (Haury et al. 1950). Evidence from the sites along Miami Wash indicates that they entered the Tonto Basin region between circa A.D. 550 and 700 (Doyel 1976a).

The Hohokam culture varied over both space and time. It was first defined by Gladwin et al. (1937) during excavations at Snaketown, south of Phoenix, Arizona. Other reports (DiPeso 1956; Haury 1932, 1945, 1976; Wasley and Johnson 1965) have broadened that definition, though they have not always clarified it. Diagnostic cultural attributes are Red-on-buff pottery, the aforementioned water-managing capabilities, domesticated plants, cremation, highly developed shell work, stone sculptures, semi-subterreanean houses, turquoise mosaics, and, at the peak of its development, knowledge of etching shell and the importation of copper.

Recent excavation at Snaketown (Haury 1976) suggests the following chronology for the Hohokam culture:

| <u>Period</u> | <u>Phase</u> | <u>Approximate Duration</u> |
|---------------|--------------|-----------------------------|
| Classic       | Civano       | A.D. 1450-1300              |
|               | Soho         | A.D. 1300-1100              |
| Sedentary     | Sacaton      | A.D. 1100-900               |
| Colonial      | Santa Cruz   | A.D. 900-700                |
|               | Gila Butte   | A.D. 700-550                |

|         |            |                 |
|---------|------------|-----------------|
| Pioneer | Snaketown  | A.D. 550-350    |
|         | Sweetwater | A.D. 350-200    |
|         | Estrella   | A.D. 200-1      |
|         | Vahki      | A.D. 1-300 B.C. |

A transitional Gila Butte-Santa Cruz phase and the Sacaton phase are in evidence in the Miami Wash sites.

The Colonial Period, encompassing the Gila Butte-Santa Cruz phase, was a time of change marked by an intensification of Mesoamerican influence and territorial expansion (Haury 1976; Martin and Plog 1973). Additions to the cultural repertoire which indicate Mesoamerican influence include ballcourts, platform mounds, and stylistic changes in pottery and clay figurines. The finely decorated pottery and carved stone receptacles and palettes are indicative of a peak in artistic achievement.(Haury 1976). A new freedom of expression in pottery decoration, as well as increased imagination and skill in other crafts cause Haury to state (1976:354-355): "It is my opinion that pottery painting, stone sculpturing of receptacles and palettes reached a state of highest elegance toward the end of the Colonial Period, from A.D. 700-900. Thereafter there is a decline in excellence..." During this period the Miami Wash area was occupied as part of the expansion northward toward Flagstaff, eastward into the Tonto Basin and Gila River area, and southward toward the valleys of the Santa Cruz and San Pedro rivers (Haury 1976).

The Sedentary Period, Sacaton Phase, shared in the "golden age" of the Hohokam (Haury 1976:265). Animal figurines, previously of minor ceremonial importance, were elevated to seemingly magical

significance during the transition into the Sacaton phase. They became more abundant and were more carefully modeled and fired; even the clay was changed. Acid etching of shells became a hallmark of the Sedentary Period. At the same time the quality of pottery decoration declined. The wide variety of bold designs are poorly executed, with brush work showing little precision and frequent paint dribbles. At the end of this phase, Snaketown was abandoned and there was a withdrawal of peoples from the exterior regions to the desert valleys. This phase marks the beginning of the Hohokam cultural decline (Haury 1976).

### The Salado

The next culture occupying the transition zone below the Mogollon rim, the Salado, is one of the least known and most controversial of the early Southwestern cultures. Haury (personal communication) feels that there are more Salado sites in Arizona than those of any other culture, yet little is written of them. Present controversy concerning these people centers on the basic questions of who they were and where they came from. Doyel (1976b) summarizes the question of origin by citing the various theories that have been advanced. According to Gladwin's interpretation, the Salado culture came to the Tonto Basin during a migration prompted by Apachean raiders of the Little Colorado culture into the Tonto-Globe area. Hawley's interpretation, cited in Doyel, saw the Salado as a combination of people from the upper Gila River who made Black-on-white pottery with Little Colorado people who made Black-on-red pottery. Haury (1945) views..



the Salado as a blend of the Anasazi and Mogollon cultures. McGregor (1965) says that they were a southern extension of the Anasazi people who mixed with the Mogollon and Hohokam producing a new culture. According to Di Peso (1956), the Hohokam were the invaders, not the Salado. The Salado--who Di Peso (1956) includes in a group called the Ootams, part of the Gran Chichimecans (Di Peso, 1974)--were a people of indigenous origin inhabiting much of the Southwestern United States and northern Mexico. The Hohokam entered this group's homeland around A.D. 1000 and were driven out by a reassertion of this indigenous group around A.D. 1300. This reassertion resulted in cultural manifestations which have identified by other archaeologists as a new culture, i.e., the Salado. Martin and Plog (1973) promote a completely different thesis. The "so-called Salado developments," they state, were in situ developments, part of the natural evolution of the Hohokam. Instead of an invasion of new peoples, or the reassertion of an indigenous one, there was a development of a hierarchy: "social stratification, an elite, a 'chiefdom' stage of social evolution" (Martin and Plog 1973:317). These theories are all presently viable because so little is known about the Salado culture. Many thorough investigations with subsequent communication and publication are necessary before the controversy will move toward resolution.

The Salado culture is most capable of definition within its heartland, the Tonto Basin. Cultural aspects attributed to the Salado in this area include (Steen 1962; McGregor 1965, Doyel 1974, 1976b): Roosevelt Black-on-white, Pinto, Gila, and Tonto Polychrome pottery,

painted basketry, large cotton blankets, fine stone and shell work, both cremation and inhumation burials, fields in alluvial valleys, and small and large compact pueblos. These settlements often consist of rectangular, contiguous rooms with an adjoining corral-like enclosure or compound. The compound might, in fact, be considered a defining element of the Salado, except that there is no general agreement on what a compound is and there is the possibility that some sites were not enclosed by them (Doyel 1976b).

The Salado abandoned their homes--as did many other Southwestern groups--around A.D. 1450. As a distinct culture, they had a very short history compared with the Hohokam, the Mogollon, or the Anasazi. Whether this brief cultural life span is a reality or an artifact of our lack of knowledge can only be resolved by further investigation.

The Salado culture, as indicated by the presence of Pinto Polychrome pottery occupied the Tonto-Globe area by A.D. 1200, although there are less certain indications of earlier habitation (Doyel personal communication).

In addition to the Hohokam phases, three other phases--the Miami phase (transitional from Hohokam to Salado), and the Roosevelt and Gila phases of the Salado culture--are represented in the Miami Wash sites. The Miami phase (A.D. 1150 to 1200) has been formulated and defined on the basis of the excavation of the Miami Wash and other local sites.<sup>1</sup> Attributes include non-contiguous surface and pit rooms grouped within an enclosing wall, Gila Plain and Gila Red as well as

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1. See Doyel 1976a for detailed discussion.

intrusive ware, clay and stone figurines, and extended or flexed burials with offerings. This new phase appears to represent a mixture of Classic Hohokam and Puebloan attributes with elements thought to be uniquely Saladoan. Evidence of the subsequent Roosevelt phase (A.D. 1200 to 1300) argues for some continuity from the Miami phase. Shared attributes include extended burials and cobble masonry architecture. Dissimilarities are evidenced by the appearance of Pinto Polychrome, Pinto Black-on-red, Salado Red and associated ceramics, lack of enclosing walls, and other changes in material culture.

Components of the Gila Phase (A.D. 1300 to 1450) occur in over 50 percent of the sites (Doyel 1976a). The houses consist of a base of wet-laid cobble masonry walls built about 1 meter high. The walls are completed with perishable materials topped with a roof supported internally by wooden posts. Pottery vessels are mainly small bowls and jars, with few large storage vessels. The phase appears to be characterized by a variety of settlement patterns suited to different purposes. The sites in Miami Wash were probably oriented towards agriculture and utilization of natural resources.

#### Site Descriptions

Of the nine sites sampled, seven small sites located on terraces above the floodplains of the drainages were excavated completely. One work site on a northeast-facing slope above the Pinal Creek floodplain had no apparent structures, but was sampled and collected. In addition, two rooms in one large (greater than 50 room) site on the top of a hill west of Miami Wash were also excavated.

Descriptions of location, vegetation, site features, and ceramic dating follow.<sup>1</sup>

Runway Ruin, Arizona V:9:55

Runway Ruin--elevation circa 1000 meters (3275 feet), is located at the end of a narrow terrace overlooking the Miami Wash floodplain. The terrace, on Gila conglomerate, is heavily eroded, with steep slopes to the north, south, and west. It is bordered to the east by a hill which rises more than 130 meters (425 feet) above the terrace. Modern vegetation (see Chapter 5 for scientific names) on the site includes mesquite, white thorn, desert broom, prickly pear, cholla, starflower, and Phacelia (no common name). The site has two components, with one Hohokam pithouse partially overlain by two contemporary Salado cobble-walled structures built in pits. Dominant ceramic types found include Gila Polychrome, Gila (?) Black-on-red, Salado Red and Four-mile Polychrome for the late Salado component, and Sacaton Red-on-buff and Snowflake Black-on-white for the early component. These pottery types indicate that the site was occupied circa A.D. 1000 to 1150 and again between circa A.D. 1250 and 1350. The absence of Tonto Polychrome narrows the range to around A.D. 1300 or earlier.

Monitor, Arizona V:9:56

Monitor is located circa 700 meters (2300 feet) north of Runway at the same elevation on a broader west-facing terrace composed of

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1. Site features and ceramic dating are from Doyel 1974, 1976a.

Gila conglomerate. Vegetation at the time of excavation included gray thorn, mesquite, salt bush, catclaw, desert broom, cholla, starflower, and heron-bill. The site is (Doyel 1974:19): "dual component Salado site with indication of use by earlier Hohokam groups." There are two pit rooms, one Hohokam pithouse, remnants of a cobble alignment on the east side of the site, fire hearths, and fire pits. The presence of a large quantity of Gila Butte, Santa Cruz, and Sacaton phase (A.D. 500 to 1100) Red-on-buff pottery and a Hohokam pithouse indicate Hohokam occupation of this site. According to the ceramics--which include corrugated and smoothed plainware, Salado Red slipped ware, sherds of Gila Polychrome, Gila (?) Black-on-red, Roosevelt Black-on-white, and some White Mountain redwares--the last occupation of the site occurred between A.D. 1250 and 1420. An earlier date is suggested by sherd collections including Cibola White ware types, St. John's Polychrome, San Carlos Red-on-brown, Casa Grande Red-on-buff and Pinto Polychrome, made in areas adjacent to the site.

Columbus, Arizona V:9:57

Columbus, at circa 1000 meters (3300 feet) above mean sea level, is located circa 1000 meters (3300 feet) north of Monitor, on diabase bedrock. The diabase forms a northwest-facing terrace, which slopes on the northwest, north, and southeast sides, down to Pinal Creek. It is backed by a hill on the west. The vegetation prior to excavation consisted of fewer shrubs and trees than other sites, but there were numerous grasses and desert marigolds. It is a large, complex site in which thirty-three features, including rooms, pithouses,

cobble structures, burials, ashpits, firepits, and a surrounding wall were excavated. Three phases of occupation in the site are documented: (1) the Sacaton phase, prior to A.D. 1100, (2) the Miami phase, circa A.D. 1100 to 1250, and (3) a final Salado occupation circa 1300 to 1350.

Refugia, Arizona V:9:59

Refugia--elevation circa 990 meters (3250 feet)--is located circa 200 meters (985 feet) north of Columbus on a steep, northwest-facing slope overlooking Pinal Creek. Two rooms, plus rock clusters, ashpits, and one burial were found on a level area of the underlying diabase. The walls of the rooms were built of the diabase rock and of dacite from upslope outcroppings. The vegetation, including juniper, crucifixion thorn, mesquite, yucca, jojoba, desert broom, and grasses, is the most mesic of all the sites.

Refugia is one of the most recent of the sites excavated. An archaeomagnetic date of A.D. 1375  $\pm$  25 obtained from Feature 1 (Doyel, personal communication) is corroborated by pottery which includes Tonto and Gila Polychrome. Roosevelt Black-on-white, Four-mile Polychrome, Salado Red, small quantities of Gila Red, and some unidentified white ware.

Multigrade, Arizona V:9:60

Multigrade, at approximately the same elevation as Runway Ruin and Monitor, sits on an east facing terrace of Miami Wash which is formed on Gila conglomerate. The terrace slopes down to the wash on the north, south and east sides, and is backed by a moderate hill to

the west. The terrace at the time of excavation was overgrown with white thorn, catclaw, mesquite, and yucca; plants in areas adjacent to the site include elderberry, nightshade, and milkweed. According to Doyel (1974:37): "Excavations at Multigrade were the most difficult of any accomplished during the project due to the predominance of terrace gravels and to the complicated and often superficial nature of the archaeological remains." Excavated features include four structures, two burials, several pits, and a trash area. The architectural evidence indicates intermittent Salado occupation. The ceramics, which include a large quantity of Pinto Polychrome, some Gila Polychrome and Gila Black-on-red, Roosevelt Black-on-white, San Carlos Red-on-brown, Four-mile Polychrome, and Salado Red, suggest occupation of the site from approximately A.D. 1150 to 1350.

#### Shaft, Arizona V:9:61

This small site is located about 500 meters (1640 feet) north of Refugia, at the same elevation, on a narrow diabase ridge. It overlooks the Pinal Creek floodplain to the north and east, a small valley to the west, and is backed by a hill to the south. The site has been disturbed both by a mining shaft sunk into the site and by the truncation of the terrace during previous highway construction. At the time of excavation the area was covered with catclaw, mesquite, crucifixion thorn, gray thorn, grasses, and barberry. The one partial room found indicates a single Salado occupation, probably of a limited or seasonal nature site. Most of the ceramics collected were either unidentified types or plainware. Doyel states (1974:42) "since no

special diagnostic material was located, the site is provisionally dated to A.D. 1200 to 1350."

Because "neither floor nor floor features could be located in the 20 cm of fill between the present ground surface and sterile soil" (Doyel 1974:42), no archaeological pollen samples were collected.

#### Tinhorn Wash, Arizona V:9:62

This site is located on a Gila conglomerate terrace at an elevation of circa 1000 meters (3300 feet), just south of the confluence of Tinhorn and Miami Washes. It is bordered by washes on the west, north, and east sides. Vegetation on the site consists of mesquite, gray thorn, desert broom, and barberry.

Tinhorn Wash site has been somewhat disturbed by recent construction and channelization, and it is therefore not apparent whether the site is intact. From the features excavated--one Salado cobble structure, a ramada, and one Hohokam pithouse--the site appears to have been occupied by both the Hohokam and the later Salado cultures. Several periods of habitation are also indicated by the ceramics. An initial occupation by the Hohokam around A.D. 700 to 750 is suggested by the presence of Gila Butte Red-on-buff ware in association with the pithouse. Subsequent Salado occupation circa A.D. 1250 or later is indicated by the presence of Pinto, Gila, and Tonto Polychrome pottery, Roosevelt Black-on-white, Gila (?) Black-on-red, and Salado red ware.



Shurban, Arizona V:9:63

Shurban is a multi-component limited use site with no definable architectural features. It is located on a diabase outcrop of a north-east-facing hillside above the confluence of Miami Wash and Pinal Creek. The site, circa 1025 meters in elevation (3350 feet), covers a large part of the slope, but only the area which showed heavy use, circa 60 square meters, was mapped and sampled.

As on other slopes, the vegetation, which includes mountain mahogany, white thorn, mesquite, snakeweed, catclaw, gray thorn, juniper, yucca, sotol, jojoba, and various herbs such as zinnia, desert marigold, nightshade, and grasses, is variable.

Shurban has no apparent architectural features, but consists of a number of bedrock mortars and metates, numerous cobble metates and manos, much chipped lithic material, and potsherds. The presence of charcoal, animal bone, and fire cracked rock suggests limited camping for the purpose of food processing. The ceramics, which indicate considerable time depth, include Santa Cruz Red-on-buff, Salado Plainwares, Roosevelt Black-on-white, and several sherds of Apachean material (Doyel 1976a). The varied cultural materials indicate periodic use from c. A.D. 700 to the mid-nineteenth century A.D.

East Ruin, Arizona V:9:68

This site, one of numerous similar sites along Pinal Creek and its tributaries which contain more than 50 rooms, is located on the top of a hill at an elevation of circa 1075 meters (3550 feet) and circa

2400 meters (7275 feet) west of Pinal Creek. From the site there is good visibility in all directions and ready access to the higher mountains above and floodplains below. The vegetation of the hilltop includes blue paloverde, mesquite, yucca, catclaw, snakeweed, prickly pear, hedgehog cactus, barberry, salt bush, juniper, false mesquite, grasses and herbs. The two rooms excavated suggest a late Salado occupation, circa A.D. 1300 to 1400. One room (Feature A) was a habitation area, the other (Feature B) was a storage room filled with vessels.

### Summary

The sites indicate multiple occupation of the area beginning circa A.D. 700 to 1100 or 1150 with the Hohokam. Later Salado occupation began circa A.D. 1150 and ceased circa A.D. 1400 to 1450. The sites, on the whole, were small, possibly being used for seasonal occupation associated with farming of the alluvial floodplains or yearly habitation by small groups of people. One site, Shurban, suggests that certain areas were used specifically for the processing of some native vegetal material. The two rooms excavated at East Ruin provide some limited knowledge of large-scale occupation of the area, but leave many tantalizing questions--such as total population of the areas at any one time--unanswered.

## CHAPTER 4

### POLLEN ANALYSIS

Palynology has been used as an archaeological tool in the Southwest for over twenty years. With the development of processual archaeology in the early 1960's archaeologists have tended to rely even more heavily upon the palynologist for assistance in the reconstruction of past environments. Increasingly, climatic change has been cited as a key causal factor in the explanation of processes of culture change (e.g., Hill 1970). Nonetheless, there are still a number of unresolved problems inherent in the use of pollen analysis in paleoenvironmental reconstructions. In order to understand these unresolved problems, it is necessary to review the basis for pollen analysis in the Southwest and the history of its use.

#### Assumptions and Basic Problems

The palynologist assumes that when one examines the pollen present in sediment one is viewing the pollen rain in that area at the time the sediment was deposited. If one knows what types of pollen are present in the sample, one can define, or at least describe, the wind-pollinated vegetation in the area from which the sample was taken. From the interpretation of the vegetation present in the environment, it is thus possible for the palynologist to

reconstruct aspects of the climate of the area. The relationship may be expressed as follows:

Pollen Sample  $\rightleftharpoons$  Pollen Rain  $\rightleftharpoons$  Vegetation Environment  $\rightleftharpoons$  Climate.

Unfortunately, as is the case with many assumptions, this equation has not been fully tested. The palynologist cannot always predict other elements of the equation from knowledge of only one element. This problem is currently being studied (Bryson and Kutzbach 1974; Davis, Brubaker, and Webb 1974).

In the arid Southwest, several problems arise which do not normally occur in other areas. The most basic of these is the low concentration of pollen in the sediment.<sup>1</sup> There are several reasons for low pollen counts. First, a large number of the desert flora is animal- or insect-pollinated (zoophilous), while many of the pollen types in the pollen rain are wind-pollinated (anemophilous). Second, as the Southwest is arid, there is a low density of plant cover; this further decreases the amount of pollen in the air. A third factor is the effect of drought, extended drought, or other abnormal precipitation on pollination. It is probable that a short period of abnormal (high or low) rainfall would be averaged in most samples because the pollen rain from a number of years is normally present in any one

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1. Soil is defined by Compton (1977:550) as, "the loose surficial mixture of mineral and organic substances that support plant roots." Sediment is defined as (549): "Loose particles that may be moved by water, wind, or glaciers, chiefly grains of rock, soil or organic remains." "Soil formation implies a period of stability" and development of a soil profile; "the more general term 'sediment' is therefore preferable for archaeological purposes" (Shackley 1975:3).

sediment sample. The effect of a prolonged drought would presumably be greater, but what that effect is is not presently known, as this source of low pollen counts has not been given careful study. Fourth, summer ground surface temperatures in the desert can exceed air temperatures because of high albedos of the surface. It is possible that high temperatures initiate oxidation of many pollen types; e.g., cottonwood pollen deposited under the trees during one spring disappears before pollination begins the next spring (Hevly, personal communication). This disappearance may be caused by a combination of heat and alkaline sediment. High sediment alkalinity is the fifth factor responsible for low pollen counts. Pollen is well preserved in acid sediments, but corrodes in alkaline sediments. Corrosion of pollen grains in the Southwest is common since much of the sediment in this arid region contains calcium carbonates.

A sixth factor, not exclusively found in desert conditions, is laboratory technique. Since Sears (1937) first attempted to extract pollen from desert sediments, the method has had to be changed drastically. The basic extraction technique used in the Paleoenvironmental Laboratories at the University of Arizona was formulated by Mehringer (1967). Briefly, it combines treatments of dilute and concentrated hydrochloric acid, 50 percent to 70 percent hydrofluoric acid, 30 percent nitric acid, and 50 percent to 7 percent potassium or sodium-hydroxide separated by distilled water washes (see page 49). It is possible that the use of caustic acids combined with dilute hydroxides may cause already corroded grain either to become corroded beyond recognition or to disappear entirely. Further experimentation with the method is therefore necessary.

### Historical Sketch

Sears (1937) was the first to attempt to extract pollen from alluvial samples<sup>1</sup> collected in the Southwest. Pollen was present in several of his slides, but not in quantities sufficient for statistical analysis. The first successful extraction of alluvial pollen from Southwestern samples was performed in conjunction with an archaeological excavation at Ramanote Cave, Santa Cruz County, Arizona, by Anderson (1955).

Since 1955, the use of pollen analysis in archaeological studies has grown considerably in volume and scope. In the late 1950's and early 1960's Martin (1963) analyzed samples from early man sites in southeastern Arizona; work in this area has been continued by Jelinek (1966), Mehringer and Haynes (1965), and Mehringer, Martin and Haynes (1967). A new dimension was added by Martin and Sharrock (1964) when they analyzed prehistoric human feces. Kelso (1971) studied human coprolites in relation to floor fill and has recently formulated an absolute counting method for pollen in human excrement (Kelso, personal communication). Human coprolites from a rock shelter in southwest Texas analyzed by Bryant (1974b) have been used

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1. By geological definition "Alluvial deposits are formed in stream channels and associated floodplains of individual streams, or as broad alluvial fans or plains where stream braiding dominates an appreciable area." (Krubein and Sloss 1963:255). "Alluvial samples" in this chapter refers to those samples which contain a large amount of sand, silt and clay, from which small amounts of pollen must be separated.

to determine aboriginal diet patterns and seasonality of site occupation. Other palynological research in archaeological sites includes the comparison of archaeological and lacustrine samples (Hevly 1964), intra-site comparisons (Hill and Hevly 1968), and ethnobotanical reconstructions of seasonally controlled cultural cycles (Bohrer 1970).

At the present time, pollen analysis in Southwestern archaeology may be divided into four non-mutually exclusive areas:

1. Interpretation of paleoenvironment and climate.
2. Intra- and inter-site correlation and dating.
3. Introduction and use of plants by man.
4. Interpretation of man's disturbance of an area.

The derivation of paleoenvironment and paleoclimate is based on the previously mentioned assumption that pollen samples reflect the environment and climate of an area at a certain time. Inter-site dating is in turn based on the paleoclimatic interpretation. The assumption here is that sites yielding samples which show a similar climate or change of climate when compared with earlier samples are contemporaneous or near-contemporaneous. Some reports which illustrate this use of palynology include Hevly (1964), Schoenwetter (1962, 1965), and Schoenwetter and Eddy (1964).

Analysis concerned with information about man's use of the vegetation in his environment are best exemplified by the previously mentioned human coprolite studies (Martin and Sharrock 1964; Kelso 1971; Bryant 1974a 1974b). Unfortunately, recognizable fossil human coprolites are rare or nonexistent in most archaeological sites, "but

probably contributed to refuse to an unknown degree" (Jelinek personal correspondence). However, interpretation of man's use of plants is still possible under the assumption that the pollen rain in a site will include pollen present from vegetal material that man brought into the structures. This is an acceptable assumption, since both corn pollen, which is not carried far by the wind (Raynor, Ogden and Hayes 1972), and squash pollen, which is insect-pollinated, have been found in numerous localities in archaeological sites (Schoenwetter 1962; Bohrer 1970; Martin and Byers 1965; Hevly 1964). Hill and Hevly (1968) employed this assumption in dating and identifying structures within Broken K Pueblo, Arizona.

Finally, the use of pollen analysis to measure man's disturbance of his immediate physical surroundings is based on the idea that in an area where man is present, disturbance will favor the growth of certain plants, which in turn will increase the amount or amounts of that type or types of pollen in the pollen rain of the site. In the Old World, the interpretation of pollen diagrams for Mesolithic and later sites has been based on the hypothesis that man not only caused disturbance, but also caused major changes in vegetation by the cutting and clearing of trees and shrubs (Godwin 1944; Keef, Wymer and Dimbleby 1965; Smith 1970; Turner 1970). This aspect has been neglected in pollen interpretations of Southwestern sites. Jelinek (1966) in the grasslands of New Mexico, estimates a 35 percent to 40 percent increase in pollen from plants favored by disturbance. Martin and Byers (1965) interpret vegetational changes at Wetherill Mesa, Colorado, as due to man's presence. Kelso (no date)



reexamines paleoenvironmental interpretations and decides that interpretations based on man's disturbance of his environment are as valid as those based on climatic changes.

Pollen analysis in Southwestern archaeological sites has progressed from an initial experimental stage to a stage where re-examination of the basic assumptions is not merely desirable, but necessary for further advancement of the science. Controlled studies in archaeological as well as in modern sites where primitive life styles are practiced would greatly expand our knowledge of environmental disturbance caused by man and enhance our interpretative abilities. My investigations over the past few years in both types of sites have led me to reconsider several of the basic assumptions that underlie the interpretation of pollen samples from archaeological contexts (see Appendices A and B). These earlier studies laid the foundation for the sampling and extraction methods used and for the hypotheses tested in the sites along Miami Wash and Pinal Creek, Arizona.

### Pollen Sampling, Extraction and Analysis Methods

#### Sampling Methods

For surface and subsurface samples collected prior to excavation it was determined that 25 to 75 grams of sediment were necessary for pollen recovery sufficient for statistical analysis. All samples were collected using a trowel washed with distilled water or saliva and wiped with clean tissue or cloth. Sediment samples were placed in a Whirl-pak (trade name) bag, sealed, and labeled. Samples

were recorded in field notebooks and checked at the end of each day. Each provenience required different collecting techniques, which are explained below.

Floor Samples. Floors present special problems in sampling, problems which have not been thoroughly investigated. A floor might be sampled by taking a single sediment sample in one location or by collecting one or two centimeters of dirt immediately above the floor over the entire floor. A method providing more information than the former but requiring less field time than the latter was chosen. "Composite" samples, consisting of trowel tips of dirt taken in a circular pattern, were collected from the quadrats of each floor. Generally two composite samples were extracted and analyzed per floor.

Metates and Manos. All whole and several fragmentary metates, as well as many manos, were wrapped in plastic bags on the sites and brought to the field laboratory. In the laboratory excess dirt was removed. The artifacts were washed with dilute hydrochloric acid to dissolve calcium carbonates and scrubbed with a clean wire brush. The wash water was collected in a trough and drained into Whirl-pak bags. The trough was cleaned after each sample collection. The liquid samples were extracted within one month of collection. All metate and mano samples collected were extracted and analyzed.

One sample (Arizona V:9:57:D8-5) from under a metate was collected, with the supposition that pollen from plants ground on the metate might also be present in adjacent floor dirt.

Vessel Samples. The assumption was made that vessels used for storage of vegetal materials were not filled with dirt during use. Sediment samples were collected from the sides and bottom of the vessels where pollen from utilized plants would be most likely to concentrate, instead of from the vessel fill.

Stratigraphic Column Samples. Sediment samples from stratigraphic columns in archaeological structures were collected in order to test the hypothesis that the pollen in the fill in a structure does not primarily reflect the effect of climatic change on the vegetation of the area surrounding the structure.

Columns of fill were left, when possible, in the center of one or more structures in each site excavated. The center was chosen because, theoretically, it is least affected by rock or dirt fall from the walls. The column of fill was prepared for sampling by removing the outermost two centimeters on one side of the column. This allowed the sampler to work with a "clean" (uncontaminated) sediment face. The column was then measured and flagging or nails were placed at those intervals to be sampled. Sampling was done at arbitrary intervals because no stratigraphic bedding was apparent in the fill of the structures. In most columns the sediment was sufficiently compact to allow collection of samples at 5 centimeter intervals, though in one column (Arizona V:9:60-69) the sediment was so friable that it could only be sampled every 10 centimeters. Samples were collected from the bottom of the column to the top to avoid contamination of the bottom by sediment falling during

collection of top samples. Before the sample from each interval was collected, the trowel was cleaned, another one to two centimeters were removed from the face, the trowel was cleaned again, and then the sample was taken. In order to measure short periods of deposition the horizontal length of the samples collected was about four times the vertical thickness.

Modern Surface Samples. Modern surface samples are necessary for a number of reasons, a primary consideration being an indication of what the present vegetation contributes to the pollen rain. Given that information, it is then possible to theorize about the vegetation of the past. The probability of plant use can also be studied by comparing the occurrence--both in terms of consistency and frequency--of rare, animal-pollinated pollen types in floor or artifact samples with their occurrence in surface samples.

Modern samples can best be collected by establishing permanent air sampling stations and collecting periodically for five to ten years in order to get an accurate picture of the pollen rain in wet and dry years. This, however, was not possible in this study. Archaeological samples are best compared with surface samples collected from areas which show no apparent sign of mechanical disturbance on or around the location sampled. In this study the surface samples with which the site samples are compared were collected from the surface of the sites before excavation began. These samples may contain ten, twenty, fifty, or possibly more, years of pollen, depending on the rate of deposition. The requirement that the surface

be undisturbed was fulfilled in all but two cases. Shaft (Arizona V:9:61) was sliced by a mine shaft and a road cut, and Tinhorn Wash Site was cut by a stream channel, as well as being extensively disturbed by nearby mining operations. The surface samples collected on these sites are therefore suspect.

Surface samples were collected in three general areas, on each site, and in conjunction with two plant transects consisting of nineteen sixteen-meter square plots. All surface samples were composite samples composed of trowel tips of dirt taken every two paces. Samples collected on the sites were taken from the interiors of those structures which were indicated by wall remnants. Interiors of rooms were sampled because prior to excavation wall remnants were usually the primary indicator of site location and size. Sampling was done prior to excavation, since flying dust from shoveling and screening could contaminate the surface around the sites with redeposited prehistoric pollen.

Burial Samples. Sediment samples were collected adjacent to various parts of burial remains in an attempt to discern ceremonial use of plants. The samples consisted of approximately 50 to 100 grams of sediment collected with a trowel next to the feet, hips, and shoulders of the skeletons (when possible), and from associated pottery vessels.

#### Extraction Method

Pollen was extracted using a variant of the method described by Mehringer (1967). The primary consideration in the extraction

process is to prevent contamination or destruction of the pollen. The following variations in the extraction method contributed to fulfilling this criterion.

The sediment was thoroughly mixed in the bags and placed in plastic beakers. First distilled water, then hydrochloric acid, was added to obtain approximately a 50 percent solution of water and acid; samples were then stirred until all reaction ceased.

Variation 1. These samples were covered and allowed to sit for circa 24 hours to ensure that all carbonates were dissolved, because a later step in the process involved the addition of hydrofluoric acid, which reacts violently with carbonates.

Next the samples were swirled into centrifuge tubes as described by Mehringer (1967), washed alternately with 60 percent and 80 percent strength solutions of hydrochloric acid, and then washed twice with distilled water. After each washing, whether with acid or water, the samples were stirred. When each step was completed, the samples were centrifuged and decanted before proceeding to the next step. To dissolve the silica minerals a 50 percent concentrate solution of hydrofluoric acid was added.

Variation 2. A 10 percent solution--instead of Mehringer's suggested 50 percent solution of hydrofluoric acid--was initially added to those samples collected from the floodplains of Miami Wash and Pinal Creek. These floodplains are presently the overflow sites for the settling pits of the copper mills, and thus reaction between chemicals used in the smelting process and the acid was possible.

The samples were allowed to sit for 24 hours before the 50 percent hydrofluoric acid was added.

Variation 3. A 50 percent solution of hydrofluoric acid was used for the second acid wash instead of 70 percent, because the effect of the combination of 70 percent hydrofluoric acid, plus the last reagent added, a weak base, may cause already corroded grains to become unrecognizable or to oxidize completely. With careful and precise hydrochloric swirl, only the smaller or less dense silicates were present in the samples in the tubes, and a second or third wash of 50 percent hydrofluoric acid was sufficient to dissolve the silicate minerals.

In addition to the extra acid washes, the samples were set in a boiling water bath for 20 minutes to ensure complete dissolution of the silicates, then washed twice with boiling distilled water to remove the acid and dissolved material. Next, concentrated hydrochloric acid was added to remove colloids from the samples; the samples were stirred, and then placed in a boiling water bath until bubbles appeared. After centrifuging and decanting, the samples were washed twice with boiling distilled water. Next, 30 percent nitric acid was added; the samples were stirred and rested for ten minutes, then centrifuged, decanted, and washed twice with boiling distilled water to remove the acid and any material in solution.

The final step was the addition of 5 percent to 7 percent sodium- or potassium-hydroxide to remove soluble basics in the samples. Though all basics were not removed, a stronger solution might have

destroyed the pollen by causing oxidation. The samples, with the hydroxide, were placed in the boiling water bath for two to three minutes, then centrifuged and decanted. Each sample was then washed with boiling distilled water until the decant was clear.

### Analysis Method

Preparatory to making slides, a few drops of a glycerol-based fuschin solution were added to the samples in the vials. The samples were then thoroughly mixed to achieve randomization of pollen grains. A few drops were drawn from the vials with a pipette, placed on a clean slide, and covered with a 22 millimeter square cover slip. Each corner of the cover slip was tacked down with glue to prevent slippage.

The pollen grains were counted using a Zeiss microscope with X12.5 eyepieces and a X40 lens. Two hundred grains, which are usually considered to be sufficient for statistical analysis (Martin 1963), were counted. In addition, each slide was completely scanned using a X12.5 eyepiece and a X20 lens to identify rare pollen types, such as corn, which are of economic importance. Pollen grains found while scanning but not in the count are denoted by "+" in the tables and graphs.

### Pollen

The interpretation of climate and climatic changes derived from analysis of pollen samples collected in archaeological sites (Schoenwetter 1962, 1965; Hevly 1964) is based on the implicit assumption that climate, as reflected in the vegetation, is the



determining factor of the pollen types and percentages found in soil samples; a corollary assumption is that the effects of this factor can be determined from those of other factors. I do not think this is possible when dealing with relative frequencies of pollen types (Lytle 1971). Two other major factors influencing pollen rain in areas associated with man are the importation and use of plants by man (the cultural factor) and the effect that man's presence has on vegetation in an area (the disturbance factor). Hypotheses concerning the effects of these two factors are tested in the Miami Wash samples.

Climate interpretation derived from stratigraphic samples collected in house fill draws upon the additional assumption that after house abandonment, the influence of climate can be distinguished from that of other contributors such as pollen incorporated into house walls which is deposited in the fill when the walls erode, pollen in sediments which is deposited in the fill during runoff, and pollen from natural plant succession after site abandonment. Until the extent of the contribution of these other factors is known, the effect of climatic change cannot be clearly distinguished.

### Cultural Pollen

#### Assumptions, Hypothesis and Prediction

As previously stated, one application of palynology is the interpretation of human utilization of plants. The implicit assumption is that plants--such as corn or squash--introduced by the inhabitants of a site into storage, work, or habitation areas,

contain pollen which then becomes part of the pollen deposition in these areas. These plants may be cultivated, encouraged (i.e., not sown, but allowed to grow in fields), or gathered. The hypothesis to be tested is that pollen from those plants used or introduced by a cultural group will be present in a predictable cultural context, i.e., will be found on floors, in burials, vessels, metates or manos. The prediction generated is that when the pollen spectra of plants used or introduced into cultural features is compared with the pollen spectra of the modern surface samples the cultural pollen will (1) be present in larger frequencies or (2) be consistently present in smaller frequencies.

It is necessary for purposes of clarity to define and discuss several of the terms of this prediction. What quantities are meant by larger and smaller frequencies? These amounts will vary, depending upon whether the source plant is anemophilous or zoophilous. Several of the plants used for cultural purposes as recorded by ethnobotanists (Castetter and Bell 1942; Whiting 1939) are animal- or insect-pollinated, and therefore little pollen would be anticipated, even in a known cultural association. For the definition of economic pollen types in pueblo kivas Hill and Hevly (1968) accepted types which were found in above average amounts when compared with those found in storage rooms, but did not state how much above average they were. Referring to pollen samples associated with a prehistoric Indian culture in west Texas, Bryant (1974b:413) says:

...pollen from zoophilous plants such as cactus, agave, yucca, sotol...are rarely found in either modern or

fossil pollen counts. Specifically, this investigator has not been able to recover more than 2% pollen from any of these zoophilous plants in soil from non-cultural zones or archaeological sites, alluvial sediments, or surface soil samples.

Pollen from wind-pollinated plants which have an ethnobotanic record of cultural use may be found in large quantities, whether or not they are used culturally. Grain amaranths were found in a large bowl at Snaketown (Castetter and Bell 1942), but their pollen type is also found in frequencies of 50 percent or more in surface samples from arid and semi-arid areas (Appendix B).

Identification of the cultural use of both zoophilous and anemophilous pollen types are based on a comparison of the archaeological pollen spectra with the modern surface samples and with the other archaeological samples. Those which occur in larger quantities than expected--based on comparison with surface samples--or in significantly greater frequency in one or more cultural associations, are judged to have been used or introduced by man. Those "significantly greater" are defined on the basis of the chi-square test for fitness.

A statement can now be made regarding the types of plants used by man which might be expected in this archaeological context. One of the best of the few botanical investigations available for the Salado culture in this region is Bohrer's (1962) analysis of vegetal material from Tonto National Monument, Arizona. Four use groups of plants--medicinal plants, wild food plants, cultivated crops and agricultural weeds, and plants in other cultural contexts--will be discussed.

According to Bohrer (1962), two medicinal plants, silk tassel (Garrya wrightii in the dogwood family) and sagebrush (Artemisia sp. in the Compositae family), were found. Wild food plants include acorns (Quercus sp.), agave or mescal (Liliaceae), cacti such as pricklypear (Opuntia engelmannii), cholla (O. vivipara and O. versicolor), hedgehog cactus (Echinocereus sp.), fishhook cactus (Mammillaria sp.), and saguaro (Cereus giganteus). Others identified are catclaw acacia (Acacia gregii), various grasses (Setaria spp.), cocklebur (Xanthium sp. in the Compositae family), hackberry (Celtis sp.), jojoba (Simmondsia chinensis), juniper (Juniperus sp.), and mesquite (Prosopis juliflora). In addition, there are yellow paloverde (Cercidium microphyllum), pinon pine (Pinus sp.), thistle (Cirsium sp., Asterae-type pollen), walnut (Juglans major), buffalo-gourd (Cucurbita foetidissima), canyon grape (Vitis arizonica in the Vitaceae family), and yucca (Yucca sp.).

The cultivated crops include six types of plants: maize (Zea mays), pumpkins and squash (Cucurbita spp.), tepary, kidney, and lima beans (Phaseolus spp.), jackbeans (Canavalia spp.), grain amaranths (Amaranthus leucocarpus), and gourds (Lagenaria siceraria). The two agricultural weeds, both grasses, are barley (Hordeum pusillum) and Carolina canarygrass (Phalaris caroliniana). Pollen types occurring in other contexts include the common reed (Phragmites communis), willow (Salix sp.), sotol (Dasyllirion sp.), bluestem "beardgrass" (Andropogon sp.), screwbean mesquite (Prosopis pubescens), and bear-grass (Nolina sp.).

Of the plant types cited here, not all could be identified through pollen analysis. When it is well preserved, silk tassel is identifiable. Oak, though it often does not preserve well in alluvial soil (Havinga 1964), is distinctly different from other grains. The lily family includes four of the plants listed: agave, beargrass, yucca, and sotol. If the preservation is good, it may be possible to identify the genus: if preservation is poor, then only the family can be discerned. Of those in the cactus family, the pricklypear and cholla are distinct. Many others can only be identified as Cereus-type grains. The catclaw acacia cannot be distinguished from white thorn acacia (Acacia constricta). Pollen from grasses (Setaria spp., barley, Carolina canarygrass, bluestem "beardgrass," maize, and common reed) are notably similar, the only accepted difference being size. Cultivated grass is normally defined as being greater than 60 to 70 microns in diameter. Operationally, cultivated grasses may have other characteristics, such as an enlarged, thickened rim (annulus) around the single pore and a thicker body (exine) than that found in wild species. Thus grass grains or fragments of grains less than 60 microns, but larger in diameter than other grasses, may be identified as cultivated if the other two properties are found to be consistent in the large whole grains. Plants in the Compositae family include cocklebur, thistle, and sagebrush. Compositae pollen are divisible into five groups; definition of three of these types is related to the length of the spines on the surface of the grains. Spines in the Ambrosia-type (wind-pollinated) pollen are circa 1.5

to 2 microns in length. Asterae-type (both wind- and insect-pollinated) are greater than 2 microns in length, but have no "tail" on the spine. Helianthus-type (insect-pollinated) has a very long spine (generally greater than 3 microns) which is elongated into a long spindly tail. The fourth group, Liguliflorae, is distinctly different, having both spines and large windows or fenestre. Artemisia, the fifth group, is identifiable to genus but not to species. The cocklebur (Ambrosia-type) and thistle (Asterae-type) can be identified as part of their respective groups.

If the hackberry and jojoba are well preserved they may be identifiable to their respective genera. Juniper-type pollen can be identified as belonging to the Cupressaceae family, and, considering the local vegetation, probably indicates the genus Juniperus. Mesquite and screwbean mesquite may both be identified as members of the genus Prosopis if the pollen is well preserved. Pollen from the yellow paloverde closely resembles the genus Holocantha and is identifiable only with difficulty. For present purposes, pollen from pinon pine trees is indistinguishable from that of other pines. Pollen grains from the gourd and squash family (Cucurbitaceae), including Cuburbita spp. and Lagenaria siceraria are theoretically identifiable, but the grains are large (usually over 60 microns) and are often found in small fragments which can only be identified as to family. Canyon grape pollen is identifiable if preserved. The tricolpate (three furrowed) grains of the tepary, kidney, and lima beans, are average in dimension with few distinguishing

characteristics. Apparently, those characteristics they do possess do not preserve well, for this investigator has no recollection of their occurrence in the pollen record in archaeological sites in the Southwest. Cheno-am pollen is a group which includes plants in the genus Amaranthus and the family Chenopodiaceae, with the exception of greasewood (Sarcobatus sp.). Pollen with this group is essentially indistinguishable. Willow (Salix) pollen is identifiable, if well preserved, by the coarse reticulation of the surface.

Of the plants cited by Bohrer (1962), the wind-pollinated types such as pine, the grasses, juniper, and the cheno-ams, would be of significance only if their pollen occurred in relatively high frequencies. Lower pollen frequencies of the following insect-pollinated plants might be significant: the lily family, cacti, acacias, Helianthus-type, hackberry, jojoba, mesquite and paloverde, walnut, the squash family, canyon grape, and beans.

It is possible, though not necessarily profitable, to regard any vegetation in a site area as having been of potential use to a people. Pollen analysis is a means by which the "probables" and the "possibles" can be separated from the mere potentials of speculation.

#### Relative Frequencies of Pollen in Floor Samples

Both major and minor pollen types are operationally defined for this study on the basis of the frequencies of anemophilous and zoophilous pollen types in the profiles. Major wind-pollinated grains occur in frequencies greater than 5 percent and major animal- or insect-pollinated types are greater than 2 percent. Minor types

occur in lower frequencies in more than 25 percent of the samples.

Rare types occur in less than 25 percent of the samples.

Chi-square tests were performed on the pollen frequencies both among floor samples and between surface averages and floor samples. The equation for the chi-square test is:

$$\chi^2 = \frac{(\text{Observed}-\text{Expected})}{\text{Expected}}.$$

The expected frequency in the floor samples is either the average of the observed frequencies of all samples or the average of the frequencies of the surface samples, depending upon which comparison was made. The test is considered to be a measure of the "goodness of fit" of two or more variables (Steel and Torrie 1960).

Theoretically, the pollen frequencies among floor samples will vary if different plants were used in different floor areas. Tests between surface and floor samples are based on the premise that large scale disturbance or plant use increases the pollen frequency of the involved vegetation in most or all of the floor samples and that modern surfaces represent undisturbed conditions. The level accepted as significant is 0.05.

Data are presented in Tables 1 and 2 and Figure 2 (in pocket).

### Interpretation and Discussion of Pollen in Floor Samples

Runway Ruin, Arizona V:9:55. The chi-square value of the comparison of the frequencies of chenopods in the floor samples with the average of the surface samples is significantly different. This variation could be explained in three different ways: (1) cultural use



Table 1: Pollen Frequencies of Floor Samples and Related Surface Samples

| Site and<br>Sample Number   | Relative frequency of pollen type (in percent) |                      |                  |              |
|-----------------------------|--|----------------------|------------------|--------------|
| Runway Ruin, Arizona V:9:55 | Cheno-ams                                      | <u>Ambrosia-Type</u> | Cultivated Grass | Liguliflorae |
| 1-74, NW 1/4                | 88   | 8.5                  | <2               |              |
| 1-89, SE 1/2                | 87   | 10.5                 | +                | < 2          |
| 3-28, NW 1/4                | 86   | 9                    | +                | < 2          |
| 3-29, SE 1/4                | 80   | 17                   | +                | < 2          |
| Surface, EW                 | 35.5   | 27                   |                  |              |
| Surface, NS                 | 32   | 30                   |                  |              |
| Monitor, Arizona V:9:56     | Cheno-Ams                                      | <u>Ambrosia-Type</u> | Cultivated Grass | <u>Abies</u> |
| 1-41, NW 1/4                | 87   | 9                    |                  | +            |
| 1-58, NE 1/4                | 91.5   | 7                    |                  |              |
| 3-37, N 1/4*                | 85.5   | 11.5                 | +                |              |
| 3-39, E 1/4*                | 79   | 17.5                 | +                |              |
| 3-67, W 1/4*                | 86   | 7.5                  | < 2              |              |
| Surface, W room, NE-SW      | 47.5   | 21.5                 |                  |              |
| Surface, W room, NW-SE      | 45.5   | 24.5                 |                  |              |
| Surface, E room, N-S        | 44   | 15                   |                  |              |
| Surface, E room, E-W        | 37   | 18.5                 |                  |              |

\*Though N 1/4, E 1/4, and W 1/4 are the field identifications given to these quadrat samples, "N," "E," and "W" normally indicate room halves rather than quarters.

Table 1, cont.

| Columbus, Arizona V:9:57 | Cheno-ams | <u>Ambrosia</u> -type | Juniperus | Liliaceae           |           |
|--------------------------|-----------|-----------------------|-----------|---------------------|-----------|
| 1-66, Floor #2, SE 1/4** | 89.5      | 7.5                   | +         |                     |           |
| 1-85, Floor #2, SE 1/4** | 91.5      | 6                     |           |                     |           |
| 6-43, SE 1/4             | 82.5      | 12                    | <2        |                     | + clump   |
| 6-77, Floor #2, E 1/2    | 80        | 12                    | <2        |                     | <2        |
| 6-78, Floor #2, W 1/2    | 92        | 5.5                   | <2        |                     | +         |
| 24-42, NE 1/4            | 87        | 10                    | <2        |                     | <2        |
| 24-44, SE 1/4            | 91.5      | 5.5                   |           |                     | <2        |
| 24-45, SW 1/4            | 67.5      | 20                    | 8         |                     | +         |
| Surface, NS              | 27        | 31.5                  | 7         |                     |           |
| Surface, EW              | 43.5      | 27.5                  | 10        |                     |           |
| Refugia, Arizona V:9:59  | Cheno-ams | <u>Ambrosia</u> -type | Juniperus | Cultivated<br>Grass | Liliaceae |
| 1-55, Floor #1, NW 1/4   | 78        | 15.5                  | <2        |                     |           |
| 1-90, Floor #2, NW 1/4   | 69        | 19                    | 2.5       | +                   | + clump   |
| 1-94, Floor #2, SW 1/4   | 71        | 19.5                  | 2         |                     |           |
| 1-222, Floor #3, NE 1/4  | 62.5      | 20.5                  | 8         |                     |           |
| Surface, EW              | 25.5      | 20                    |           |                     |           |
| Surface, NS              | 27.5      | 22.5                  |           |                     |           |

\*\*Field identifications of samples 1-66 and 1-85 indicate they are from the same floor and quadrat though it is apparent that two different samples were collected.

Table 1, cont.

| Multigrade, Arizona V:9:60   | Cheno-ams | <u>Ambrosia</u> -type | Cultivated Grass |        |
|------------------------------|-----------|-----------------------|------------------|--------|
| 3-28, Total floor            | 70.5      | 17                    |                  |        |
| 9-45, SE 1/4                 | 87        | 8.5                   |                  |        |
| 9-71, Total floor            | 84.5      | 11.5                  |                  |        |
| Z-11, W 1/2                  | 81        | 17.5                  |                  |        |
| Surface, NS                  | 43.5      | 25.5                  |                  |        |
| Surface, EW                  | 37        | 22                    |                  |        |
| Tinhorn Wash, Arizona V:9:62 | Cheno-ams | <u>Ambrosia</u> -type | Cultivated Grass |        |
| 6-47, Floor contact          | 92        | 6                     |                  |        |
| 6-59, SE 1/4                 | 93        | 6                     |                  |        |
| 10-18, SE 1/4                | 85.5      | 10                    |                  |        |
| 10-28, NW 1/4                | 86        | 11                    | <2               |        |
| 10-30, SE 1/4                | 86.5      | 10.5                  |                  |        |
| 10-39, NE 1/4                | 81.5      | 15.5                  |                  |        |
| Surface, NS                  | 27.5      | 31                    |                  |        |
| Surface, EW                  | 40.5      | 18                    |                  |        |
| East Ruin, Arizona V:9:68    | Cheno-ams | <u>Ambrosia</u> -type | Cultivated Grass | Cholla |
| A-57, S 1/2                  | 89.5      | 7.5                   |                  | +      |
| A-66, N 1/2                  | 92        | 5.5                   |                  | +      |
| B-39, SW 1/4                 | 93.5      | 4.5                   |                  | <2     |
| B-41, NW 1/4                 | 88        | 7.5                   | +                | +      |
| B-49, SE 1/4                 | 92.5      | 5                     |                  | +      |
| B-50, NE 1/4                 | 96        | 2                     |                  | <2     |

Table 2. Pollen Counts in Floor Samples, Miami Wash, Arizona

| Provenience                    | Cheno-ams | <u>Ambrosia-type</u> | Gramineae | Cultivated Gramineae | <u>Juniperus</u> | <u>Quercus</u> | <u>Artemisia</u> | Asterae-type | cf. <u>Croton</u> | Cruciferae | <u>Cuscuta</u> | <u>Eriastrum</u> | <u>Eriogonum</u> | cf. <u>Eriogonum</u> | <u>Erodium-type</u> | <u>Euphorbia</u> | <u>Helianthus-type</u> | Labiatae | Liguliflorae | cf. <u>Linaris</u> | Malvaceae | Nyctaginaceae | Onagraceae,<br><u>Oenothera-type</u> | <u>Plantago</u> | <u>Tidestronmia</u> | <u>Tribulus</u> | cf. <u>Vicia</u> |
|--------------------------------|-----------|----------------------|-----------|----------------------|------------------|----------------|------------------|--------------|-------------------|------------|----------------|------------------|------------------|----------------------|---------------------|------------------|------------------------|----------|--------------|--------------------|-----------|---------------|--------------------------------------|-----------------|---------------------|-----------------|------------------|
| Runway Ruin,<br>Arizona V:9:55 |           |                      |           |                      |                  |                |                  |              |                   |            |                |                  |                  |                      |                     |                  |                        |          |              |                    |           |               |                                      |                 |                     |                 |                  |
| 1-74 NW 1/4                    | 176       | 17                   |           | 3                    |                  |                |                  | +            |                   |            |                |                  |                  | 1                    | +                   |                  |                        |          |              |                    | +         | 1             |                                      |                 |                     | +               |                  |
| 1-89 SE 1/4                    | 174       | 21                   |           | +                    |                  |                |                  |              |                   |            |                |                  | 1                | 1                    |                     |                  |                        |          | 1            |                    | 2         | 1             |                                      |                 |                     |                 |                  |
| 3-28 NW 1/4                    | 178       | 18                   |           | +                    | 1                |                |                  |              |                   |            |                |                  |                  |                      |                     |                  |                        |          | 1            |                    | +         | +             |                                      |                 |                     | +               |                  |
| 3-39 SE 1/4                    | 160       | 34                   | 2         | +                    |                  |                |                  |              |                   |            |                |                  |                  |                      |                     |                  |                        |          | 2            |                    | +         | +             |                                      |                 |                     | +               |                  |
| E-W Surface                    | 71        | 54                   | 4         |                      | 17               | 8              | 2                | 6            | +                 | 3          | 3              | +                | +                |                      | 6                   | +                |                        | 1        |              | +                  |           | +             |                                      |                 | +                   |                 | 1                |
| N-S Surface                    | 64        | 61                   | 10        |                      | 13               | 6              | 1                |              |                   |            | 4              | 2                | 2                |                      | 3                   | 2                |                        |          |              |                    |           | +             |                                      |                 |                     | +               |                  |
| Monitor<br>Arizona V:9:56      |           |                      |           |                      |                  |                |                  |              |                   |            |                |                  |                  |                      |                     |                  |                        |          |              |                    |           |               |                                      |                 |                     |                 |                  |
| 1-41 NW 1/4                    | 174       | 18                   | 1         |                      | 3                |                |                  |              |                   |            |                |                  |                  | 2                    |                     |                  |                        |          |              |                    | +         | +             |                                      |                 |                     |                 |                  |
| 1-58 NE 1/4                    | 183       | 14                   | 1         |                      |                  |                |                  |              |                   |            |                |                  |                  | +                    |                     |                  |                        |          |              |                    | +         | +             |                                      |                 |                     |                 |                  |
| 3-37 N 1/4                     | 171       | 23                   | 1         | +                    | 3                |                |                  |              |                   |            |                |                  | +                |                      |                     |                  |                        |          |              |                    | 1         | +             | +                                    |                 |                     |                 |                  |
| 3-39 E 1/4                     | 158       | 35                   | 4         | +                    | 1                |                |                  |              |                   |            |                |                  |                  | +                    |                     |                  |                        |          |              |                    |           |               |                                      |                 |                     |                 |                  |
| 3-67 W 1/4                     | 172       | 15                   | 4         | 1                    | 2                | 1              |                  |              |                   | 1          |                |                  |                  |                      |                     |                  |                        |          | 1            |                    | +         |               |                                      |                 |                     |                 |                  |
| NE-SW Surface,<br>W room       | 95        | 43                   | 8         |                      | 5                | 4              |                  |              | +                 | 1          |                |                  | +                |                      |                     | +                |                        |          | 1            | 2                  | 1         | +             |                                      |                 |                     |                 |                  |
| NW-SE Surface,<br>W room       | 91        | 49                   | 2         |                      | 10               | 9              | 1                |              |                   |            |                |                  | 2                |                      | 4                   |                  | 1                      | 1        |              | 1                  | 3         | 1             |                                      |                 |                     |                 |                  |
| N-S Surface,<br>E room         | 88        | 30                   | 10        |                      | 23               | 12             | 3                |              |                   |            |                |                  | 2                |                      | 5                   |                  |                        |          |              |                    |           |               |                                      |                 |                     |                 |                  |
| E-W Surface,<br>E room         | 74        | 37                   | 6         |                      | 18               | 20             | 3                |              |                   |            |                |                  | +                | +                    | 8                   |                  | +                      |          |              |                    | 1         | +             | +                                    | +               |                     |                 |                  |

Table 2 . Pollen Counts in Floor Samples, Miami Wash, Arizona, cont.

| Provenience                 | Cheno-ams | <u>Ambrosia-type</u> | Gramineae | Cultivated<br>Gramineae | <u>Juniperus</u> | <u>Quercus</u> | <u>Artemisia</u> | Asterae-type | <u>cf. Croton</u> | Cruciferae | <u>Cuscuta</u> | <u>Eriastrum</u> | <u>Eriogonum</u> | <u>cf. Eriogonum</u> | <u>Erodium-type</u> | <u>Euphorbia</u> | <u>Helianthus-type</u> | Labiatae | Liguliflorae | <u>cf. Linaris</u> | Malvaceae | Nyctaginaceae | Onagraceae,<br><u>Oenothera-type</u> | <u>Plantago</u> | <u>Tidestrommia</u> | <u>Tribulus</u> | <u>cf. Vicia</u> |
|-----------------------------|-----------|----------------------|-----------|-------------------------|------------------|----------------|------------------|--------------|-------------------|------------|----------------|------------------|------------------|----------------------|---------------------|------------------|------------------------|----------|--------------|--------------------|-----------|---------------|--------------------------------------|-----------------|---------------------|-----------------|------------------|
| Columbus,<br>Arizona V:9:57 |           |                      |           |                         |                  |                |                  |              |                   |            |                |                  |                  |                      |                     |                  |                        |          |              |                    |           |               |                                      |                 |                     |                 |                  |
| 1-66, SE ,                  |           |                      |           |                         |                  |                |                  |              |                   |            |                |                  |                  |                      |                     |                  |                        |          |              |                    |           |               |                                      |                 |                     |                 |                  |
| Floor #2                    | 179       | 15                   | 4         |                         |                  | 1              |                  |              |                   |            |                |                  | +                |                      |                     |                  |                        |          |              |                    |           | 1             |                                      |                 |                     |                 |                  |
| 1-85, SE 1/4,               |           |                      |           |                         |                  |                |                  |              |                   |            |                |                  |                  |                      |                     |                  |                        |          |              |                    |           |               |                                      |                 |                     |                 |                  |
| Floor #2                    | 183       | 12                   | 3         |                         |                  |                | +                | 1            |                   |            |                |                  |                  |                      |                     |                  |                        |          |              |                    | 1         | +             |                                      |                 |                     |                 |                  |
| 6-43, SE 1/4                | 165       | 24                   | 3         | +                       | 2                |                |                  | 1            |                   |            |                |                  |                  | 2                    | +                   |                  |                        |          |              |                    | 3         | +             |                                      |                 |                     |                 |                  |
| 6-77, E 1/4,                |           |                      |           |                         |                  |                |                  |              |                   |            |                |                  |                  |                      |                     |                  |                        |          |              |                    |           |               |                                      |                 |                     |                 |                  |
| Floor #2                    | 160       | 24                   | 4         | 1                       | 2                | 1              |                  | 1            |                   |            |                |                  |                  | 1                    | 2                   |                  |                        | 1        |              |                    | 1         |               |                                      |                 |                     |                 |                  |
| 6-78, W                     |           |                      |           |                         |                  |                |                  |              |                   |            |                |                  |                  |                      |                     |                  |                        |          |              |                    |           |               |                                      |                 |                     |                 |                  |
| Floor #2                    | 184       | 11                   | 1         | +                       | 1                |                |                  |              |                   |            |                |                  |                  |                      |                     |                  |                        |          |              |                    | 2         | +             |                                      |                 |                     |                 |                  |
| 24-44, SE 1/4               | 183       | 11                   |           |                         |                  |                |                  |              |                   |            |                |                  |                  |                      |                     |                  |                        |          |              |                    | 1         |               |                                      |                 | 1                   |                 |                  |
| 24-45, SW 1/4               | 125       | 40                   | 4         |                         | 16               |                | +                |              |                   |            | 1              |                  | +                | +                    |                     | 1                |                        |          |              |                    | 1         |               |                                      | 1               |                     | +               |                  |
| N-S Surface                 | 54        | 63                   | 19        |                         | 14               | 17             |                  |              |                   |            | 3              |                  | 2                |                      |                     | 2                |                        |          |              |                    | 1         | +             |                                      |                 |                     | +               |                  |
| E-W Surface                 | 87        | 55                   | 8         |                         | 20               | 9              |                  |              |                   | 1          | 5              |                  | 1                |                      | +                   | 1                |                        | 1        |              |                    | 8         | +             |                                      | 1               |                     |                 |                  |

Table 2. Pollen Counts in Floor Samples, Miami Wash, Arizona, cont.

| Provenience                     | Cheno-ams | <u>Ambrosia-type</u> | <u>Gramineae</u> | <u>Cultivated Gramineae</u> | <u>Juniperus</u> | <u>Quercus</u> | <u>Artemisia</u> | <u>Asterace-type</u> | <u>cf. Croton</u> | <u>Cruciferae</u> | <u>Cuscuta</u> | <u>Eriastrum</u> | <u>Eriogonum</u> | <u>cf. Eriogonum</u> | <u>Erodium-type</u> | <u>Euphorbia</u> | <u>Helianthus-type</u> | <u>Labiatae</u> | <u>Liguliflorae</u> | <u>cf. Linaris</u> | <u>Malvaceae</u> | <u>Nyctaginaceae</u> | <u>Onagraceae, Oenothera-type</u> | <u>Plantago</u> | <u>Tidestrommia</u> | <u>Tribulus</u> | <u>cf. Vicia</u> |
|---------------------------------|-----------|----------------------|------------------|-----------------------------|------------------|----------------|------------------|----------------------|-------------------|-------------------|----------------|------------------|------------------|----------------------|---------------------|------------------|------------------------|-----------------|---------------------|--------------------|------------------|----------------------|-----------------------------------|-----------------|---------------------|-----------------|------------------|
| Refugia Ruin,<br>Arizona V:9:59 |           |                      |                  |                             |                  |                |                  |                      |                   |                   |                |                  |                  |                      |                     |                  |                        |                 |                     |                    |                  |                      |                                   |                 |                     |                 |                  |
| 1-55, NW 1/4,<br>Floor #1       | 156       | 31                   | 2                |                             | 2                | 2              |                  | 3                    |                   |                   |                |                  |                  |                      |                     |                  | 1                      |                 |                     |                    | +                | +                    |                                   |                 |                     |                 |                  |
| 1-90, NW 1/4,<br>Floor #2       | 138       | 38                   | 5                | +                           | 5                | 1              |                  | 3                    |                   |                   | 1              |                  |                  |                      | +                   | 1                |                        |                 |                     |                    | +                | 1                    | 1                                 | 1               |                     |                 |                  |
| 1-94, SW 1/4,<br>Floor #2       | 142       | 39                   | 6                |                             | 4                |                |                  | 2                    |                   |                   |                |                  |                  |                      |                     |                  | 2                      |                 |                     |                    | 1                | 1                    |                                   |                 |                     |                 |                  |
| 1-122 NE 1/4,<br>Floor #3       | 125       | 41                   | 3                |                             | 16               | 1              |                  | 9                    |                   |                   |                |                  | 1                |                      |                     |                  |                        |                 |                     |                    | 1                |                      |                                   |                 |                     |                 |                  |
| E-W Surface                     | 51        | 40                   | 11               |                             | 34               | 16             | 2                | 6                    |                   |                   | +              |                  |                  |                      | 2                   | +                |                        | 1               |                     |                    | +                |                      |                                   |                 |                     |                 |                  |
| N-S Surface                     | 55        | 45                   | 12               |                             | 27               | 18             |                  | 4                    |                   | 1                 | 2              |                  | +                |                      | 5                   | 2                |                        | 1               |                     | 1                  |                  |                      |                                   |                 |                     |                 |                  |
| Multigrade,<br>Arizona V:9:60   |           |                      |                  |                             |                  |                |                  |                      |                   |                   |                |                  |                  |                      |                     |                  |                        |                 |                     |                    |                  |                      |                                   |                 |                     |                 |                  |
| 3-28, Total                     |           |                      |                  |                             |                  |                |                  |                      |                   |                   |                |                  |                  |                      |                     |                  |                        |                 |                     |                    |                  |                      |                                   |                 |                     |                 |                  |
| Floor                           | 141       | 34                   | 5                |                             | 8                |                |                  | 1                    |                   |                   |                |                  |                  |                      |                     |                  |                        |                 | 1                   |                    | 5                |                      |                                   |                 |                     |                 |                  |
| 9-45, SE 1/4                    | 174       | 17                   | 4                |                             | 1                |                |                  | 2                    |                   |                   |                |                  |                  |                      |                     |                  |                        |                 |                     |                    | 2                | +                    |                                   |                 | 1                   |                 |                  |
| 9-71, Total                     |           |                      |                  |                             |                  |                |                  |                      |                   |                   |                |                  |                  |                      |                     |                  |                        |                 |                     |                    |                  |                      |                                   |                 |                     |                 |                  |
| Floor                           | 169       | 23                   | 2                |                             | 3                |                |                  | 1                    |                   |                   |                |                  |                  |                      |                     |                  |                        |                 | 1                   |                    |                  |                      |                                   |                 | 1                   |                 |                  |
| 7-11, W 1/2                     | 162       | 35                   | 1                | 1                           | 1                |                |                  |                      |                   |                   |                |                  |                  |                      |                     |                  |                        |                 |                     |                    | +                | +                    |                                   |                 |                     |                 |                  |
| N-S Surface                     | 87        | 51                   | 10               |                             | 18               | 16             |                  | 2                    | +                 |                   | 1              | +                |                  | +                    | +                   | +                |                        |                 |                     |                    | 1                | +                    |                                   | +               | 1                   |                 | +                |
| E-W Surface                     | 74        | 44                   | 13               |                             | 27               | 13             |                  | 1                    | +                 |                   | 3              | +                |                  | 2                    | 2                   | +                |                        | +               |                     |                    | 1                | +                    |                                   | 3               |                     | +               |                  |

Table 2 . Pollen Counts in Floor Samples, Miami Wash, Arizona, cont.

| Provenience                     | Cheno-ams | <u>Ambrosia-type</u> | Gramineae | Cultivated<br>Gramineae | <u>Juniperus</u> | <u>Quercus</u> | <u>Artemisia</u> | Asterae-type | cf. <u>Croton</u> | Cruciferae | <u>Cuscuta</u> | <u>Eriastrum</u> | <u>Eriogonum</u> | cf. <u>Eriogonum</u> | <u>Erodium-type</u> | <u>Euphorbia</u> | <u>Helianthus-type</u> | Labiatae | Liguliflorae | cf. <u>Linaris</u> | Malvaceae | Nyctaginaceae | Onagraceae,<br><u>Oenothera-type</u> | <u>Plantago</u> | <u>Tidestromia</u> | <u>Tribulus</u> | cf. <u>Vicia</u> |
|---------------------------------|-----------|----------------------|-----------|-------------------------|------------------|----------------|------------------|--------------|-------------------|------------|----------------|------------------|------------------|----------------------|---------------------|------------------|------------------------|----------|--------------|--------------------|-----------|---------------|--------------------------------------|-----------------|--------------------|-----------------|------------------|
| Tinhorn Wash,<br>Arizona V:9:62 |           |                      |           |                         |                  |                |                  |              |                   |            |                |                  |                  |                      |                     |                  |                        |          |              |                    |           |               |                                      |                 |                    |                 |                  |
| 6-47                            | 184       | 12                   | +         |                         |                  |                | 1                |              |                   |            |                |                  |                  |                      |                     |                  |                        |          | +            |                    |           | +             |                                      |                 |                    |                 |                  |
| 6-59, SE 1/4                    | 186       | 12                   | +         |                         | 1                |                |                  |              |                   |            |                |                  |                  |                      |                     |                  |                        |          | +            |                    |           | +             |                                      |                 |                    |                 |                  |
| 10-18, SW 1/4                   | 171       | 20                   | 4         |                         | 3                | +              |                  |              |                   |            |                |                  | 2                |                      | +                   |                  |                        |          | +            |                    |           | +             |                                      |                 |                    |                 |                  |
| 10-28, NW 1/4                   | 172       | 22                   | 1         | 1                       | 1                |                |                  |              |                   |            |                |                  |                  | +                    |                     |                  | 1                      |          |              |                    | +         | 1             |                                      |                 |                    |                 |                  |
| 10-30, SE 1/4                   | 173       | 21                   | 1         |                         | 1                |                | 1                |              |                   |            |                |                  |                  | +                    |                     |                  |                        |          |              |                    | +         | +             |                                      |                 |                    |                 |                  |
| 10-39, NE 1/4                   | 163       | 31                   | 1         |                         |                  | 1              | 2                |              |                   |            |                |                  |                  | +                    |                     |                  | 1                      |          |              |                    | +         | 1             |                                      |                 |                    |                 |                  |
| N-S Surface                     | 55        | 62                   | 7         |                         | 11               | 17             | 1                | +            |                   |            | 1              |                  | +                |                      | 3                   | 1                |                        |          | +            |                    | +         | 1             |                                      | +               |                    |                 |                  |
| E-W Surface                     | 81        | 37                   | 17        |                         | 6                | 19             | 4                | 1            |                   | 1          |                |                  | 1                |                      | +                   |                  |                        | +        |              |                    | +         | +             |                                      |                 |                    |                 |                  |
| East Ruin,<br>Arizona V:9:68    |           |                      |           |                         |                  |                |                  |              |                   |            |                |                  |                  |                      |                     |                  |                        |          |              |                    |           |               |                                      |                 |                    |                 |                  |
| A-57, S 1/2                     | 179       | 15                   | +         |                         | 1                |                | 1                |              |                   |            |                |                  |                  |                      | 1                   |                  |                        |          | 1            |                    | +         |               |                                      |                 |                    |                 |                  |
| A-66, N 1/2                     | 184       | 11                   | 2         |                         |                  |                |                  | 2            |                   |            |                |                  | +                |                      |                     |                  |                        |          |              |                    | +         | +             |                                      |                 |                    |                 |                  |
| B-39, SW 1/4                    | 187       | 9                    |           |                         | 1                |                |                  |              |                   |            |                |                  |                  |                      |                     |                  |                        |          |              | 1                  | +         |               |                                      | +               |                    |                 |                  |
| B-41, NW 1/4                    | 176       | 15                   | 3         | +                       | +                | 1              |                  | +            |                   |            |                |                  |                  |                      |                     |                  |                        |          |              |                    | +         |               |                                      | +               |                    |                 |                  |
| B-49, SE 1/4                    | 185       | 10                   | 1         |                         | 2                |                |                  | 1            |                   |            |                |                  | +                |                      | +                   |                  |                        |          |              |                    |           | +             |                                      | +               |                    |                 |                  |
| B-50, NW 1/4                    | 192       | 3                    |           |                         |                  |                |                  | +            |                   |            |                |                  |                  |                      |                     |                  |                        |          |              |                    |           |               |                                      |                 |                    |                 |                  |

Table 2. Pollen Counts in Floor Samples, Miami Wash, Arizona, cont.

| Provenience                    | <u>Acacia</u> | <u>Canotia-type</u> | <u>Celtis</u> | <u>Cercidium</u> | <u>cf. Condalia</u> | <u>Cylindropuntia</u> | <u>Dodonaea</u> | <u>Ephedra</u><br><u>nevadensis-type</u> | <u>Ephedra</u><br><u>torreyana-type</u> | <u>Fraxinus</u> | <u>Juglans</u> | <u>cf. Krameria</u> | <u>Leguminosae</u> | <u>Liliaceae</u> | <u>Mimosa</u> | <u>Pinus</u> | <u>Prosopis</u> | <u>Rhamnus</u> | <u>Rosaceae</u> | <u>Salix</u> | <u>Scrophulariaceae</u> | <u>Simmondsia</u> |
|--------------------------------|---------------|---------------------|---------------|------------------|---------------------|-----------------------|-----------------|--|---|-----------------|----------------|---------------------|--------------------|------------------|---------------|--------------|-----------------|----------------|-----------------|--------------|-------------------------|-------------------|
| Runway Ruin,<br>Arizona V:9:55 |               |                     |               |                  |                     |                       |                 |  |   |                 |                |                     |                    |                  |               |              |                 |                |                 |              |                         |                   |
| 1-74 NW 1/4                    | +             |                     |               |                  |                     |                       |                 | 2  |   |                 |                |                     |                    |                  |               |              |                 |                |                 |              |                         |                   |
| 1-89 SE 1/4                    |               |                     |               |                  |                     |                       |                 |  |   |                 |                |                     |                    |                  |               |              |                 |                |                 |              |                         |                   |
| 3-28 NW 1/4                    |               |                     |               |                  |                     | +                     |                 |  | 1                                       |                 |                | 2                   |                    |                  |               |              |                 |                |                 |              |                         |                   |
| 3-39 SE 1/4                    |               |                     |               |                  |                     |                       |                 |  | 2                                       |                 |                |                     |                    |                  |               | 1            |                 |                |                 |              |                         |                   |
| E-W Surface                    | 11            |                     | 1             |                  |                     | +                     |                 |  | +                                       |                 |                |                     |                    |                  |               | 5            | 4               |                |                 | 1            |                         | 2                 |
| N-S Surface                    | 13            |                     |               | 2                |                     |                       |                 | +  |   | 1               |                |                     |                    | 1                |               | 6            | 3               |                |                 |              |                         | 2                 |
| Monitor<br>Arizona V:9:56      |               |                     |               |                  |                     |                       |                 |  |   |                 |                |                     |                    |                  |               |              |                 |                |                 |              |                         |                   |
| 1-41 NW 1/4                    |               |                     |               |                  |                     | +                     |                 |  |   |                 |                |                     |                    |                  |               |              | +               |                |                 |              |                         |                   |
| 1-58 NE 1/4                    |               |                     |               |                  |                     |                       |                 |  |   |                 |                |                     |                    |                  |               | 1            |                 |                |                 |              |                         |                   |
| 3-37 N 1/4                     |               |                     |               |                  |                     |                       |                 |  | +                                       |                 |                |                     |                    | +                |               |              |                 |                |                 |              |                         |                   |
| 3-39 E 1/4                     | 1             |                     |               |                  |                     |                       |                 | +  |   |                 |                |                     |                    |                  |               |              |                 |                |                 |              |                         |                   |
| 3-67 W 1/4                     |               |                     |               |                  |                     |                       |                 |  | 1                                       |                 |                |                     |                    | +                |               |              |                 |                |                 |              |                         |                   |
| NE-SW Surface,<br>W room       | 2             |                     | 2             | 2                |                     |                       |                 | +  | +                                       | +               |                |                     | 1                  |                  | 1             | 4            | 14              | 1              | 1               |              |                         | 3                 |
| NW-SE Surface,<br>W room       | 2             |                     | 3             | 1                |                     | +                     |                 |  | +                                       |                 |                |                     |                    |                  |               | 6            | 10              | 3              | 2               | 1            | 1                       | 5                 |
| N-S Surface,<br>E room         | +             |                     | 1             | +                |                     |                       | +               | +  | 2                                       | +               | +              |                     |                    |                  |               | 4            | 15              | 2              |                 |              |                         | 1                 |
| E-W Surface,<br>E room         |               |                     |               | 2                | 2                   | +                     |                 | +  | 1                                       |                 |                |                     |                    |                  | 1             |              | 23              | 1              |                 |              |                         | 2                 |



Table 2. Pollen Counts in Floor Samples, Miami Wash, Arizona, cont.

| Provenience                  | <u>Acacia</u> | <u>Canotia-type</u> | <u>Celtis</u> | <u>Cercidium</u> | <u>cf. Condalia</u> | <u>Cylindropuntia</u> | <u>Dodonaea</u> | <u>Ephedra</u><br><u>nevadensis-type</u> | <u>Ephedra</u><br><u>torreyana-type</u> | <u>Fraxinus</u> | <u>Juglans</u> | <u>cf. Krameria</u> | <u>Leguminosae</u> | <u>Liliaceae</u> | <u>Mimosa</u> | <u>Pinus</u> | <u>Prosopis</u> | <u>Rhamnus</u> | <u>Rosaceae</u> | <u>Salix</u> | <u>Scrophulariaceae</u> | <u>Simmondsia</u> |
|------------------------------|---------------|---------------------|---------------|------------------|---------------------|-----------------------|-----------------|--|---|-----------------|----------------|---------------------|--------------------|------------------|---------------|--------------|-----------------|----------------|-----------------|--------------|-------------------------|-------------------|
| Columbus,<br>Arizona, V:9:57 |               |                     |               |                  |                     |                       |                 |  |   |                 |                |                     |                    |                  |               |              |                 |                |                 |              |                         |                   |
| 1-66, SE 1/4<br>Floor #2     |               |                     |               |                  |                     |                       |                 |  |   |                 |                |                     |                    |                  |               | +            |                 |                |                 |              |                         |                   |
| 1-85, SE 1/4,<br>Floor #2    |               |                     |               |                  |                     |                       |                 |  |   |                 |                |                     |                    |                  |               | +            |                 |                |                 |              |                         |                   |
| 6-43, SE 1/4                 |               |                     |               |                  |                     |                       |                 |  |   |                 |                |                     |                    | +                |               | +            |                 |                |                 |              |                         |                   |
| 6-77, E 1/2,<br>Floor #2     |               |                     |               |                  |                     |                       |                 |  |   |                 |                |                     |                    |                  |               | 1            |                 |                |                 |              |                         |                   |
| 6-78, W 1/2,<br>Floor #2     |               |                     |               |                  |                     | +                     |                 | +  |   |                 |                |                     | 1                  | 1                |               | +            |                 |                |                 |              |                         |                   |
| 24-44, SE 1/4                |               |                     |               |                  |                     |                       |                 |  |   |                 |                |                     |                    |                  |               | 1            |                 |                |                 |              |                         |                   |
| 24-45, SW 1/4                |               |                     |               |                  |                     |                       |                 |  |   |                 |                |                     |                    |                  |               | +            |                 |                |                 |              | +                       |                   |
| N-S Surface                  | 3             | 1                   | 4             |                  | 2                   |                       | +               |  |   | 1               |                |                     |                    |                  |               | 2            | 2               |                |                 | 1            |                         | 4                 |
| E-W Surface                  | 4             |                     |               |                  | 2                   |                       |                 | 1  |   |                 |                | 1                   |                    |                  |               | +            | 1               |                |                 |              |                         |                   |

Table 2. Pollen Counts in Floor Samples, Miami Wash, Arizona, cont.

| Provenience                          | <u>Acacia</u> | <u>Canotia-type</u> | <u>Celtis</u> | <u>Cercidium</u> | <u>cf. Condalia</u> | <u>Cylindropuntia</u> | <u>Dodonaea</u> | <u>Ephedra</u><br><u>nevadensis-type</u> | <u>Ephedra</u><br><u>torreyana-type</u> | <u>Fraxinus</u> | <u>Juglans</u> | <u>cf. Krameria</u> | <u>Leguminosae</u> | <u>Liliaceae</u> | <u>Mimosa</u> | <u>Pinus</u> | <u>Prosopis</u> | <u>Rhamnus</u> | <u>Rosaceae</u> | <u>Salix</u> | <u>Scrophulariaceae</u> | <u>Simmondsia</u> |
|--------------------------------------|---------------|---------------------|---------------|------------------|---------------------|-----------------------|-----------------|--|---|-----------------|----------------|---------------------|--------------------|------------------|---------------|--------------|-----------------|----------------|-----------------|--------------|-------------------------|-------------------|
| Refugia Ruin,<br>Arizona V:9:59      |               |                     |               |                  |                     |                       |                 |  |   |                 |                |                     |                    |                  |               |              |                 |                |                 |              |                         |                   |
| 1-55, NW 1/4,<br>Floor #1            | 1             |                     |               |                  |                     |                       |                 |  | 1                                       |                 |                |                     |                    |                  |               |              |                 |                | 1               |              |                         |                   |
| 1-90, NW 1/4,<br>Floor #2            |               |                     |               |                  |                     |                       |                 |  |   |                 |                |                     |                    | +                |               | 2            |                 |                |                 |              |                         |                   |
| 1-94, SW 1/4,<br>Floor #2            |               |                     |               |                  |                     |                       |                 |  |   |                 |                |                     |                    |                  |               |              |                 |                |                 |              |                         |                   |
| 1-122, NW 1/4,<br>Floor #3           |               |                     |               |                  |                     |                       |                 |  |   |                 |                |                     |                    |                  |               | 2            |                 |                | 1               |              |                         |                   |
| E-W Surface                          | 4             | 4                   |               |                  |                     |                       |                 | 2  |   |                 |                |                     | 1                  |                  | 1             | 6            | 10              |                |                 |              |                         | 9                 |
| N-S Surface                          | 2             | 6                   | 1             | 1                |                     |                       |                 | 1  |   |                 |                |                     |                    |                  | 2             | 4            | 6               |                | 1               |              |                         | 2                 |
| Multigrade<br>Arizona V:9:60         |               |                     |               |                  |                     |                       |                 |  |   |                 |                |                     |                    |                  |               |              |                 |                |                 |              |                         |                   |
| 3-28, Total<br>Floor                 |               |                     |               |                  |                     |                       |                 |  |   |                 |                |                     |                    |                  |               |              | 2               |                |                 |              |                         |                   |
| 9-45, SE 1/4<br>9-71, Total<br>Floor |               |                     |               |                  |                     |                       |                 |  |   |                 |                |                     |                    |                  |               |              |                 |                |                 |              |                         |                   |
| 7-11, W 1/2<br>N-S Surface           | 2             | +                   | 1             |                  |                     |                       | 1               | +  | 1                                       |                 | +              |                     |                    | 3                | 1             | 2            | +               |                |                 |              | +                       | 1                 |
| E-W Surface                          | 2             |                     | 1             | 1                |                     |                       | +               |  | +                                       |                 |                |                     |                    |                  | 2             | 2            | 3               |                | 1               | 1            |                         | 3                 |

Table 2. Pollen Counts in Floor Samples, Miami Wash, Arizona, cont.

| Provenience                     | <u>Acaia</u> | <u>Canotia-type</u> | <u>Celtis</u> | <u>Cercidium</u> | <u>cf. Condalia</u> | <u>Cylindropuntia</u> | <u>Dodonaea</u> | <u>Ephedra</u> | <u>nevadensis-type</u> | <u>Ephedra</u> | <u>torreyana-type</u> | <u>Fraxinus</u> | <u>Juglans</u> | <u>cf. Krameria</u> | <u>Leguminosae</u> | <u>Liliaceae</u> | <u>Mimosa</u> | <u>Pinus</u> | <u>Prosopis</u> | <u>Rhamnus</u> | <u>Rosaceae</u> | <u>Salix</u> | <u>Scrophulariaceae</u> | <u>Simmondsia</u> |
|---------------------------------|--------------|---------------------|---------------|------------------|---------------------|-----------------------|-----------------|----------------|------------------------|----------------|-----------------------|-----------------|----------------|---------------------|--------------------|------------------|---------------|--------------|-----------------|----------------|-----------------|--------------|-------------------------|-------------------|
| Tinhorn Wash,<br>Arizona V:9:62 |              |                     |               |                  |                     |                       |                 |                |                        |                |                       |                 |                |                     |                    |                  |               |              |                 |                |                 |              |                         |                   |
| 6-47                            |              |                     |               |                  |                     |                       |                 |                |                        |                |                       |                 |                |                     |                    |                  |               | 2            |                 |                |                 |              |                         |                   |
| 6-59, SE 1/4                    |              |                     |               |                  |                     | +                     |                 | +              |                        |                |                       |                 |                |                     |                    |                  |               |              |                 |                |                 | 1            |                         |                   |
| 10-18, SW 1/4                   | +            |                     |               |                  |                     |                       |                 |                |                        |                |                       |                 |                |                     |                    |                  |               |              | +               |                |                 |              |                         |                   |
| 10-28, NW 1/4                   |              |                     |               |                  |                     |                       |                 | +              |                        | +              |                       |                 |                |                     |                    |                  |               | 1            |                 |                |                 |              |                         |                   |
| 10-30, SE 1/4                   |              |                     |               |                  |                     |                       |                 | +              |                        |                |                       |                 |                |                     |                    | 1                |               | 1            |                 |                |                 |              |                         |                   |
| 10-39, NE 1/4                   |              |                     |               |                  |                     |                       |                 |                |                        |                |                       |                 |                |                     |                    |                  |               |              |                 |                |                 |              |                         |                   |
| N-S Surface                     | 1            | 1                   |               | 1                |                     |                       | 1               |                |                        |                |                       | +               |                |                     | 2                  | +                |               | 4            | 28              |                |                 |              |                         | 3                 |
| E-W Surface                     | 2            |                     | 1             |                  | 2                   |                       | +               |                |                        |                |                       |                 |                |                     |                    |                  |               |              | 28              |                | +               |              |                         | +                 |
| East Ruin,<br>Arizona V:9:68    |              |                     |               |                  |                     |                       |                 |                |                        |                |                       |                 |                |                     |                    |                  |               |              |                 |                |                 |              |                         |                   |
| A57, S 1/2                      | 1            |                     |               |                  |                     | +                     |                 |                |                        |                |                       |                 |                |                     |                    |                  |               | 1            | 1               |                |                 |              |                         |                   |
| A-66, N 1/2                     |              |                     |               | 1                |                     | +                     |                 | +              |                        |                |                       |                 |                |                     |                    |                  |               |              |                 |                |                 |              |                         |                   |
| B-39, SW 1/4                    |              |                     |               |                  |                     | 1                     |                 |                |                        | +              |                       |                 |                |                     |                    |                  |               | 1            |                 |                |                 |              |                         |                   |
| B-41, NW 1/4                    |              |                     |               |                  |                     | +                     |                 | +              |                        | +              |                       |                 |                |                     |                    |                  |               | 4            |                 |                |                 |              |                         |                   |
| B-49, SE 1/4                    |              |                     |               |                  |                     | +                     |                 | +              |                        | +              |                       |                 |                |                     |                    |                  |               | 1            |                 |                |                 |              |                         |                   |
| B-50, NE 1/4                    |              |                     |               |                  |                     | +                     |                 | +              |                        |                |                       |                 |                |                     |                    |                  |               | 1            |                 |                |                 |              |                         |                   |

Table 2. Pollen Counts in Floor Samples, Miami Wash, Arizona, cont.

| Provenience                    | <u>Solonaceae</u> | <u>Gilia</u> | <u>Abies</u> | <u>Cleome</u> | <u>Populus</u> | <u>Ceanothus</u> | <u>Cereus</u> | <u>Rhus</u> | <u>Ericaceae</u> | <u>Alnus</u> | <u>Platyopuntia</u> | <u>Sarcobatus</u> |
|--------------------------------|-------------------|--------------|--------------|---------------|----------------|------------------|---------------|-------------|------------------|--------------|---------------------|-------------------|
| Runway Ruin,<br>Arizona V:9:55 |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| 1-74 NW 1/4                    |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| 1-89 SE 1/4                    |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| 3-28 NW 1/4                    |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| 3-39 SE 1/4                    |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| E-W Surface                    |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| N-S Surface                    |                   | +            |              |               |                |                  |               |             |                  |              |                     |                   |
| Monitor,<br>Arizona V:9:56     |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| 1-41 NW 1/4                    |                   |              | +            |               |                |                  |               |             |                  |              |                     |                   |
| 1-58 NE 1/4                    |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| 3-37 N 1/4                     |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| 3-39 E 1/4                     |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| 3-67 W 1/4                     |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| NE-SW Surface,<br>W room       |                   |              |              |               |                | 1                | 1             |             |                  |              |                     |                   |
| NW-SE Surface,<br>W room       |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| N-S Surface,<br>E room         |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| E-W Surface,<br>E room         | +                 |              |              |               |                |                  |               |             |                  |              |                     |                   |

Table 2. Pollen Counts in Floor Samples, Miami Wash, Arizona, cont.

| Provenience    | <u>Solonaceae</u> | <u>Gilia</u> | <u>Abies</u> | <u>Cleome</u> | <u>Populus</u> | <u>Ceanothus</u> | <u>Cereus</u> | <u>Rhus</u> | <u>Ericaceae</u> | <u>Alnus</u> | <u>Platyopuntia</u> | <u>Sarcobatus</u> |
|----------------|-------------------|--------------|--------------|---------------|----------------|------------------|---------------|-------------|------------------|--------------|---------------------|-------------------|
| Columbus,      |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| Arizona V:9:57 |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| 1-66, SE 1/4,  |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| Floor #2       |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| 1-85, SE 1/4,  |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| Floor #2       |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| 6-43, SE 1/4   |                   |              |              |               |                | +                |               |             |                  |              |                     |                   |
| 6-77, E 1/2,   |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| Floor #2       |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| 6-78, W 1/2,   |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| Floor #2       |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| 24-44, SE 1/4  |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| 24-45, SW 1/4  |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| N-S Surface    |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| E-W Surface    |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |

Table 2. Pollen Counts in Floor Samples, Miami Wash, Arizona, cont.

| Provenience    | <u>Solonaceae</u> | <u>Gilia</u> | <u>Abies</u> | <u>Cleome</u> | <u>Populus</u> | <u>Ceanothus</u> | <u>Cereus</u> | <u>Rhus</u> | <u>Ericaceae</u> | <u>Alnus</u> | <u>Platyopuntia</u> | <u>Sarcobatus</u> |
|----------------|-------------------|--------------|--------------|---------------|----------------|------------------|---------------|-------------|------------------|--------------|---------------------|-------------------|
| Refugua Ruin,  |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| Arizona V:9:59 |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| 1-55, NW 1/4,  |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| Floor #1       |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| 1-90, NW 1/4,  |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| Floor #2       |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| 1-94, SW 1/4,, |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| Floor #2       |                   |              |              |               |                |                  |               | 1           |                  |              |                     |                   |
| 1-122 NE 1/4,  |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| Floor #3       |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| E-W Surface    |                   |              |              |               |                |                  |               |             | +                |              |                     |                   |
| N-S Surface    |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| Multigrade,    |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| Arizona V:9:60 |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| 3-28, Total    |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| Floor          |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| 9-45, SE 1/4   |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| 9-71, Total    |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| Floor          |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| 7-11, W 1/2    |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| N-S Surface    |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| E-W Surface    |                   |              |              |               |                |                  |               |             | +                | 1            |                     |                   |

Table 2. Pollen Counts in Floor Samples, Miami Wash, Arizona, cont.

| Provenience                     | <u>Solanaceae</u> | <u>Gilia</u> | <u>Abies</u> | <u>Cleome</u> | <u>Populus</u> | <u>Ceanothus</u> | <u>Cereus</u> | <u>Rhus</u> | <u>Ericaceae</u> | <u>Alnus</u> | <u>Platyopuntia</u> | <u>Sarcobatus</u> |
|---------------------------------|-------------------|--------------|--------------|---------------|----------------|------------------|---------------|-------------|------------------|--------------|---------------------|-------------------|
| Tinhorn Wash,<br>Arizona F:9:62 |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| 6-47                            |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| 6-59, SE 1/4                    |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| 10-18, SW 1/4                   |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| 10-28, NW 1/4                   |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| 10-30, SE 1/4                   |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| 10-39, NW 1/4                   |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| N-S Surface                     | +                 |              |              |               |                |                  |               |             |                  |              |                     |                   |
| E-W Surface                     |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| East Ruin,<br>Arizona V:9:68    |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| A-57, S 1/2                     |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| A-66, N 1/2                     |                   |              |              |               |                |                  |               |             |                  |              | +                   |                   |
| B-39, SW 1/4                    |                   |              |              |               |                |                  |               |             |                  |              |                     | +                 |
| B-41, NW 1/4                    |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| B-49, SE, 1/4                   |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |
| B-50, NE 1/4                    |                   |              |              |               |                |                  |               |             |                  |              |                     |                   |

of grain amaranths or other cheno-am plants during occupation, (2) increased numbers of similar "weed-type" plants due to occupation disturbance, or (3) a change in climate causing fewer of these plants to grow in the area today. These possible explanations will be discussed at a later point in the text.

The high occurrence (17 percent) of Ambrosia-type pollen in sample 3-39, when tested against its similar occurrence in other floor samples, was not found to be significant. Cultivated grass, probably maize, is present in both features 1 and 3. In studies of corn pollen drift from corn fields, 63 percent of the pollen liberated was deposited within the field area (Raynor, Ogden and Hayes 1972). This implies that corn pollen found in an archaeological context either originated in close proximity (less than 60 meters) to that location or else was introduced by man. Liguliflorae occurs in three of the four feature samples, but is absent from both surface samples. Though its frequency is too low to be significant according to the chi-square test, its consistent appearance suggests that it might have been introduced into the sites by man.

Monitor, Arizona V:9:56. The frequencies of both Ambrosia-type and cheno-am pollen, when tested against their averages in the surface samples, show cheno-ams but not Ambrosia-type to be significantly different. Of the minor groups, cultivated grass is present, indicating probable presence of maize during site occupation.



One grain of spruce was found while scanning the slide for the northwest quadrat of feature 1. Spruce pollen was found in only one other sample at the top of a stratigraphic column. The closest spruce trees are, according to Kearney and Peebles (1960) and Little (1950), in the White Mountains. However, Little (1971) records Abies concolor in the area of the Dripping Springs Mountains less than 16 kilometers (10 miles) south of Globe. Though no interpretation may be based on a single grain, the ethnobotanical study of the sites (Chapter 5) supports a cultural origin.

Columbus, Arizona V:9:57. The 20 percent occurrence of Ambrosia-type pollen and 8 percent occurrence of Juniperus pollen in sample 24-45 vary significantly at the 0.05 level from the average frequencies of these types on floors. These figures indicate cultural introduction or activity using these plants. The frequencies of cheno-ams on the floors are significantly different at the 0.05 level from their average surface occurrence.

On the minor types, Gramineae and Pinus are consistently present, but these are wind-pollinated plants and their frequencies are similar to or less than their present contribution to the pollen rain at Columbus. One occurrence, not easily tested but of definite interest, is the clump of grains of the lily family found while scanning the slide for feature 6-43. Plants in this family are

insect-pollinated and the presence of a clump indicates that a portion or all of an anther was present in the sample. Anthers could have been carried on blossoms brought into the structure to be processed for a meal or for some other activity. No other minor type in the floor samples at Columbus is considered to be of cultural significance.

Refugia, Arizona V:9:59. The high frequencies of cheno-ams attain statistical significance when compared with surface samples. The 8 percent frequency of juniper in sample 1-122 is significant in comparison with samples from other floors. Cultivated grass is present, as is a clump of Liliaceae in one of the samples. No other minor or major type is of apparent significance.

Multigrade, Arizona V:9:60. Cheno-ams differ significantly from their frequencies in the surface samples. The Ambrosia-type frequencies from floors are also significantly different when compared with each other. Cultivated grass is present in one sample, indicating the probable presence of maize.

Tinhorn Wash, Arizona V:9:62. The cheno-am percentages in the floor samples are significantly different from those in the surface samples, but Ambrosia-type pollen is not. Of the minor types, only cultivated grass is of apparent importance in terms of culturally utilized plants.

East Ruin, Arizona V:9:68. Because the decision to excavate this site was not made until the end of the season, no surface samples were collected prior to excavation. Cheno-am frequencies are at least 88 percent, probably indicating use of cheno-ams plants or extensive disturbance. The cultivated grass grains found support the presence of maize in this site. Cholla pollen was found in low frequencies while scanning each of the six samples in this site, but in only four of the other thirty floor samples. This consistent occurrence suggests cultural introduction or use at this site.

#### Pollen in Metate and Mano Samples

Metate and mano samples are compared among themselves in order to test the hypothesis that they were used to grind different plants. If this is true, the percentages of each pollen type should vary significantly among the samples.

Data are in Tables 3 and 4 and Figure 3.

The cheno-am frequencies within the metate and mano samples are significantly different. This supports the hypothesis of variable use of the artifacts. Sample 68-B-60 has a very high cheno-am frequency (94 percent) and might have been used for grinding grain amaranths or some other cheno-am type plant.

Variations of Ambrosia-type pollen are also significant at the 0.05 level. This may indicate that artifacts with high relative

Table 3: Important Pollen Types in Metates and Manos

Sample No. Relative Frequencies of Pollen Types (in percent)

| Arizona<br>V:9: | Cheno-<br>ams | <u>Ambrosia-</u><br>type | Cultivated<br>Grass | <u>Prosopis</u> | Liliaceae |
|-----------------|---------------|--------------------------|---------------------|-----------------|-----------|
| 55:3:63         | 87            | 10.5                     |                     |                 |           |
| 55-3-64         | 78.5          | 13                       | 2                   |                 |           |
| 55-F3-8         | 67.5          | 18.5                     |                     | 2               |           |
| 56-3-79         | 79            | 12.5                     |                     | 2               |           |
| 56-15-3         | 78.5          | 14.5                     |                     |                 |           |
| 56-11-6         | 65            | 25.5                     | +                   | 2               |           |
| 57-F9-26        | 81            | 10                       |                     |                 |           |
| 57-H8-5         | 52            | 17                       |                     | 10.5            |           |
| 57-H10-15       | 84.5          |                          |                     |                 |           |
| 57-J9-14        | 83            | 10.5                     |                     | 2               |           |
| 59-1-79         | 73            | 18.5                     | +                   | 2               |           |
| 59-1-80         | 55            | 17.5                     |                     |                 | 17        |
| 62-3-7          | 85            | 10.5                     |                     | +               | +         |
| 62-7-79         | 88.5          | 6                        |                     | 2               |           |
| 68-B-60         | 94            | 3                        |                     |                 |           |

frequencies--like 56-11-6-- were used for grinding Ambrosia-type plants, or it may merely reflect a low cheno-am percentage. When the relative frequency of one type of pollen increases or decreases absolutely, all other types must decrease or increase respectively in percentage, even though they remain the same in actual numbers.

The presence of cultivated grass in four of the samples from metates and manos supports the premise that the artifacts were used for grinding maize. The clump of Liguliflorae in 57-H10-15 may also indicate use of that type of plant.

Two other occurrences of interest are the presence of 10.5 percent mesquite pollen in 57-H-5 and 17 percent Liliaceae type in

Table 4 . Pollen Counts in Artifactual Association, Miami Wash, Arizona

| Provenience                       |           |                      |           |                         |                  |                |                  |              |            |                  |                      |                |                  |                        |              |           |               |                                      |                    |               |
|-----------------------------------|-----------|----------------------|-----------|-------------------------|------------------|----------------|------------------|--------------|------------|------------------|----------------------|----------------|------------------|------------------------|--------------|-----------|---------------|--------------------------------------|--------------------|---------------|
| Metates &<br>Manos<br>Arizona V:9 | Cheno-ams | <u>Ambrosia-type</u> | Gramineae | Cultivated<br>Gramineae | <u>Juniperus</u> | <u>Quercus</u> | <u>Artemisia</u> | Asterae-type | Cruciferae | <u>Eriogonum</u> | <u>cf. Eriogonum</u> | <u>Erodium</u> | <u>Euphorbia</u> | <u>Helianthus-type</u> | Liguliflorae | Malvaceae | Nyctaginaceae | Onagraceae,<br><u>Oenothera-type</u> | <u>Tidestromia</u> | <u>Acacia</u> |
| 55-3-63                           | 174       | 21                   | 1         |                         | 2                |                |                  |              |            |                  | 1                    | +              |                  |                        |              |           | +             |                                      |                    |               |
| 55-3-64                           | 157       | 26                   | 3         | 3                       | 1                |                |                  | 7            |            |                  |                      |                |                  | 1                      |              |           | +             | +                                    |                    |               |
| 55-F3-8                           | 135       | 37                   | 9         |                         | 2                | 3              |                  | 2            |            |                  |                      | 1              | 2                | 1                      |              |           | +             |                                      | 4                  |               |
| 56-3-79                           | 158       | 25                   | 5         |                         | +                | +              |                  | 3            |            | 3                |                      |                |                  |                        |              | +         | 1             | +                                    |                    |               |
| 56-15-3                           | 157       | 29                   | 3         |                         | 4                |                |                  | 1            |            | 3                |                      |                |                  |                        |              |           | +             |                                      |                    |               |
| 56-11-6                           | 130       | 51                   | 5         | +                       | 4                | 1              |                  | 1            | 1          | 2                |                      |                |                  |                        |              |           | +             | +                                    | 1                  |               |
| 57-F9-26                          | 162       | 20                   | 3         |                         | 6                | 2              |                  | 3            |            |                  |                      |                |                  |                        |              |           | 1             |                                      | 2                  |               |
| 57-H8-5                           | 104       | 34                   | 5         |                         | 8                | 11             | 1                | 2            | 1          | 1                |                      | 1              |                  |                        |              |           | +             |                                      | 4                  |               |
| 57-H10-15                         | 169       | 20                   | 2         |                         | 3                |                | 1                | 3            |            |                  |                      |                |                  |                        | 1            |           | +             | 1                                    | +                  |               |
| 57-J9-14                          | 166       | 21                   | 6         |                         | 2                |                |                  | +            |            | 1                |                      |                |                  |                        |              |           |               |                                      | +                  |               |
| 59-1-79                           | 146       | 37                   | 6         | +                       | 3                |                |                  | 2            |            |                  |                      |                | 1                |                        |              |           | +             |                                      |                    |               |
| 59-1-80                           | 110       | 35                   | 3         |                         | 4                |                |                  | 3            |            | 2                |                      |                |                  |                        | 1            |           | +             |                                      | 1                  |               |
| 62-3-7                            | 170       | 21                   | 2         |                         | 2                | 1              |                  | +            |            | +                | 1                    |                | +                |                        | 1            | +         | 1             |                                      | +                  |               |
| 62-6-79                           | 177       | 12                   | 5         |                         | 1                | 2              |                  |              |            |                  |                      |                |                  |                        |              |           | +             |                                      |                    |               |
| 68-B-60                           | 188       | 6                    | 1         |                         | 1                |                | 1                |              |            | +                |                      |                |                  |                        |              |           | +             |                                      |                    |               |
| Vessels<br>Arizona V:9:68         |           |                      |           |                         |                  |                |                  |              |            |                  |                      |                |                  |                        |              |           |               |                                      |                    |               |
| A-80                              | 184       | 10                   |           |                         | 5                |                |                  |              |            |                  |                      |                |                  |                        | +            |           |               | +                                    |                    |               |
| A-84                              | 177       | 16                   |           | +                       | 3                |                |                  |              |            |                  |                      |                |                  |                        |              | +         | +             | 1                                    |                    |               |
| A-102                             | 177       | 13                   |           |                         | 5                |                |                  | 1            |            |                  |                      |                |                  |                        |              | 1         |               |                                      | 1                  |               |
| B-69                              | 180       | 13                   | 2         |                         | 3                |                |                  | 1            |            | +                |                      |                |                  |                        |              | +         | +             |                                      |                    |               |



59-1-80. The mesquite percent is statistically different from the other samples at the 0.05 level, but caution must be exercised in interpreting its meaning because a grain of Morus (mulberry) was found during scanning. Though mulberry may be native to the area (Kearney and Peebles 1960), it is normally present only in modern samples, due to its increased use as an ornamental. Further evidence of modern contamination is the presence of a grain of Rhus glabra type, a pollen group which is otherwise found only in the modern surface samples of this study. Finally, two different and distinct stages of preservation were noted in the sample. For the above reasons contamination of the sample is estimated to be a near certainty, and therefore any cultural or other archaeological interpretation of this sample would be invalid.

The high frequency, 17 percent, of Liliaceae pollen in sample 59-1-80, is fortunately, not best explained by contamination. Liliaceae grains were found in only two other metate and mano samples. From preserved characteristics the pollen most resembles yucca. This occurrence supports the premise that yucca or a related plant was used by the Indians.

No other pollen type clearly indicates use or introduction by the inhabitants.

#### Pollen in Vessel Samples

Data are in Tables 4 and 5 and Figure 3.

Table 5: Important Pollen Types in Vessels

| Vessel<br>Number | Relative Frequencies of Pollen Types (in percent) |                   |                     |                |
|------------------|---|-------------------|---------------------|----------------|
|                  | Cheno-ams   | Ambrosia-<br>type | Cultivated<br>Grass | Cylindropuntia |
| Arizona V:9:     |   |                   |                     |                |
| 68-A-80          | 92  | 5                 |                     | < 2            |
| 68-A-84          | 88.5  | 8.5               | +                   | +              |
| 68-A-102         | 88.5  | 6.5               |                     | < 2            |
| 68-B-69          | 96  | 6.5               |                     | +              |

The vessel samples contain only four pollen groups of apparent interest. Like other samples taken from cultural contexts, the frequency of weed-type pollen is very high, above 88 percent. In addition, clumps of cheno-am pollen are present in three samples: 68-A-80, A-84, and A-102. Both the cheno-am frequency and the presence of clumps support the cultural use or introduction of *Chenopodiaceae* family and/or Amaranthus-type plants.

Of the minor types, cultivated grass pollen is found in one sample, 68-A-84, possibly indicating storage of maize at some time. *Cylindropuntia* pollen is present in all four vessel samples in low frequencies (less than 2 percent) or was found while scanning. Its consistency supports cultural use, but its frequency does not. At best this can be interpreted as signifying that it was possibly introduced.

The vessels, which presumably were used to store food or other materials, were disappointing in terms of the few pollen types which allowed cultural interpretation. It is possible that too much fill material instead of vessel wall material was collected, thereby masking the presence of rare or infrequent cultural pollen types. On



the other hand, the food may have been prepared for storage in a manner which eliminated most of the pollen clinging to it. The literature on this subject (Bohrer 1962, Bryant 1974b) indicates that fruits or seeds (which may no longer have pollen) are often stored, whereas flowers (which contain the reproductive structures carrying pollen) are usually prepared to be eaten rather than to be stored.

### Pollen in Burial Samples

Data are in Tables 6 and 7 and Figure 4.

Table 6: Important Pollen Types in Burials

| Burial<br>Sample No. | Relative Pollen Frequencies (in percent) |                          |                                   |
|----------------------|--|--------------------------|-----------------------------------|
|                      | Cheno-ams                                | <u>Ambrosia-</u><br>type | <u>Typha angustifolia</u><br>type |
| Arizona V:9:         |  |                          |                                   |
| 55-6-3 vessel        | 87                                       | 9.5                      |                                   |
| 57-12-18             |  |                          |                                   |
| vessel #2            | 88.5                                     | 9                        |                                   |
| 60-7-7, Below        |  |                          |                                   |
| skull                | 76.5                                     | 18.5                     |                                   |
| 62-9-7, next         |  |                          |                                   |
| to feet              | 85.5                                     | 11                       |                                   |
| 62-9-9, next         |  |                          |                                   |
| to skull             | 92                                       | 7.5                      | +                                 |
| 62-9-10, under       |  |                          |                                   |
| vessel               | 87.5                                     | 8                        |                                   |

As with vessels, the burial samples are somewhat disappointing. The usual high frequency of cheno-am pollen is present, but any variation within both the cheno-ams and the Ambrosia-type counts is not statistically significant. One grain of Typha angustifolia-type pollen found in 62-9-9 is not unexpected in that cattails are presently

Table 7, Pollen Counts from Burials, Miami Wash, Arizona

|                                | <u>Cheno-ams</u> | <u>Ambrosia-type</u> | <u>Gramineae</u> | <u>Cultivated Gramineae</u> | <u>Juniperus</u> | <u>Quercus</u> | <u>Artemisia</u> | <u>Asterace-type</u> | <u>Cuscuta</u> | <u>Ephedra nevadensis-type</u> | <u>Ephedra torreyana-type</u> | <u>Eriogonum</u> | <u>cf. Eriogonum</u> | <u>Erodium-type</u> | <u>Liguliflorae</u> | <u>Malvaceae</u> | <u>Nyctaginaceae</u> | <u>Tidestromia</u> | <u>Tribulus</u> | <u>Acacia</u> | <u>Liliaceae</u> | <u>Pinus</u> | <u>Helianthus-type</u> | <u>Juglans</u> | <u>Prosopis</u> | <u>Typha angustifolia-type</u> |
|--------------------------------|------------------|----------------------|------------------|-----------------------------|------------------|----------------|------------------|----------------------|----------------|--------------------------------|-------------------------------|------------------|----------------------|---------------------|---------------------|------------------|----------------------|--------------------|-----------------|---------------|------------------|--------------|------------------------|----------------|-----------------|--------------------------------|
| Providence                     |                  |                      |                  |                             |                  |                |                  |                      |                |                                |                               |                  |                      |                     |                     |                  |                      |                    |                 |               |                  |              |                        |                |                 |                                |
| Runway Ruin                    |                  |                      |                  |                             |                  |                |                  |                      |                |                                |                               |                  |                      |                     |                     |                  |                      |                    |                 |               |                  |              |                        |                |                 |                                |
| Arizona V:9:55                 |                  |                      |                  |                             |                  |                |                  |                      |                |                                |                               |                  |                      |                     |                     |                  |                      |                    |                 |               |                  |              |                        |                |                 |                                |
| 6-3, Burial vessel             | 174              | 19                   |                  |                             | 2                |                | 1                | 1                    | +              |                                |                               |                  |                      |                     | 1                   | 1                | +                    |                    | +               |               |                  | 1            |                        |                |                 |                                |
| Columbus                       |                  |                      |                  |                             |                  |                |                  |                      |                |                                |                               |                  |                      |                     |                     |                  |                      |                    |                 |               |                  |              |                        |                |                 |                                |
| Arizona V:9:57                 |                  |                      |                  |                             |                  |                |                  |                      |                |                                |                               |                  |                      |                     |                     |                  |                      |                    |                 |               |                  |              |                        |                |                 |                                |
| 36-6, under rock lining in pit | 165              | 22                   |                  |                             |                  |                |                  | 7                    |                |                                | 1                             |                  |                      |                     |                     | +                | 1                    |                    | +               |               | 1                | +            | 1                      |                |                 |                                |
| D8-5, below metate             | 170              | 22                   |                  |                             | 3                | 1              |                  |                      |                |                                |                               |                  |                      |                     | 1                   | +                | 2                    |                    |                 | +             | +                | +            |                        |                |                 |                                |
| 12-17, burial vessel           | 177              | 18                   | 2                | +                           | 1                | 1              |                  |                      |                |                                |                               |                  |                      |                     |                     |                  |                      | +                  | 1               | +             |                  | +            |                        |                |                 |                                |
| Multigrade                     |                  |                      |                  |                             |                  |                |                  |                      |                |                                |                               |                  |                      |                     |                     |                  |                      |                    |                 |               |                  |              |                        |                |                 |                                |
| Arizona V:9:60                 |                  |                      |                  |                             |                  |                |                  |                      |                |                                |                               |                  |                      |                     |                     |                  |                      |                    |                 |               |                  |              |                        |                |                 |                                |
| 7-7, below skull in burial     | 153              | 37                   | 3                |                             | 3                |                |                  | 2                    |                |                                |                               | 1                |                      | +                   |                     |                  | +                    |                    |                 | +             |                  |              |                        | 1              |                 |                                |
| D5-36, pit                     | 185              | 10                   |                  |                             |                  |                |                  |                      |                |                                | +                             | 1                |                      |                     | 1                   | +                | 1                    |                    |                 |               | 1                | 1            |                        | 1              |                 | 1                              |

Table 7, cont.

| Providence     | Cheno-ams | <u>Ambrósia-type</u> | Gramineae | Cultivated<br>Gramineae | <u>Juniperus</u> | <u>Quercus</u> | <u>Artemisia</u> | Asterae-type | <u>Cuscuta</u> | <u>Ephedra</u><br><u>nevadensis-type</u> | <u>Ephedra torreyana-</u><br><u>type</u> | <u>Eriogonum</u> | cf. <u>Eriogonum</u> | <u>Erodium-type</u> | <u>Liguliflorae</u> | Malvaceae | Nyctaginaceae | <u>Tidestromia</u> | <u>Tribulus</u> | <u>Acacia</u> | <u>Liliaceae</u> | <u>Pinus</u> | <u>Helianthus-type</u> | <u>Juglans</u> | <u>Prosopis</u> | <u>Typha angustifolia-</u><br><u>type</u> |
|----------------|-----------|----------------------|-----------|-------------------------|------------------|----------------|------------------|--------------|----------------|--|--|------------------|----------------------|---------------------|---------------------|-----------|---------------|--------------------|-----------------|---------------|------------------|--------------|------------------------|----------------|-----------------|---|
| Tinhorn Wash   |           |                      |           |                         |                  |                |                  |              |                |  |  |                  |                      |                     |                     |           |               |                    |                 |               |                  |              |                        |                |                 |   |
| Site           |           |                      |           |                         |                  |                |                  |              |                |  |  |                  |                      |                     |                     |           |               |                    |                 |               |                  |              |                        |                |                 |   |
| Arizona V:9:62 |           |                      |           |                         |                  |                |                  |              |                |  |  |                  |                      |                     |                     |           |               |                    |                 |               |                  |              |                        |                |                 |   |
| 9-7, burial-   |           |                      |           |                         |                  |                |                  |              |                |  |  |                  |                      |                     |                     |           |               |                    |                 |               |                  |              |                        |                |                 |   |
| feet           | 171       | 22                   | 3         |                         | 2                |                | 1                |              |                |  |  |                  | 2                    |                     |                     |           | +             |                    |                 |               |                  | +            |                        |                |                 |   |
| 9-9, burial-   |           |                      |           |                         |                  |                |                  |              |                |  |  |                  |                      |                     |                     |           |               |                    |                 |               |                  |              |                        |                |                 |   |
| skull          | 184       | 15                   | +         |                         | 1                |                |                  |              |                | +  |  |                  | +                    | +                   | +                   |           | +             |                    |                 |               |                  | +            |                        |                |                 | +   |
| 9-10, under    |           |                      |           |                         |                  |                |                  |              |                |  |  |                  |                      |                     |                     |           |               |                    |                 |               |                  |              |                        |                |                 |   |
| vessel at      |           |                      |           |                         |                  |                |                  |              |                |  |  |                  |                      |                     |                     |           |               |                    |                 |               |                  |              |                        |                |                 |   |
| top of         |           |                      |           |                         |                  |                |                  |              |                |  |  |                  |                      |                     |                     |           |               |                    |                 |               |                  |              |                        |                |                 |   |
| burial         | 175       | 16                   | 3         |                         | 1                |                |                  |              | 1              | +  |  |                  | 1                    |                     |                     | 2         |               |                    |                 |               |                  | 1            |                        |                |                 |   |



growing next to the site. It could have been transported by air or introduced by water or mud gathered in the stream.

Numerous reasons for the lack of variety of pollen types in the samples are possible. Perhaps the samples were not collected in the "right places,"--i.e., locations where offerings of plants or their products were laid--or possibly no vegetal gifts were made. A satisfactory answer is not obtainable from the present information.

### Conclusion

Representative pollen indicating probable use of three plant types are cheno-ams, cultivated grass, and Liliaceae. Plants possibly used or introduced by man include Ambrosia-type, Cylindropuntia, Liguliflorae, and Juniperus.

Bohrer's (1962) study at Tonto Basin, Arizona, includes all but two of these pollen types, i.e., Abies and Liguliflorae. Bryant (1974a) cites evidence that dandelions (included in the Liguliflorae) were eaten by aboriginal inhabitants in the area of Mammoth Cave, Kentucky. Liguliflorae type plants are found growing in the Miami Wash area today. According to ethnobotanical evidence, spruce also seems to have been used. Most of the pollen groups of the other plants are present in the samples, but their relative frequencies and/or occurrences do not indicate economic importance.

### Pollen and the Environment

One of the ways in which pollen analysis is used by archaeologists in the Southwest is to interpret the environment of a site

during the time of its occupation. Such interpretation is subsequently used to interpret climatic conditions and, when enough sites and samples are available, for chronological assessment and placement (Schoenwetter 1970). The assumption upon which such interpretations are based is that the pollen rain in a site primarily reflects or represents the native vegetation and the regional pollen rain. At the same time other palynologists use pollen analysis to describe the vegetal disturbance in a site as it affects the pollen rain (Martin and Byers 1965; Kelso, personal communication), the premise being that pollen reflects man's disturbance of the environment more than it reflects the native vegetation or the regional pollen rain. Before further analyses of this type are made, these theories need to be tested. Based on the preliminary data of a short-lived investigation (Appendix B), I formed two main hypotheses concerning the pollen rain in sites during the course of human occupation: (1) man's effect on the vegetation on a site is so profound that the pollen rain in a permanently or frequently occupied site reflects this disturbance more than it reflects the natural pollen rain; and (2) pollen deposited in a structure after it is abandoned does not primarily reflect the effect of climatic change on the local and regional vegetation, but rather very localized factors including continued occupation of the site and disturbance around it, redeposition from eroding house walls and surface sediments, and natural plant succession after the site is abandoned, as well as regional factors such as climate.

Two predictions can be generated from these hypotheses:

(1) pollen from those plants favored by disturbance will occur in larger frequencies in site samples than in modern samples from undisturbed areas; and (2) the pollen profiles from stratigraphic columns in room fill will be dissimilar, since they each reflect very localized as well as regional conditions.

Hypothesis and Prediction  
Relating to Environment  
During Occupation

Two phrases need to be defined: "plants favored by disturbance," and "larger frequencies." First, what plants grow especially well in disturbed areas? One pollen study (Appendix B) done on the Papago Reservation at San Xavier Mission, Tucson, Arizona, suggests that the pollen frequency of plants in the family Chenopodiaceae and the genus Amaranthus increased because of man's presence. Another investigation into the pollen of abandoned Indian fields in northern New Mexico (Appendix B) indicates that, when compared with control samples, the two major contributors to the increased frequency of herb pollen in the fields are chenopod and Ambrosia-type pollen. The Miami Wash-Pinal Creek area has aspects in common with the locations of both of these Southwestern studies, but from personal observation, the vegetation is more similar to the Sonoran Desert-riparian environment of San Xavier than to the plateaus of northern New Mexico. Therefore, for this

study, the definition of "plants favored by disturbance" will be those plants which produce cheno-am pollen.

Actual estimates of increases in pollen from plants favored by disturbance are based on both theory and empirical data. Hevly (1964) estimates that the frequency of cheno-am pollen in cultural contexts is 15 percent greater than its occurrence in the natural pollen rain. Jelinek (1966), referring to grassland environment in New Mexico, attributes cheno-am frequencies above 40 percent to sedentary occupation. In the San Xavier Mission study the difference between cheno-am pollen in the mission samples, when compared with the control samples, is at least 30 percent in all but one sample. "Larger frequencies," then, should be cheno-am pollen on the order of 30 percent to 40 percent above those in the modern surface samples from the same area.

Considering the above definitions, the revised prediction is: the frequency of cheno-am pollen on occupation floors will be at least 30 percent greater than its frequency in surface samples collected on the same sites.

Data. Man's effect on the vegetal environment is reflected in the pollen rain around his living areas. Pollen extracted from floor samples was probably deposited during or directly after occupation, and can therefore supply information about the nature of the wind-pollinated vegetation of the sites at that time.



The prediction stated above can be tested by determining the difference between the frequency of cheno-am pollen in the floor samples and its average frequency for each site in modern surface samples. This prediction assumes that there has not been significant climatic change causing a concomitant vegetational change. This possibility will be discussed later. Data are in Tables 2 and 8.

Interpretation and Discussion. The prediction concerning disturbance during occupation is supported by the data. The archaeological samples reflect a very different pollen rain from that found in the modern surface samples and support the hypothesis that this difference is due to man's disturbance of the area.

However, one problem is encountered in this interpretation. Earlier in this chapter the existence of high frequencies of cheno-ams in floor samples was used to support the supposition for use and/or introduction of Chenopodiaceae and/or Amaranthus plants by the inhabitants, yet the same frequencies are now interpreted as supporting extensive disturbance. But these two sources of high frequencies need not be mutually exclusive. If disturbance increased the amount of weed-type plants whose seeds were used for food, then one would expect more of those types to be collected and brought into houses and storage rooms. The probability of such use is supported by the very high differences (40 percent and 50 percent) between many of the floor samples and the surface samples. At San Xavier (Appendix B) the present vegetation is not generally utilized by the Papagos

Table 8. Differences in Cheno-am Frequencies and Floor Dates

| Site Provenience<br>and Sample Number | Percent Cheno-ams in Floor<br>Samples Less Average Percent<br>Cheno-ams in Surface Samples | Dates       |
|---------------------------------------|--|-------------|
| Runway Ruin                           |  |             |
| Arizona V:9:55                        | 54.25  | A.D. c.1    |
| 1-74                                  | 54.25  | c.1250-1350 |
| 1-89                                  | 53.25  | c.1250-1350 |
| 3-28                                  | 52.25  | c.1250-1350 |
| 3-39                                  | 46.25  | c.1250-1350 |
| Monitor                               |  |             |
| Arizona V:9:56                        |  |             |
| 1-41                                  | 43.5   | c.1350-1450 |
| 1-58                                  | 48   | c.1350-1450 |
| 3-37                                  | 42   | c.1250-1350 |
| 3-39                                  | 35.5   | c.1250-1350 |
| Columbus                              |  |             |
| Arizona V:9:57                        |  |             |
| 1-66                                  | 54.25  | c.1150-1200 |
| 1-85                                  | 56.25  | c.1150-1200 |
| 6-43                                  | 47.25  | c.1150-1200 |
| 6-77                                  | 44.75  | c.1150-1200 |
| 6-78                                  | 56.75  | c.1150-1200 |
| 24-42                                 | 51.75  | c.1000-1150 |
| 24-44                                 | 56.25  | c.1000-1150 |
| 24-45                                 | 32.25  | c.1000-1150 |

Table 8, cont.

| Site Provenience<br>and Sample Number | Percent Cheno-ams in Floor<br>Samples Less Average Percent<br>Cheno-ams in Surface Samples | Dates                            |
|---------------------------------------|--|----------------------------------|
| Refugia                               |  |                                  |
| Arizona V:9:59                        |  |                                  |
| 1-55                                  | 52.5   | A.D. c.1350-1450                 |
| 1-90                                  | 42.5   | c.1350-1450                      |
| 1-94                                  | 44.5   | c.1350-1450                      |
| 1-22                                  | 36   | c.1350-1450                      |
|                                       |  | Paleomagnetic Date 1375 $\pm$ 25 |
| Multigrade                            |  |                                  |
| Arizona V:9:60                        |  |                                  |
| 3-28                                  | 30.25  | c.1150-1350                      |
| 9-45                                  | 46.75  | c.1250-1350                      |
| 9-71                                  | 44.25  | c.1250-1350                      |
| Z-11                                  | 40.75  | c.1150-1250                      |
| Tinhorn Wash                          |  |                                  |
| Arizona V:9:62                        |  |                                  |
| 6-47                                  | 58   | c.750                            |
| 6-59                                  | 59   | c.750                            |
| 10-18                                 | 51.5   | c.1250-1350                      |
| 10-28                                 | 52   | c.1250-1350                      |
| 10-30                                 | 52.5   | c.1250-1350                      |
| 10-39                                 | 47.5   | c.1250-1350                      |

(Fontana, personal communication). The pollen found on floors is a combination of airborne pollen and pollen tracked in by feet. The increase in disturbance pollen at San Xavier is 10 percent to 20 percent less than the increase of disturbance pollen in the Miami Wash sites when compared with the surface pollen in both areas. It is possible that disturbance accounts for 30 percent to 40 percent of the difference between the floor and surface pollen, the rest being due to plant use, or the increased cheno-ams could also be due to differences in the amount of disturbance around the sites as compared with San Xavier.

One other factor must be considered. There are three possible sources of pollen in a site. Two of these, cultural introduction and disturbance of plants, are used to interpret the floor samples. The third, the natural pollen rain--i.e., the pollen from those plants unaffected by man--is used to interpret the vegetal environment of sites (Hevly 1964; Schoenwetter 1962, 1965). The possibility that this source explains the high cheno-ams values and other significantly different frequencies must be also explored.

There is no additional direct evidence concerning the environment of the sites during occupation other than the pollen analysis and the ethnobotanical and zoological material. Wood found in association with structures during excavation is not suitable for dating (Doyel, personal communication). However, there is dendrochronological/climatological evidence for the period A.D. 1100 to 1400 in the Sierra Anchas, approximately 32 kilometers (circa 20

miles) north of the sites. Modern tree-ring records from Grasshopper, Arizona, approximately 43 kilometers (circa 30 miles) northeast of the Sierra Anchas, are also available (Drew 1976). The cross-correlation of the data from these two areas is estimated to be at least 0.90 (Robinson, personal communication).

Robinson (personal communication) made the following interpretation of the Sierra Ancha record:

The major features seem to me to be the lengthy average to below average conditions between 1170 and 1300 with the exception of a brief spurt around 1200 and the very favorable period between 1300 and 1330 or so.

This chronology is formed from Douglas-fir and ponderosa pine. These species, especially Douglas-fir, integrate the climate of the entire year up to the summer of growth including the prior summer...So I believe that we are seeing in this plot a representation of the total annual effective moisture--and effective moisture for trees is closely related to direct precip[itation].

It is also his opinion that the modern record (the last 50 to 100 years) for the Grasshopper area indicates a climate not substantially different from that recorded in the Sierra Ancha data.

In comparing the pollen profiles with the tree-ring records three topics will be explored: (1) the approximate dates of the archaeological structures from which the pollen samples were collected, (2) apparent differences between the pre-1300 and post-1300 A.D. floor samples, and (3) a comparison of the modern pollen profiles with the pollen profiles from the floors.

Robinson in his interpretation of the Sierra Ancha dendro-chronological record, notes a change from average to below average ring width before 1300 to an above average width from 1300 to 1330. If

the pollen record on house floors during occupation primarily reflects climate, then a change in the record for this period should be noticeable. Ideally this would simply be a matter of comparing those samples from floors which are dated as pre-1300 with those samples from floors in the same site dating to post-1300. However, two problems exist: (1) if one assumes that floors were swept occasionally during occupation, the pollen samples would be a combination of occupational and post-occupational deposition and therefore would not be strictly contemporaneous with the floors; and (2) the dating of the floors is based on seriation of ceramics and a few archaeomagnetic dates (Table 8). These dates encompass a minimum of 50 years (Arizona V:9:57-1 and 6 and the archaeomagnetic date from Arizona V:59:59-1), up to a maximum of 200 years. Many of the floors span the A.D. 1300 period of climatic change noted by Robinson. No site has a floor (with pollen samples) which is dated prior to 1300 and a separate floor with samples dated after 1300.

It is possible, however, to compare the modern tree-ring and pollen records with the older records. Robinson states that the modern tree-ring record indicates a climate which does not differ substantially from the Sierra Ancha record. Yet, in this study, a change in the pollen frequencies is very noticeable, for cheno-am frequencies from floors dating to A.D. 1100 to 1400 differ from modern cheno-am frequencies by 30.25 percent to 56.25 percent. Such large variations are not found even when comparing pollen samples from pre- and post-1300 floors among sites, which now have different vegetation.

It is evident from this discussion that in order for valid comparisons to be made between dendrochronological records and archaeological pollen samples, the dating of archaeological sites and structures must be precise. It is also evident that though no substantial difference in climate is apparent between the modern tree-ring record and the past tree-ring record, the pollen rain has changed over time.

There is yet another problem associated with an environmental-climatic interpretation of the data. Environmental interpretation and cultural interpretation of the same samples are usually mutually exclusive. If the interpretation of pollen through cultural use is accepted, then, subsequent environmental interpretation is unacceptable unless the percent of introduced pollen types is known. Means of circumventing this problem have been suggested. Schoenwetter and Eddy (1964) devised an "equalized adjusted pollen sum" which eliminates plants thought to have been introduced (e.g., Zea, Cucurbita, and others), plants that reflect riparian or cienega conditions, and other plants whose interpretations are controversial. But they retained in toto the cheno-am frequencies. This is not a satisfactory solution unless the types included are known not to have been introduced or affected by the presence of man.

Jelinek (1966) proposes a method which correlates pollen frequencies with the existence of hunting and gathering as opposed to cultivation. He interprets the increase in cheno-am frequencies coinciding with occupation by cultivators as indicative of disturbance, and the decrease in cheno-am frequencies coincident

with hunter/gatherer artifacts as reflecting increased natural pollen rain. He then attempts to (1508):

...isolate climatically significant relations in the remaining pollen groups, which can be assumed to represent the natural pollen rain.

As a test of this hypothesis, the pollen percentages were recalculated for each sample, with the assumption that all grains of cheno-am exceeding 40 percent...reflected cultural activity, as did all Zea pollen.

I feel that this is more valid than the previously mentioned method, but still see a problem with relative frequencies. In any case, this method is not applicable "in areas of more intensive cultivation where relatively great quantities of sherds might obscure the relations of other materials (Jelinek 1966:1509)," i.e. at the Miami Wash sites.

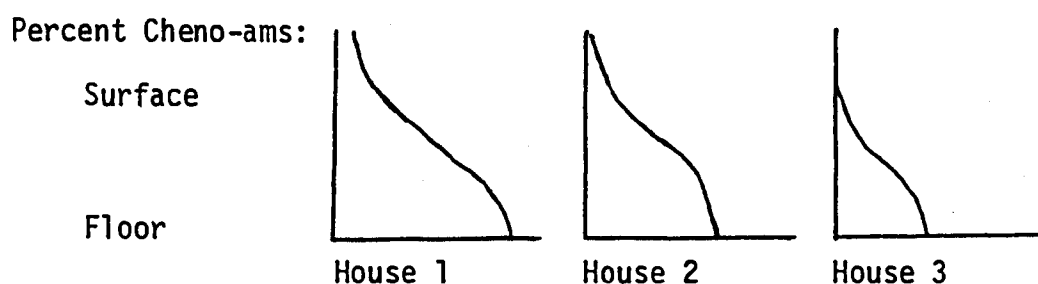
Hypothesis and Prediction  
Relating to Climate  
After Occupation

As pollen samples gathered on floors of archaeological structures are used to interpret climate during the occupation of a site, pollen samples collected from stratigraphic columns in prehistoric structures are used to interpret post-occupational climatic history of an area (Hevly 1964, Schoenwetter 1962, 1965). This kind of interpretation is based on the assumption that the pollen deposited in these structures reflects climatic change after the structures were abandoned and that this contribution can be discerned. I reject this assumption and hypothesize that pollen profiles from stratigraphic columns do not only reflect climatic change, but instead reflect both local and regional conditions including: (1) house fill composed of debris and waste deposited by later occupants of the site as well as

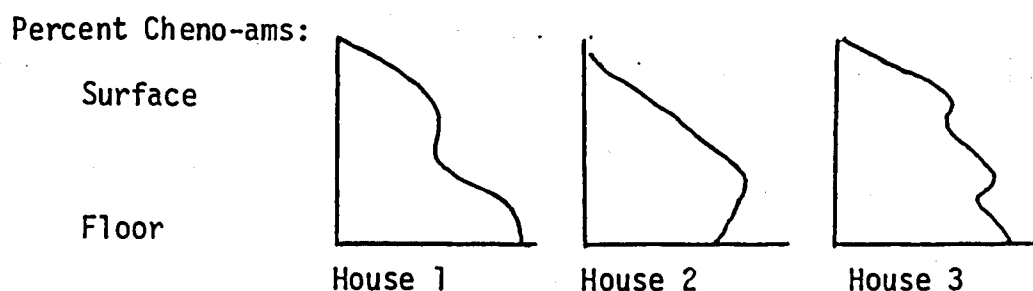


material eroded from the house walls, (2) plant succession subsequent to site occupation when plants favored by disturbance are replaced by more natural vegetation, (3) the effect of local depositional conditions such as slope, rock type, attitude (as the data in Figure 5--in pocket--show), and (4) climatic change.

My prediction is: If only one common factor is reflected in the pollen profiles of the stratigraphic columns then the profiles should be similar, i.e., though the actual pollen frequencies will differ, the effect of the changes will be the same and the curves for a single pollen type will be similar.



If one factor is not common and/or more than one factor is controlling pollen deposition in the house floors, then the pollen diagrams will be different both in actual frequencies as well as in their profiles:



Stratigraphic Data. Samples were collected from one column from at least one room in each site. Samples were taken at five centimeter intervals in all but one column; the column in Arizona V:9:60, Feature 9, consisted of very loose material and was therefore sampled at 10 centimeter levels only. Two columns were collected in Arizona V:9:68, Feature B. The resultant data are shown in Figures 6 and 7. (in pocket) and Table 9.

The dominant pollen type in most samples is cheno-am. It is followed and, in some cases, superceded in frequency by Ambrosia-type. Types which occur in a majority of the samples, but generally in frequencies less than ten percent, are Gramineae, Pinus, Juniperus, Asterae-type, Eriogonum or cf. Eriogonum, and Nyctaginaceae. Other types occur in less than half the samples at frequencies under ten percent.

What similarities are apparent in the pollen profiles? There are two obvious features which most of the profiles have in common: (1) cheno-ams are relatively high in frequency on the floors and generally decrease towards the surface, and (2) both Ambrosia-type and the arboreal pollen types tend to increase toward and at the surface.

There are more apparent dissimilarities than similarities. Though cheno-ams generally decrease towards the surface, each profile has its own particular configuration. The number of peaks of cheno-ams varies from two to five. In some samples the cheno-am maximum occurs not on the floor, but from 5 to 30 centimeters above it.

Table 9. Pollen Counts from Stratigraphic Columns, Miami Wash, Arizona

| Provenience                 | Cheno-ams | <u>Ambrosia-type</u> | Gramineae | Cultivated Gramineae | <u>Juniperus</u> | <u>Quercus</u> | <u>Artemisia</u> | Asterae-type | cf. <u>Croton</u> | Cruciferae | <u>Cuscuta</u> | <u>Eriogonum</u> | cf. <u>Eriogonum</u> | <u>Erodium-type</u> | <u>Euphorbia</u> | <u>Gilia</u> | <u>Helianthus-type</u> | Labiatae | Liguliflorae | Malvaceae | Nyctaginaceae | Onagraceae, <u>Oenothera-type</u> |
|-----------------------------|-----------|----------------------|-----------|----------------------|------------------|----------------|------------------|--------------|-------------------|------------|----------------|------------------|----------------------|---------------------|------------------|--------------|------------------------|----------|--------------|-----------|---------------|-----------------------------------|
| Runway Ruin, Arizona V:9:55 |           |                      |           |                      |                  |                |                  |              |                   |            |                |                  |                      |                     |                  |              |                        |          |              |           |               |                                   |
| Feature 1                   |           |                      |           |                      |                  |                |                  |              |                   |            |                |                  |                      |                     |                  |              |                        |          |              |           |               |                                   |
| 50                          | 72        | 67                   | 7         |                      | 11               | 7              | 2                | 4            | +                 | 1          | +              | 1                |                      | 5                   | 1                | +            |                        |          |              | +         | 1             |                                   |
| 45                          | 108       | 55                   | 8         |                      | 7                | 1              | +                | 8            |                   |            |                |                  | 4                    | 1                   | +                | +            |                        | 2        |              |           | +             | +                                 |
| 40                          | 134       | 47                   | 2         |                      | 7                |                |                  | 1            |                   |            |                |                  | 2                    | 3                   |                  |              |                        |          |              |           | 1             |                                   |
| 35                          | 153       | 33                   | 5         |                      | 3                |                |                  | 3            |                   |            |                |                  |                      | 1                   |                  |              |                        |          |              |           | 1             |                                   |
| 30                          | 151       | 39                   | 2         |                      | 4                |                |                  | 2            |                   |            |                |                  |                      | 1                   | +                |              |                        |          |              | +         | +             |                                   |
| 25                          | 153       | 33                   | 1         |                      | 4                | +              |                  | 3            |                   |            |                |                  | 2                    |                     |                  |              |                        |          |              | +         | +             |                                   |
| 20                          | 160       | 34                   | 1         |                      |                  |                |                  | 2            |                   |            |                |                  |                      |                     |                  |              | 1                      |          |              |           | 1             |                                   |
| 15                          | 151       | 38                   |           |                      | 1                |                | 1                | 4            |                   |            |                |                  | 1                    |                     |                  |              |                        |          |              | +         | 1             |                                   |
| 10                          | 156       | 32                   | 3         |                      | 2                |                |                  | 4            |                   |            |                |                  |                      |                     |                  |              |                        | 1        |              |           | +             |                                   |
| 5                           | 168       | 23                   |           | 1                    | 1                |                |                  | 3            |                   |            |                |                  |                      |                     |                  |              |                        | 1        |              |           | 2             |                                   |
| Floor Contact               | 171       | 23                   | 1         |                      | 1                |                |                  |              |                   |            |                |                  | 1                    |                     |                  |              |                        |          |              |           | 1             |                                   |
| Feature 3                   |           |                      |           |                      |                  |                |                  |              |                   |            |                |                  |                      |                     |                  |              |                        |          |              |           |               |                                   |
| 45                          | 47        | 61                   | 10        |                      | 9                | 11             | 1                | 3            |                   | 1          | 6              | 15               |                      | 4                   | 1                | +            | 1                      |          | 1            |           | +             |                                   |
| 40                          | 53        | 79                   | 17        |                      | 8                | 8              |                  | 6            |                   | 1          |                |                  | 1                    | 4                   |                  |              |                        |          |              |           | 3             | +                                 |
| 35                          | 152       | 34                   | 4         |                      | 3                |                |                  | 1            |                   |            |                |                  | 3                    | +                   |                  |              |                        |          |              |           | 1             | 1                                 |
| 30                          | 162       | 39                   | 1         |                      | 5                |                |                  | 1            |                   |            |                |                  |                      |                     |                  |              |                        | 1        | +            |           | +             |                                   |
| 25                          | 157       | 33                   | 1         | 1                    | 3                |                |                  | 2            |                   |            |                |                  |                      |                     |                  |              |                        |          |              |           |               |                                   |
| 20                          | 147       | 41                   | 3         |                      | 2                |                |                  | 3            |                   |            |                |                  | 2                    |                     |                  |              |                        |          |              |           | 1             |                                   |
| 15                          | 138       | 44                   | 4         |                      | 3                | +              |                  |              |                   | 1          |                |                  |                      |                     |                  |              |                        |          |              |           | 3             |                                   |

Table 9. Pollen Counts from Statigraphic Columns, Miami Wash, Arizona, cont.

| Provenience             | Cheno-ams | Ambrosia-type | Gramineae | Cultivated Gramineae | Juniperus | Quercus | Artemisia | Asterae-type | cf. Croton | Cruciferae | Cuscuta | Eriogonum | cf. Eriogonum | Erodium-type | Euphorbia | Gilia | Helianthus-type | Labiatae | Liguliflorae | Malvaceae | Nyctaginaceae | Onagraceae, Oenothera-type |
|-------------------------|-----------|---------------|-----------|----------------------|-----------|---------|-----------|--------------|------------|------------|---------|-----------|---------------|--------------|-----------|-------|-----------------|----------|--------------|-----------|---------------|----------------------------|
| Centimeters Above Floor |           |               |           |                      |           |         |           |              |            |            |         |           |               |              |           |       |                 |          |              |           |               |                            |
| 10                      | 165       | 26            | 2         | +                    |           | 1       |           | 1            |            |            |         |           | 1             |              | 1         |       |                 |          |              |           |               |                            |
| 5                       | 173       | 23            | 2         |                      | +         |         |           |              |            |            |         |           | 1             | +            |           |       |                 |          |              |           | +             |                            |
| Floor Contact           | 175       | 23            |           |                      |           | 1       |           |              |            |            |         |           |               | +            |           |       |                 |          |              | +         |               |                            |
| Feature 5               |           |               |           |                      |           |         |           |              |            |            |         |           |               |              |           |       |                 |          |              |           |               |                            |
| 30                      | 171       | 21            | 1         |                      | 1         |         |           |              |            |            | 1       | 1         |               |              |           |       |                 |          | 1            |           | 1             |                            |
| 25                      | 171       | 22            | 1         | +                    |           |         | 1         | 2            |            |            |         | 1         |               |              |           |       |                 |          | 1            | +         | +             |                            |
| 20                      | 150       | 36            | 3         |                      | 1         |         |           |              |            |            |         |           | +             |              |           |       |                 |          |              |           | +             |                            |
| 15                      | 165       | 30            | 2         | 1                    | 2         |         |           |              |            |            |         |           |               |              |           |       |                 |          |              |           |               | +                          |
| 10                      | 167       | 29            | +         |                      | 1         |         |           | 1            |            |            |         |           |               |              |           |       |                 |          |              |           |               |                            |
| 5                       | 163       | 28            | 1         | +                    | 2         |         |           | 2            |            |            |         |           | 3             | +            |           |       |                 |          |              | +         |               |                            |
| Floor Contact           | 167       | 25            |           |                      |           |         |           | 2            |            |            |         |           | 2             |              |           |       |                 |          | 2            |           | 1             |                            |
| Monitor                 |           |               |           |                      |           |         |           |              |            |            |         |           |               |              |           |       |                 |          |              |           |               |                            |
| Arizona V:9:56          |           |               |           |                      |           |         |           |              |            |            |         |           |               |              |           |       |                 |          |              |           |               |                            |
| Feature 1               |           |               |           |                      |           |         |           |              |            |            |         |           |               |              |           |       |                 |          |              |           |               |                            |
| 40                      | 141       | 37            | 4         |                      | 7         | 2       | 2         | 1            |            |            |         |           | +             | 5            | 1         |       |                 |          |              |           | 1             |                            |
| 35                      | 152       | 26            | 1         |                      | 8         |         |           | 3            |            |            |         |           | +             | 5            |           |       |                 |          |              | 1         | 1             |                            |
| 30                      | 167       | 20            | 1         |                      | 6         |         |           | 1            |            |            |         |           |               | 1            |           |       |                 |          |              |           | +             |                            |
| 25                      | 164       | 23            | +         |                      | 3         | 1       |           | 2            |            |            |         |           |               | 4            |           |       |                 |          |              |           | 1             |                            |
| 20                      | 150       | 31            | 1         |                      | 3         |         |           | 4            |            |            |         | 1         | 8             |              |           |       |                 |          |              |           |               |                            |
| 15                      | 138       | 45            | 2         |                      | 7         | 1       |           | 2            |            |            |         |           | 3             |              |           |       |                 |          |              |           | 1             |                            |

Table 9. Pollen Counts from Stratigraphic Columns, Miami Wash, Arizona, cont.

| Provenience              |  | Cheno-ams | Ambrosia-type | Gramineae | Cultivated Gramineae | Juniperus | Quercus | Artemisia | Asterae-type | cf. Croton | Cruciferae | Cuscuta | Eriogonum | cf. Eriogonum | Erodium-type | Euphorbia | Gilia | Helianthus-type | Labiatae | Liguliflorae | Malvaceae | Nyctaginaceae | Onagraceae, Oenothera-type |
|--------------------------|--|-----------|---------------|-----------|----------------------|-----------|---------|-----------|--------------|------------|------------|---------|-----------|---------------|--------------|-----------|-------|-----------------|----------|--------------|-----------|---------------|----------------------------|
| 10                       |  | 159       | 29            | 1         |                      | 1         | 1       |           | 2            |            |            |         |           | 5             |              |           |       |                 |          |              | 3         |               |                            |
| 5                        |  | 171       | 22            | 3         |                      | 1         |         |           |              |            |            |         |           | 1             |              |           |       |                 |          |              | +         | +             |                            |
| Floor Contact            |  | 172       | 21            | +         | 1                    | 3         |         |           |              |            |            |         | 3         |               |              |           |       |                 |          |              |           | +             | +                          |
| Feature 3                |  |           |               |           |                      |           |         |           |              |            |            |         |           |               |              |           |       |                 |          |              |           |               |                            |
| 25                       |  | 163       | 29            | 3         |                      | 2         |         |           |              |            | 1          |         |           | 1             |              |           |       |                 |          | 1            | +         | +             |                            |
| 20                       |  | 159       | 28            | 4         |                      | 3         | 1       | 1         |              |            |            |         |           | 3             |              |           |       |                 |          |              |           |               |                            |
| 15                       |  | 150       | 20            | 10        |                      | 3         | 1       |           | 2            |            | 1          |         |           |               | 8            |           |       |                 |          |              |           | 2             |                            |
| 10                       |  | 170       | 36            | 2         | +                    |           |         |           |              |            |            |         |           |               |              |           |       | 1               |          |              |           |               |                            |
| 5                        |  | 169       | 19            | 3         | 1                    | 4         |         |           |              |            | 1          |         |           |               |              |           |       |                 |          |              |           |               |                            |
| Floor Contact            |  | 177       | 19            |           |                      | +         |         |           |              |            |            |         |           |               |              |           |       |                 |          |              | 1         |               | 1                          |
| Columbus, Arizona V:9:57 |  |           |               |           |                      |           |         |           |              |            |            |         |           |               |              |           |       |                 |          |              |           |               |                            |
| Feature 1                |  |           |               |           |                      |           |         |           |              |            |            |         |           |               |              |           |       |                 |          |              |           |               |                            |
| 45                       |  | 177       | 17            | +         |                      | 5         |         |           |              |            |            |         |           |               |              |           |       |                 |          |              | 1         | +             |                            |
| 40                       |  | 167       | 29            |           |                      | 1         |         |           | 1            |            |            |         |           | 1             |              |           |       |                 |          | +            | 1         |               |                            |
| 35                       |  | 165       | 22            |           |                      | 5         |         |           | 2            |            |            |         |           | 1             | +            |           |       |                 |          |              | 1         | 2             |                            |
| 30                       |  | 177       | 18            | 2         |                      | 1         |         |           |              |            |            |         | 1         |               |              |           |       |                 |          |              |           |               |                            |
| 25                       |  | 171       | 22            |           |                      | 2         |         |           | 1            |            |            |         |           |               |              | 1         |       |                 |          |              | +         |               |                            |
| 20                       |  | 180       | 15            | 1         | 1                    | 1         |         |           |              |            |            |         |           |               |              |           |       | 1               |          | +            |           |               |                            |
| 15                       |  | 184       | 12            |           |                      |           |         |           | +            |            |            |         |           | 2             |              | 1         |       |                 |          |              | +         | 1             |                            |
| 10                       |  | 175       | 21            | +         |                      | 2         |         |           | 1            |            |            |         |           |               |              |           |       |                 |          |              |           |               |                            |

Table 9 . Pollen Counts from Stratigraphic Columns, Miami Wash, Arizona, cont.

| Table 9 . Pollen Counts from Stratigraphic Columns, Miami Wash, Arizona, cont. |                            |           |                      |           |                         |                  |                |                  |              |                   |            |                |                  |                      |                     |                  |              |                        |          |              |           |               |                                      |
|--|----------------------------|-----------|----------------------|-----------|-------------------------|------------------|----------------|------------------|--------------|-------------------|------------|----------------|------------------|----------------------|---------------------|------------------|--------------|------------------------|----------|--------------|-----------|---------------|--------------------------------------|
| Provenience  | Centimeters<br>Above Floor | Cheno-ams | <u>Ambrosia-type</u> | Gramineae | Cultivated<br>Gramineae | <u>Juniperus</u> | <u>Quercus</u> | <u>Artemisia</u> | Asterae-type | <u>cf. Croton</u> | Cruciferae | <u>Cuscuta</u> | <u>Eriogonum</u> | <u>cf. Eriogonum</u> | <u>Erodium-type</u> | <u>Euphorbia</u> | <u>Gilia</u> | <u>Helianthus-type</u> | Labiatae | Liguliflorae | Malvaceae | Nyctaginaceae | Onagraceae,<br><u>Oenothera-type</u> |
| 5  |                            | 176       | 17                   | 2         |                         | 1                |                |                  | 2            |                   |            |                | 1                |                      |                     |                  |              |                        |          |              |           | +             |                                      |
| Floor #2 Contact   |                            | 172       | 19                   | 2         |                         | 2                | 1              |                  | 2            |                   |            |                |                  | +                    |                     |                  |              |                        |          |              | 1         | 1             |                                      |
| Feature 6  |                            |           |                      |           |                         |                  |                |                  |              |                   |            |                |                  |                      |                     |                  |              |                        |          |              |           |               |                                      |
| 30   |                            | 162       | 27                   | 3         |                         |                  |                |                  | 1            |                   |            |                | +                |                      |                     | +                |              |                        |          |              | +         | 5             |                                      |
| 25   |                            | 183       | 13                   | 1         |                         | 1                |                |                  |              |                   |            |                |                  |                      | +                   |                  |              |                        |          |              |           | +             |                                      |
| 20   |                            | 171       | 22                   | 2         |                         | 1                | +              | 1                | 1            |                   |            |                |                  |                      | 1                   |                  |              |                        |          |              |           | 1             |                                      |
| 15   |                            | 189       | 8                    | +         |                         | +                | 1              |                  |              |                   |            |                | 1                |                      |                     |                  |              |                        |          |              |           | +             |                                      |
| 10   |                            | 181       | 16                   |           |                         | 1                |                | +                |              |                   |            |                | 1                |                      | 1                   |                  |              |                        |          |              |           | +             |                                      |
| 5  |                            | 184       | 12                   | 1         |                         | 1                |                |                  |              |                   |            |                |                  |                      |                     |                  |              |                        |          |              |           |               |                                      |
| Floor #2 Contact   |                            | 186       | 13                   | +         |                         |                  |                |                  |              |                   |            |                |                  |                      |                     |                  |              |                        |          |              |           | 1             |                                      |
| Refugia, Arizona V:9:59  |                            |           |                      |           |                         |                  |                |                  |              |                   |            |                |                  |                      |                     |                  |              |                        |          |              |           |               |                                      |
| Feature 1  |                            |           |                      |           |                         |                  |                |                  |              |                   |            |                |                  |                      |                     |                  |              |                        |          |              |           |               |                                      |
| 25   |                            | 47        | 39                   | 17        |                         | 40               | 12             | 2                | 2            | +                 |            | 1              | 1                |                      | +                   | 3                |              |                        | 1        | +            | +         | +             |                                      |
| 20   |                            | 60        | 55                   | 17        |                         | 41               | 3              |                  |              |                   | 2          | 1              | +                |                      | +                   |                  |              |                        |          |              | +         |               |                                      |
| 15   |                            | 104       | 53                   | 5         |                         | 21               | 4              | 1                |              |                   |            |                | 2                |                      | 1                   | 1                |              | +                      |          |              | 1         | +             |                                      |
| 10   |                            | 76        | 63                   | 16        |                         | 29               | 4              |                  |              |                   |            |                |                  |                      | 3                   |                  |              |                        |          |              |           | 1             |                                      |
| 5  |                            | 65        | 71                   | 10        |                         | 38               |                |                  | 1            |                   |            |                |                  |                      | 1                   |                  |              |                        |          |              |           | 1             |                                      |
| Floor #2 Contact   |                            | 118       | 55                   | 3         |                         | 8                | 1              |                  | 8            |                   |            |                | 1                |                      | +                   | 1                |              |                        |          |              | 2         | 1             |                                      |
| Multigrade, Arizona V:9:60   |                            |           |                      |           |                         |                  |                |                  |              |                   |            |                |                  |                      |                     |                  |              |                        |          |              |           |               |                                      |
| Feature 2  |                            |           |                      |           |                         |                  |                |                  |              |                   |            |                |                  |                      |                     |                  |              |                        |          |              |           |               |                                      |
| 30   |                            | 160       | 31                   | 1         |                         | 5                |                |                  | 2            |                   |            |                |                  |                      |                     |                  |              |                        |          | 1            |           |               |                                      |
| 25   |                            | 170       | 23                   | 2         |                         | 2                |                |                  | 2            |                   |            |                |                  |                      |                     |                  |              |                        |          |              | +         |               |                                      |
| 20   |                            | 177       | 23                   |           |                         | +                |                |                  | +            |                   |            |                |                  |                      |                     |                  |              |                        |          |              | +         |               |                                      |
| 15   |                            | 183       | 13                   | 2         |                         |                  |                |                  | 1            |                   |            |                |                  |                      |                     |                  |              |                        |          |              | +         |               |                                      |

Table 9. Pollen Counts from Stratigraphic Columns, Miami Wash, Arizona, cont.

| Provenience | Centimeters<br>Above Floor | Cheno-ams | <u>Ambrosia-type</u> | Gramineae | Cultivated<br>Gramineae | <u>Juniperus</u> | <u>Quercus</u> | <u>Artemisia</u> | Asterae-type | cf. <u>Croton</u> | Cruciferae | <u>Cuscuta</u> | <u>Eriogonum</u> | cf. <u>Eriogonum</u> | <u>Erodium-type</u> | <u>Ephorbia</u> | <u>Gilia</u> | <u>Helianthus-type</u> | Labiatae | Liguliflorae | Malvaceae | Nyctaginaceae | Onagraceae,<br><u>Oenothera-type</u> |
|-------------|----------------------------|-----------|----------------------|-----------|-------------------------|------------------|----------------|------------------|--------------|-------------------|------------|----------------|------------------|----------------------|---------------------|-----------------|--------------|------------------------|----------|--------------|-----------|---------------|--------------------------------------|
|             | 10                         | 186       | 00                   |           |                         | 2                |                |                  |              |                   |            |                |                  |                      |                     |                 |              |                        |          |              | 1         | 1             |                                      |
|             | 5                          | 174       | 17                   | 1         |                         | 4                |                |                  | 3            |                   |            |                |                  |                      |                     |                 |              |                        |          |              | +         | +             |                                      |
|             | Floor Contact              | 163       | 34                   |           |                         |                  |                |                  | 1            |                   |            |                |                  |                      | 1                   |                 |              |                        |          |              | 1         | +             |                                      |
|             | Feature 9                  |           |                      |           |                         |                  |                |                  |              |                   |            |                |                  |                      |                     |                 |              |                        |          |              |           |               |                                      |
|             | 75                         | 161       | 30                   | 1         |                         | 8                |                |                  | +            |                   |            |                |                  |                      |                     |                 |              |                        |          |              |           | +             |                                      |
|             | 65                         | 171       | 24                   |           |                         | 1                |                |                  |              |                   |            |                |                  | 1                    |                     |                 |              |                        |          |              | +         | 2             |                                      |
|             | 55                         | 182       | 16                   |           |                         |                  |                |                  |              |                   |            |                |                  |                      |                     |                 |              |                        |          |              | 1         |               |                                      |
|             | 45                         | 184       | 14                   |           |                         | 1                |                |                  |              |                   |            |                |                  |                      |                     |                 |              |                        |          |              |           | +             |                                      |
|             | 35                         | 160       | 28                   |           |                         | 4                |                | 1                | 2            |                   |            |                |                  |                      |                     |                 |              |                        |          |              |           | 3             |                                      |
|             | 25                         | 178       | 17                   | 1         |                         | 1                |                | +                |              |                   |            |                |                  |                      |                     |                 |              |                        |          |              | +         | 1             |                                      |
|             | 15                         | 193       | 5                    |           |                         | 2                |                |                  |              |                   |            |                |                  |                      |                     |                 |              |                        |          |              |           |               |                                      |
|             | 5                          | 168       | 26                   | 1         |                         | 3                |                |                  |              |                   |            |                |                  |                      |                     |                 |              |                        |          |              |           | +             |                                      |
|             | Tinhorn,<br>Arizona V:9:62 |           |                      |           |                         |                  |                |                  |              |                   |            |                |                  |                      |                     |                 |              |                        |          |              |           |               |                                      |
|             | Feature 10                 |           |                      |           |                         |                  |                |                  |              |                   |            |                |                  |                      |                     |                 |              |                        |          |              |           |               |                                      |
|             | 28                         | 145       | 40                   | 11        |                         | 3                |                |                  |              |                   |            |                | +                |                      |                     | 1               |              |                        |          |              |           | +             |                                      |
|             | 25                         | 151       | 34                   | 3         |                         | 6                | 1              |                  | 3            |                   |            |                |                  |                      |                     | +               |              |                        |          |              |           | 1             |                                      |
|             | 20                         | 174       | 21                   |           |                         |                  |                |                  | 1            |                   |            |                |                  | 3                    |                     |                 |              |                        |          |              |           | 1             |                                      |
|             | 15                         | 184       | 12                   | 1         |                         |                  |                |                  |              |                   |            |                |                  |                      |                     |                 |              |                        |          |              |           |               |                                      |
|             | 10                         | 179       | 16                   | 1         |                         | 1                |                |                  |              |                   |            |                | 1                | 1                    | 1                   |                 |              |                        |          |              |           |               |                                      |
|             | 5                          | 183       | 15                   |           |                         |                  |                | 1                |              |                   |            |                |                  |                      |                     |                 |              |                        |          |              |           | +             |                                      |
|             | Floor Contact              | 188       | 10                   | 1         |                         |                  |                |                  |              |                   |            |                |                  |                      |                     |                 |              |                        | 1        |              |           |               |                                      |
|             | -4                         | 177       | 18                   | 1         |                         | 2                |                |                  |              |                   |            |                |                  |                      |                     |                 |              |                        |          |              | +         | +             | 1                                    |

Table 9 . Pollen Counts from Stratigraphic Columns, Miami Wash, Arizona, cont.

| Provenience               | Cheno-ams | <u>Ambrosia-type</u> | <u>Gramineae</u> | <u>Cultivated Gramineae</u> | <u>Juniperus</u> | <u>Quercus</u> | <u>Artemisia</u> | <u>Asterae-type</u> | <u>cf. Croton</u> | <u>Cruciferae</u> | <u>Cuscuta</u> | <u>Eriogonum</u> | <u>cf. Eriogonum</u> | <u>Erodium-type</u> | <u>Ephorbia</u> | <u>Gilia</u> | <u>Helianthus-type</u> | <u>Labiatae</u> | <u>Liguliflorae</u> | <u>Malvaceae</u> | <u>Nyctaginaceae</u> | <u>Onagraceae, Oenothera-type</u> |
|---------------------------|-----------|----------------------|------------------|-----------------------------|------------------|----------------|------------------|---------------------|-------------------|-------------------|----------------|------------------|----------------------|---------------------|-----------------|--------------|------------------------|-----------------|---------------------|------------------|----------------------|-----------------------------------|
| Centimeters Above Floor   |           |                      |                  |                             |                  |                |                  |                     |                   |                   |                |                  |                      |                     |                 |              |                        |                 |                     |                  |                      |                                   |
| East Ruin, Arizona V:9:58 |           |                      |                  |                             |                  |                |                  |                     |                   |                   |                |                  |                      |                     |                 |              |                        |                 |                     |                  |                      |                                   |
| Feature A                 |           |                      |                  |                             |                  |                |                  |                     |                   |                   |                |                  |                      |                     |                 |              |                        |                 |                     |                  |                      |                                   |
| 65                        | 140       | 40                   | +                |                             | 15               | 2              |                  |                     |                   | 1                 |                |                  |                      |                     |                 |              |                        |                 |                     |                  | +                    |                                   |
| 60                        | 163       | 28                   | 1                |                             | 4                | 2              |                  |                     |                   | 2                 |                |                  |                      |                     |                 |              |                        |                 |                     | +                | +                    |                                   |
| 55                        | 176       | 15                   | 1                |                             | 2                |                |                  | 2                   |                   |                   |                |                  |                      |                     |                 |              |                        |                 |                     |                  | +                    |                                   |
| 50                        | 184       | 14                   |                  |                             | 1                |                |                  |                     |                   |                   |                |                  | +                    |                     |                 |              |                        |                 |                     |                  | +                    |                                   |
| 45                        | 182       | 17                   |                  |                             |                  |                |                  |                     |                   |                   |                |                  |                      |                     |                 |              |                        |                 |                     |                  |                      |                                   |
| 40                        | 188       | 9                    | 1                |                             | 1                |                |                  |                     |                   |                   |                |                  |                      |                     |                 |              |                        |                 |                     |                  |                      |                                   |
| 35                        | 188       | 10                   |                  |                             |                  |                |                  | 1                   |                   |                   |                |                  |                      |                     |                 |              |                        |                 |                     |                  | 1                    |                                   |
| 30                        | 193       | 6                    |                  |                             |                  |                |                  |                     |                   |                   |                |                  |                      |                     |                 |              |                        |                 |                     |                  | +                    |                                   |
| 25                        | 190       | 7                    | 1                |                             |                  | +              |                  |                     |                   |                   |                |                  |                      |                     |                 |              |                        |                 |                     |                  |                      |                                   |
| 20                        | 195       | 4                    | +                |                             |                  |                |                  |                     |                   |                   |                |                  |                      |                     |                 |              |                        |                 | +                   |                  |                      |                                   |
| 15                        | 188       | 10                   |                  |                             | 1                |                |                  |                     |                   |                   |                |                  |                      |                     |                 |              |                        |                 |                     |                  | +                    |                                   |
| 10                        | 185       | 12                   |                  |                             | 2                |                |                  |                     |                   |                   |                |                  |                      |                     |                 |              |                        |                 | 1                   |                  |                      |                                   |
| 5                         | 190       | 6                    | +                |                             | 1                |                |                  | 2                   |                   |                   |                |                  |                      |                     |                 |              |                        |                 |                     |                  | +                    |                                   |
| Floor Contact             | 179       | 18                   |                  |                             | 3                |                |                  |                     |                   |                   |                |                  |                      |                     |                 |              |                        |                 |                     |                  | +                    |                                   |
| Feature B, Column 1       |           |                      |                  |                             |                  |                |                  |                     |                   |                   |                |                  |                      |                     |                 |              |                        |                 |                     |                  |                      |                                   |
| 65                        | 119       | 37                   | 16               |                             | 10               | 4              | 1                | 4                   |                   |                   |                | +                |                      |                     |                 |              |                        |                 |                     |                  | +                    |                                   |
| 60                        | 68        | 67                   | 20               |                             | 14               | 14             |                  | 2                   |                   | 2                 |                | 1                |                      | 1                   | 1               |              |                        |                 |                     |                  | 1                    |                                   |
| 55                        | 114       | 47                   | 8                |                             | 9                | 3              |                  | 2                   |                   |                   |                |                  | 2                    | 1                   | 1               |              | 1                      |                 | +                   | 2                |                      |                                   |
| 50                        | 95        | 40                   | 1                |                             | 4                |                |                  | 7                   |                   | +                 |                |                  |                      |                     |                 |              |                        |                 |                     | +                | +                    |                                   |
| 45                        | 168       | 20                   |                  |                             | 6                | +              |                  | 3                   |                   |                   |                |                  |                      |                     |                 |              |                        |                 |                     | +                | +                    |                                   |
| 40                        | 167       | 17                   |                  |                             | 13               |                |                  | 3                   |                   |                   |                |                  |                      |                     |                 |              |                        |                 |                     | +                |                      |                                   |



Table 9 . Pollen Counts from Stratigraphic Columns, Miami Wash, Arizona, cont.

| Provenience         | Cheno-ams | <u>Ambrosia-type</u> | Gramineae | Cultivated Gramineae | Juniperus | Quercus | Artemisia | Asterae-type | cf. <u>Croton</u> | Cruciferae | Cuscuta | Eriogonum | cf. <u>Eriogonum</u> | <u>Erodium-type</u> | <u>Ephorbia</u> | <u>Gilia</u> | <u>Helianthus-type</u> | Labiatae | Liguliflorae | Malvaceae | Nyctaginaceae | Onagraceae,<br><u>Oenothera-type</u> |
|---------------------|-----------|----------------------|-----------|----------------------|-----------|---------|-----------|--------------|-------------------|------------|---------|-----------|----------------------|---------------------|-----------------|--------------|------------------------|----------|--------------|-----------|---------------|--------------------------------------|
| 35                  | 184       | 13                   |           |                      | 1         | +       |           | 2            |                   |            |         |           |                      |                     |                 |              |                        |          |              | +         | +             |                                      |
| 30                  | 190       | 9                    |           |                      | 1         |         |           |              |                   |            |         |           |                      |                     |                 |              |                        |          |              |           |               |                                      |
| 25                  | 193       | 5                    | +         |                      | 1         |         |           |              |                   |            |         |           |                      |                     |                 |              |                        |          |              |           | +             |                                      |
| 20                  | 185       | 12                   |           |                      | 1         | 1       |           |              |                   | 1          |         |           |                      |                     |                 |              |                        |          |              |           |               |                                      |
| 15                  | 186       | 9                    | 1         |                      | +         |         |           |              |                   |            |         |           |                      |                     |                 |              |                        |          | 1            |           |               |                                      |
| 10                  | 190       | 6                    | 1         |                      |           |         |           |              |                   |            |         | 1         |                      |                     |                 |              |                        |          |              |           |               |                                      |
| 5                   | 188       | 10                   |           |                      |           |         |           |              |                   |            |         |           |                      |                     |                 |              |                        |          |              |           | +             |                                      |
| Floor Contact       | 187       | 10                   | 2         |                      | 1         |         |           |              |                   |            |         |           |                      |                     |                 |              |                        |          |              |           |               |                                      |
| Feature B, Column 2 |           |                      |           |                      |           |         |           |              |                   |            |         |           |                      |                     |                 |              |                        |          |              |           |               |                                      |
| 68                  | 96        | 47                   | 20        |                      | 17        | 5       |           | 2            |                   |            |         | +         |                      | 2                   |                 |              |                        | 2        |              |           |               |                                      |
| 65                  | 115       | 49                   | 6         |                      | 9         | 6       | 1         | 3            |                   |            |         | 1         |                      | 2                   |                 |              |                        |          |              |           |               |                                      |
| 60                  | 138       | 37                   | 2         |                      | 11        | 1       |           | 6            |                   |            |         |           |                      | +                   |                 |              |                        |          |              |           |               |                                      |
| 55                  | 164       | 24                   | +         |                      | 1         |         |           | 4            |                   |            |         |           | 1                    |                     |                 |              |                        |          |              |           |               |                                      |
| 50                  | 186       | 9                    |           |                      | 1         |         |           | 1            |                   |            |         |           |                      |                     |                 |              |                        |          |              |           | 1             |                                      |
| 45                  | 176       | 20                   | 1         |                      | 2         |         |           |              |                   |            |         |           |                      |                     |                 |              |                        |          |              |           |               |                                      |
| 40                  | 184       | 11                   | +         |                      | +         |         |           | 1            |                   |            |         |           |                      |                     |                 |              |                        |          |              |           |               |                                      |
| 35                  | 188       | 9                    | 1         |                      | +         |         |           |              |                   |            |         |           |                      |                     |                 |              |                        |          |              |           |               |                                      |
| 30                  | 193       | 7                    | +         |                      |           |         |           |              |                   |            |         |           |                      |                     |                 |              |                        |          |              | +         |               |                                      |
| 25                  | 189       | 9                    | 1         |                      | 1         | +       |           |              |                   |            |         |           |                      |                     |                 |              |                        |          |              |           |               |                                      |
| 20                  | 189       | 5                    |           | 1                    | +         |         |           | 3            |                   |            |         |           |                      |                     |                 |              |                        |          |              | 1         |               |                                      |
| 15                  | 184       | 10                   | 2         |                      | 2         |         |           |              |                   |            |         |           | 1                    |                     |                 |              |                        |          |              |           |               |                                      |
| 10                  | 182       | 13                   | 3         | +                    |           | +       |           | 1            |                   |            |         |           |                      |                     |                 |              |                        |          |              |           |               |                                      |
| 5                   | 184       | 8                    |           |                      | 4         |         |           |              |                   | 2          |         |           |                      |                     |                 |              |                        |          |              |           |               |                                      |
| Floor Contact       | 187       | 6                    | 2         | +                    | 3         |         |           | +            |                   |            |         |           |                      |                     |                 |              |                        |          |              |           |               |                                      |

Table 9 . Pollen Counts from Stratigraphic Columns, Miami Wash, Arizona, cont.

| Provenience                    | <u>Tidestromia</u> | <u>Tribulus</u> | <u>Acacia</u> | <u>Alnus</u> | <u>Canotia-type</u> | <u>Celtis</u> | <u>Cercidium</u> | <u>Cylindropuntia</u> | <u>Dodonaea</u> | <u>Ephedra nevadensis-type</u> | <u>Ephedra torreyana-type</u> | <u>Fraxinus</u> | <u>Leguminosae</u> | <u>Liliaceae</u> | <u>Pinus</u> | <u>Prosopis</u> | <u>Rosaceae</u> | <u>Sarcobatus</u> |
|--------------------------------|--------------------|-----------------|---------------|--------------|---------------------|---------------|------------------|-----------------------|-----------------|--------------------------------|-------------------------------|-----------------|--------------------|------------------|--------------|-----------------|-----------------|-------------------|
| Centimeters Above Floor        |                    |                 |               |              |                     |               |                  |                       |                 |                                |                               |                 |                    |                  |              |                 |                 |                   |
| Runway Ruin,<br>Arizona V:9:55 |                    |                 |               |              |                     |               |                  |                       |                 |                                |                               |                 |                    |                  |              |                 |                 |                   |
| Feature 1                      |                    |                 |               |              |                     |               |                  |                       |                 |                                |                               |                 |                    |                  |              |                 |                 |                   |
| 50                             |                    |                 | 7             | 1            |                     |               |                  | 1                     |                 | 1                              | +                             |                 | +                  |                  | 6            | 4               |                 |                   |
| 45                             |                    | 1               | 1             |              |                     |               |                  |                       | 1               | 1                              |                               |                 |                    |                  | 2            |                 |                 |                   |
| 40                             |                    |                 | +             |              |                     |               |                  | 1                     |                 | +                              |                               |                 |                    |                  | 2            |                 |                 |                   |
| 35                             |                    | +               |               |              |                     |               |                  |                       |                 | +                              |                               |                 |                    |                  | 1            |                 |                 |                   |
| 30                             |                    |                 |               |              |                     |               |                  | +                     |                 |                                |                               |                 |                    |                  | +            |                 |                 |                   |
| 25                             |                    | 1               |               |              |                     |               |                  |                       |                 |                                | 1                             |                 |                    |                  | +            |                 |                 |                   |
| 20                             |                    | 1               | +             |              |                     |               |                  |                       |                 |                                | 1                             |                 |                    |                  |              |                 |                 |                   |
| 15                             |                    |                 |               |              |                     |               |                  |                       |                 |                                |                               |                 |                    |                  | 1            |                 |                 |                   |
| 10                             |                    | 1               |               |              |                     |               |                  |                       |                 |                                |                               |                 |                    |                  | 1            |                 |                 |                   |
| 5                              |                    |                 |               |              |                     |               |                  |                       |                 |                                |                               |                 |                    |                  | 1            |                 |                 |                   |
| Floor Contact                  |                    |                 | 1             |              |                     |               |                  | +                     |                 |                                |                               |                 |                    |                  |              |                 |                 |                   |
| Feature 3                      |                    |                 |               |              |                     |               |                  |                       |                 |                                |                               |                 |                    |                  |              |                 |                 |                   |
| 45                             |                    | 1               | 7             |              |                     |               |                  |                       | 1               |                                | 1                             |                 | 5                  | 1                | 1            |                 | 2               |                   |
| 40                             |                    |                 | 6             | +            |                     |               |                  | 1                     |                 |                                | +                             |                 |                    | +                | 8            |                 | 2               |                   |
| 35                             |                    |                 |               |              |                     |               |                  |                       |                 |                                | +                             |                 |                    |                  | 1            |                 |                 | 1                 |
| 30                             |                    |                 |               |              |                     |               |                  |                       |                 | 1                              |                               |                 |                    |                  | +            |                 |                 |                   |
| 25                             |                    |                 |               |              |                     |               |                  |                       |                 |                                |                               |                 | +                  |                  | 1            |                 |                 |                   |
| 20                             |                    |                 |               |              |                     |               |                  |                       |                 |                                |                               |                 |                    |                  | 2            |                 |                 |                   |
| 15                             |                    |                 | 1             |              |                     |               |                  |                       |                 |                                |                               |                 |                    |                  | 3            |                 |                 |                   |

Table 9 . Pollen Counts from Stratigraphic Columns, Miami Wash, Arizona, cont.

| Provenience                | <u>Tidestromia</u> | <u>Tribulus</u> | <u>Acacia</u> | <u>Alnus</u> | <u>Canotia-type</u> | <u>Celtis</u> | <u>Cercidium</u> | <u>Cylindropuntia</u> | <u>Dodonaea</u> | <u>Ephedra nevadensis-type</u> | <u>Ephedra torreyana-type</u> | <u>Fraxinus</u> | <u>Leguminosae</u> | <u>Liliaceae</u> | <u>Pinus</u> | <u>Prosopis</u> | <u>Rosaceae</u> | <u>Sarcobatus</u> |
|----------------------------|--------------------|-----------------|---------------|--------------|---------------------|---------------|------------------|-----------------------|-----------------|--------------------------------|-------------------------------|-----------------|--------------------|------------------|--------------|-----------------|-----------------|-------------------|
| Centimeters Above Floor    |                    |                 |               |              |                     |               |                  |                       |                 |                                |                               |                 |                    |                  |              |                 |                 |                   |
| 10                         |                    | 2               |               |              |                     |               |                  |                       |                 | 1                              |                               |                 |                    |                  |              |                 |                 |                   |
| 5                          |                    |                 |               |              |                     |               |                  | +                     |                 |                                | 1                             |                 |                    |                  | +            |                 |                 |                   |
| Floor Contact              |                    |                 |               |              |                     |               |                  |                       |                 |                                |                               |                 |                    |                  |              |                 |                 |                   |
| Feature 5                  |                    |                 |               |              |                     |               |                  |                       |                 |                                |                               |                 |                    |                  |              |                 |                 |                   |
| 30                         |                    |                 |               |              |                     |               |                  |                       |                 | +                              |                               |                 |                    | +                | 1            |                 |                 |                   |
| 25                         |                    |                 | +             |              |                     |               |                  |                       |                 | 1                              |                               |                 |                    |                  | +            |                 |                 |                   |
| 20                         |                    |                 |               |              |                     |               |                  |                       |                 |                                |                               |                 |                    |                  |              |                 |                 |                   |
| 15                         |                    |                 |               |              |                     |               |                  |                       |                 |                                |                               |                 |                    |                  | +            |                 |                 |                   |
| 10                         |                    |                 |               |              |                     |               |                  |                       |                 | 1                              |                               |                 |                    |                  | 1            |                 |                 |                   |
| 5                          |                    |                 |               |              |                     |               |                  |                       |                 |                                |                               |                 |                    |                  | 1            |                 |                 |                   |
| Floor Contact              |                    |                 |               |              |                     |               |                  |                       |                 |                                |                               |                 |                    |                  | 1            |                 |                 |                   |
| Monitor,<br>Arizona V:9:56 |                    |                 |               |              |                     |               |                  |                       |                 |                                |                               |                 |                    |                  |              |                 |                 |                   |
| Feature 1                  |                    |                 |               |              |                     |               |                  |                       |                 |                                |                               |                 |                    |                  |              |                 |                 |                   |
| 40                         |                    |                 | 1             |              |                     |               |                  |                       |                 |                                |                               |                 |                    |                  |              |                 |                 |                   |
| 35                         |                    |                 | 2             |              |                     |               |                  |                       |                 | 1                              |                               |                 |                    |                  | +            |                 |                 |                   |
| 30                         |                    |                 |               |              |                     |               |                  |                       |                 |                                |                               |                 |                    |                  | 1            | 1               |                 |                   |
| 25                         |                    |                 | 1             |              |                     |               | 1                |                       |                 | +                              |                               |                 |                    |                  | +            |                 |                 |                   |
| 20                         |                    |                 | +             |              |                     |               |                  |                       |                 | 2                              |                               |                 |                    |                  | +            |                 |                 |                   |
| 15                         |                    |                 |               |              |                     |               |                  |                       |                 |                                |                               |                 |                    |                  | 1            |                 |                 |                   |

Table 9. Pollen Counts from Stratigraphic Columns, Miami Wash, Arizona, cont.

| Provenience                 | <u>Tidestromia</u> | <u>Tribulus</u> | <u>Acacia</u> | <u>Alnus</u> | <u>Canotia-type</u> | <u>Celtis</u> | <u>Cercidium</u> | <u>Cylindropuntia</u> | <u>Dodonaea</u> | <u>Ephedra</u><br><u>nevadensis-</u><br><u>type</u> | <u>Ephedra</u><br><u>torreyana-</u><br><u>type</u> | <u>Fraxinus</u> | <u>Leguminosae</u> | <u>Liliaceae</u> | <u>Pinus</u> | <u>Prosopis</u> | <u>Rosaceae</u> | <u>Sarcobatus</u> |
|-----------------------------|--------------------|-----------------|---------------|--------------|---------------------|---------------|------------------|-----------------------|-----------------|---|--|-----------------|--------------------|------------------|--------------|-----------------|-----------------|-------------------|
| Centimeters<br>Above Floor  |                    |                 |               |              |                     |               |                  |                       |                 |   |  |                 |                    |                  |              |                 |                 |                   |
| 10                          |                    |                 |               |              |                     |               |                  |                       |                 | 1   |  |                 |                    |                  |              |                 |                 |                   |
| 5                           |                    |                 |               |              |                     |               |                  |                       |                 |   |  |                 |                    |                  |              |                 |                 |                   |
| Floor Contact               |                    | +               |               |              |                     |               |                  |                       |                 |   |  |                 |                    |                  | +            |                 |                 |                   |
| Feature 3                   |                    |                 |               |              |                     |               |                  |                       |                 |   |  |                 |                    |                  |              |                 |                 |                   |
| 25                          |                    |                 |               |              |                     |               |                  |                       |                 |   |  |                 |                    | +                |              |                 |                 |                   |
| 20                          |                    | 1               |               |              |                     |               |                  |                       |                 |   |  |                 |                    |                  |              |                 |                 |                   |
| 15                          |                    | +               |               |              |                     |               |                  |                       |                 |   |  |                 | 1                  |                  |              |                 |                 | 2                 |
| 10                          |                    |                 |               |              |                     |               |                  |                       |                 |   | +  |                 |                    |                  | 1            |                 |                 |                   |
| 5                           |                    |                 |               |              |                     |               |                  | 2                     |                 |   |  |                 | +                  |                  | 1            |                 |                 |                   |
| Floor Contact               |                    | +               |               |              |                     |               |                  |                       |                 | 1   | +  |                 |                    |                  | 1            |                 |                 |                   |
| Columbus,<br>Arizona V:9:57 |                    |                 |               |              |                     |               |                  |                       |                 |   |  |                 |                    |                  |              |                 |                 |                   |
| Feature 1                   |                    |                 |               |              |                     |               |                  |                       |                 |   |  |                 |                    |                  |              |                 |                 |                   |
| 45                          |                    |                 |               |              |                     |               |                  | +                     |                 |   |  |                 |                    |                  | +            |                 |                 |                   |
| 40                          |                    |                 |               |              |                     |               |                  |                       |                 |   |  |                 |                    |                  | +            |                 |                 |                   |
| 35                          |                    | +               | 1             |              |                     |               |                  |                       |                 |   | +  |                 | 1                  |                  | +            |                 |                 |                   |
| 30                          |                    |                 |               |              |                     |               |                  |                       |                 | 1   |  |                 |                    |                  | +            |                 |                 |                   |
| 25                          |                    |                 |               |              |                     |               |                  |                       |                 |   |  |                 |                    |                  |              |                 |                 |                   |
| 20                          |                    |                 |               |              |                     |               |                  |                       |                 | 1   |  |                 |                    |                  | +            |                 |                 |                   |
| 15                          |                    |                 |               |              |                     |               |                  |                       |                 |   |  |                 |                    |                  | +            |                 |                 |                   |
| 10                          |                    |                 |               |              |                     |               |                  |                       |                 | +   |  |                 |                    |                  | 1            |                 |                 |                   |

Table 9 . Pollen Counts from Stratigraphic Columns, Miami Wash, Arizona, cont.

| Provenience                | <u>Tidestromia</u> | <u>Tribulus</u> | <u>Acacia</u> | <u>Alnus</u> | <u>Canotia-type</u> | <u>Celtis</u> | <u>Cercidium</u> | <u>Cylindropuntia</u> | <u>Dodonaea</u> | <u>Ephedra nevadensis-type</u> | <u>Ephedra torreyana-type</u> | <u>Fraxinus</u> | <u>Leguminosae</u> | <u>Liliaceae</u> | <u>Pinus</u> | <u>Prosopis</u> | <u>Rosa ceae</u> | <u>Sarcobatus</u> |
|----------------------------|--------------------|-----------------|---------------|--------------|---------------------|---------------|------------------|-----------------------|-----------------|--------------------------------|-------------------------------|-----------------|--------------------|------------------|--------------|-----------------|------------------|-------------------|
| 5                          |                    |                 |               |              |                     |               |                  |                       |                 | 1                              |                               |                 |                    |                  |              |                 |                  |                   |
| Floor #2 Contact           |                    |                 |               |              |                     |               |                  |                       |                 | +                              |                               |                 |                    |                  |              |                 |                  |                   |
| Feature 6                  |                    |                 |               |              |                     |               |                  |                       |                 |                                |                               |                 |                    |                  |              |                 |                  |                   |
| 30                         |                    | +               | 1             |              |                     |               |                  |                       |                 |                                |                               | 1               |                    |                  |              |                 |                  |                   |
| 25                         |                    |                 |               |              |                     |               |                  |                       |                 |                                |                               |                 |                    | +                |              |                 |                  |                   |
| 20                         |                    | +               |               |              |                     |               | +                |                       |                 | +                              | +                             |                 |                    |                  | +            |                 |                  |                   |
| 15                         |                    |                 |               |              |                     |               | 1                |                       |                 | +                              |                               |                 |                    |                  | +            |                 |                  |                   |
| 10                         |                    |                 |               |              |                     |               |                  |                       |                 | +                              |                               |                 |                    |                  | +            |                 |                  |                   |
| 5                          |                    |                 |               |              |                     |               |                  |                       |                 | 1                              |                               |                 | 1                  |                  | +            |                 |                  |                   |
| Floor #2 Contact           |                    |                 |               |              |                     |               |                  |                       |                 |                                | +                             |                 |                    |                  |              |                 |                  |                   |
| Refugia, Arizona V:9:59    |                    |                 |               |              |                     |               |                  |                       |                 |                                |                               |                 |                    |                  |              |                 |                  |                   |
| Feature 1                  |                    |                 |               |              |                     |               |                  |                       |                 |                                |                               |                 |                    |                  |              |                 |                  |                   |
| 25                         |                    |                 |               | 1            | 4                   | 1             | 1                |                       |                 | +                              | 2                             | 3               |                    | +                | 4            | 16              | +                |                   |
| 20                         |                    | 1               |               | 1            | 5                   |               | 1                |                       |                 |                                |                               | 1               |                    |                  | 6            | 2               | 1                |                   |
| 15                         |                    |                 |               | 1            |                     |               |                  |                       |                 | +                              | 2                             |                 |                    | 1                | 2            |                 |                  |                   |
| 10                         |                    |                 |               | 3            | 1                   |               |                  |                       |                 | 1                              |                               |                 |                    | 1                | +            |                 | 1                |                   |
| 5                          |                    |                 |               | 2            | 2                   |               |                  |                       |                 |                                | 1                             |                 |                    | 5                | 1            |                 |                  |                   |
| Floor #2 Contact           |                    |                 |               |              |                     |               |                  |                       |                 | 4                              |                               |                 |                    |                  | 2            |                 |                  |                   |
| Multigrade, Arizona V:9:60 |                    |                 |               |              |                     |               |                  |                       |                 |                                |                               |                 |                    |                  |              |                 |                  |                   |
| Feature 2                  |                    |                 |               |              |                     |               |                  |                       |                 |                                |                               |                 |                    |                  |              |                 |                  |                   |
| 30                         |                    | 1               |               |              |                     |               |                  |                       |                 |                                |                               |                 |                    |                  | +            |                 |                  |                   |
| 25                         |                    |                 |               |              |                     |               |                  |                       |                 |                                |                               |                 |                    |                  |              |                 |                  |                   |
| 20                         |                    |                 |               |              |                     |               |                  |                       |                 |                                |                               |                 |                    |                  |              |                 |                  |                   |
| 15                         |                    |                 |               |              |                     |               |                  |                       |                 |                                |                               |                 |                    |                  | 1            |                 |                  |                   |

Table 9. Pollen Counts from Stratigraphic Columns, Miami Wash, Arizona, cont.

| Provenience                | <u>Tidestromia</u> | <u>Tribulus</u> | <u>Acacia</u> | <u>Alnus</u> | <u>Canotia-type</u> | <u>Celtis</u> | <u>Cercidium</u> | <u>Cylindropuntia</u> | <u>Dodonea</u> | <u>Ephedra</u><br><u>nevadensis-</u><br><u>type</u> | <u>Ephedra</u><br><u>torreyana-</u><br><u>type</u> | <u>Fraxinus</u> | <u>Leguminosae</u> | <u>Liliaceae</u> | <u>Pinus</u> | <u>Prosopis</u> | <u>Rosaceae</u> | <u>Sarcobatus</u> |
|----------------------------|--------------------|-----------------|---------------|--------------|---------------------|---------------|------------------|-----------------------|----------------|---|--|-----------------|--------------------|------------------|--------------|-----------------|-----------------|-------------------|
| Centimeters<br>Above Floor |                    |                 |               |              |                     |               |                  |                       |                |   |  |                 |                    |                  |              |                 |                 |                   |
| 10                         |                    |                 |               |              |                     |               |                  |                       |                |   |  |                 |                    |                  |              |                 |                 |                   |
| 5                          |                    |                 |               |              |                     |               |                  | +                     |                |   |  |                 |                    |                  | +            |                 |                 |                   |
| Floor Contact              |                    |                 |               |              |                     |               |                  |                       |                |   | 1  |                 |                    |                  |              |                 |                 |                   |
| Feature 9                  |                    |                 |               |              |                     |               |                  |                       |                |   |  |                 |                    |                  |              |                 |                 |                   |
| 75                         |                    |                 |               |              |                     |               |                  | +                     |                | +   | +  |                 |                    |                  | +            |                 |                 |                   |
| 65                         |                    |                 |               |              |                     |               |                  |                       |                | +   | 1  |                 |                    |                  |              |                 |                 |                   |
| 55                         |                    |                 |               |              |                     |               |                  |                       |                |   |  |                 |                    |                  | 1            |                 |                 |                   |
| 45                         |                    |                 |               |              |                     |               |                  |                       |                |   | 1  |                 |                    |                  |              |                 |                 |                   |
| 35                         |                    |                 |               |              |                     |               |                  |                       |                |   | 1  |                 | 1                  |                  | +            |                 |                 |                   |
| 25                         |                    | 1               |               |              |                     |               |                  | 1                     |                | +   |  |                 |                    |                  | +            |                 |                 |                   |
| 15                         |                    |                 |               |              |                     |               |                  |                       |                | +   |  |                 | 1                  |                  | 1            |                 |                 |                   |
| 5                          |                    |                 |               |              |                     |               |                  |                       |                |   |  |                 |                    |                  |              |                 |                 |                   |
| Tinhorn,<br>Arizona V:9:62 |                    |                 |               |              |                     |               |                  |                       |                |   |  |                 |                    |                  |              |                 |                 |                   |
| Feature 10                 |                    |                 |               |              |                     |               |                  |                       |                | +   |  |                 |                    |                  |              |                 |                 |                   |
| 28                         |                    |                 |               |              |                     |               |                  |                       |                |   | 1  |                 |                    |                  |              |                 |                 |                   |
| 25                         |                    |                 |               |              |                     |               |                  |                       |                |   |  |                 |                    |                  |              |                 |                 |                   |
| 20                         |                    |                 | 2             |              |                     |               |                  |                       |                | 1   |  |                 |                    |                  |              |                 |                 |                   |
| 15                         |                    |                 |               |              |                     |               |                  |                       |                |   |  |                 |                    |                  |              |                 |                 |                   |
| 10                         |                    |                 |               |              |                     |               |                  |                       |                |   |  |                 |                    |                  |              |                 |                 |                   |
| 5                          | 1                  |                 |               |              |                     |               |                  |                       |                | +   |  |                 |                    |                  |              |                 |                 |                   |
| Floor Contact              |                    |                 |               |              | 1                   |               | 1                |                       |                |   |  |                 |                    |                  | 1            |                 |                 |                   |
| -4                         |                    |                 |               |              |                     | 1             |                  |                       |                |   |  |                 |                    |                  |              |                 |                 |                   |

Table 9 . Pollen Counts from Stratigraphic Columns, Miami Wash, Arizona, cont.

| Provenience                               | <u>Tidestromia</u> | <u>Tribulus</u> | <u>Acacia</u> | <u>Alnus</u> | <u>Canotia-type</u> | <u>Celtis</u> | <u>Cercidium</u> | <u>Cylindropuntia</u> | <u>Dodonaea</u> | <u>Ephedra</u><br><u>nevadensis-</u><br><u>type</u> | <u>Ephedra</u><br><u>torreyana-</u><br><u>type</u> | <u>Fraxinus</u> | <u>Leguminosae</u> | <u>Liliaceae</u> | <u>Pinus</u> | <u>Prosopis</u> | <u>Rosaceae</u> | <u>Sarcobatus</u> |
|---|--------------------|-----------------|---------------|--------------|---------------------|---------------|------------------|-----------------------|-----------------|---|--|-----------------|--------------------|------------------|--------------|-----------------|-----------------|-------------------|
| East Ruin,<br>Arizona V:9:58<br>Feature A |                    |                 |               |              |                     |               |                  |                       |                 |   |  |                 |                    |                  |              |                 |                 |                   |
| 65  |                    |                 |               |              |                     |               |                  |                       |                 | 1   |  |                 |                    |                  | 1            |                 |                 |                   |
| 60  |                    |                 |               |              |                     |               |                  |                       |                 |   |  |                 |                    |                  | +            |                 |                 |                   |
| 55  | 1                  |                 |               |              |                     |               |                  |                       |                 | 1   | 1  |                 |                    |                  | 1            |                 |                 |                   |
| 50  |                    |                 |               |              |                     |               |                  | +                     |                 | +   |  |                 |                    |                  | 1            |                 |                 |                   |
| 45  |                    |                 |               |              |                     |               |                  | 1                     |                 |   |  |                 | +                  |                  |              |                 |                 |                   |
| 40  |                    |                 |               |              |                     |               |                  | +                     |                 | 1   |  |                 |                    |                  | +            |                 |                 |                   |
| 35  |                    |                 |               |              |                     |               |                  |                       |                 |   |  |                 |                    |                  |              |                 |                 |                   |
| 30  |                    |                 |               |              |                     |               |                  | 1                     |                 |   | +  |                 |                    |                  |              |                 |                 |                   |
| 25  |                    |                 |               |              |                     |               |                  | 1                     |                 | 1   |  |                 |                    |                  | +            |                 |                 |                   |
| 20  |                    |                 |               |              |                     |               |                  |                       |                 |   | +  |                 |                    |                  | 1            |                 |                 |                   |
| 15  |                    |                 |               |              |                     |               |                  | 1                     |                 |   |  |                 |                    |                  |              |                 |                 |                   |
| 10  |                    |                 |               |              |                     |               |                  | +                     |                 |   |  |                 |                    |                  | +            |                 |                 |                   |
| 5   |                    |                 |               |              |                     |               |                  | +                     |                 |   |  |                 |                    |                  |              |                 |                 |                   |
| Floor Contact                             |                    |                 |               |              |                     |               |                  |                       |                 |   |  |                 |                    |                  | +            |                 |                 |                   |
| Feature B, Column 1                       |                    |                 |               |              |                     |               |                  |                       |                 |   |  |                 |                    |                  |              |                 |                 |                   |
| 65  | 2                  |                 | +             |              |                     |               |                  |                       |                 | +   | 1  |                 |                    |                  | 10           | 2               | 1               |                   |
| 60  | 2                  |                 | +             |              |                     |               |                  | 1                     |                 | 1   | +  |                 |                    |                  | 14           |                 |                 |                   |
| 55  | 6                  |                 |               |              |                     |               |                  | +                     |                 | +   |  |                 |                    | 1 1              | 9            |                 |                 |                   |
| 50  | 1                  |                 | +             |              |                     |               |                  | +                     |                 | +   | +  |                 |                    |                  | 4            |                 |                 |                   |
| 45  | 2                  |                 |               |              |                     |               |                  |                       |                 | 1   |  |                 |                    |                  | 6            |                 |                 |                   |
| 40  | +                  |                 |               |              |                     |               |                  |                       |                 |   |  |                 |                    |                  | 13           |                 |                 |                   |

Table 9. Pollen Counts from Stratigraphic Columns, Miami Wash, Arizona, cont.

| Provenience         | <u>Tidestromia</u> | <u>Tribulus</u> | <u>Acacia</u> | <u>Alnus</u> | <u>Canotia-type</u> | <u>Celtis</u> | <u>Cercidium</u> | <u>Cylindropuntia</u> | <u>Dodonaea</u> | <u>Ephedra nevadensis-type</u> | <u>Ephedra torreyana-type</u> | <u>Fraxinus</u> | <u>Leguminosae</u> | <u>Liliaceae</u> | <u>Pinus</u> | <u>Prosopis</u> | <u>Rosaceae</u> | <u>Sarcobatus</u> |
|---------------------|--------------------|-----------------|---------------|--------------|---------------------|---------------|------------------|-----------------------|-----------------|--------------------------------|-------------------------------|-----------------|--------------------|------------------|--------------|-----------------|-----------------|-------------------|
| 35                  |                    |                 |               |              |                     |               |                  | +                     |                 |                                |                               |                 |                    |                  | 1            |                 |                 |                   |
| 30                  |                    |                 |               |              |                     |               |                  |                       |                 |                                |                               |                 |                    |                  | 1            |                 |                 |                   |
| 25                  |                    |                 |               |              |                     |               |                  |                       |                 |                                |                               |                 |                    |                  | 1            |                 |                 |                   |
| 20                  |                    |                 |               |              |                     |               |                  | +                     |                 |                                |                               |                 |                    |                  | 1            |                 |                 |                   |
| 15                  |                    |                 |               |              |                     |               |                  | 1                     |                 | 1                              |                               |                 |                    |                  | +            |                 |                 |                   |
| 10                  |                    |                 |               |              |                     |               |                  |                       |                 |                                |                               |                 |                    |                  |              |                 |                 |                   |
| 5                   |                    |                 |               |              |                     |               |                  | 2                     |                 |                                | +                             |                 |                    |                  |              |                 |                 |                   |
| Floor Contact       |                    |                 |               |              |                     |               |                  | +                     |                 | +                              |                               |                 |                    |                  | 1            |                 |                 |                   |
| Feature B, Column 2 |                    |                 |               |              |                     |               |                  |                       |                 |                                |                               |                 |                    |                  |              |                 |                 |                   |
| 68                  | 1                  |                 | 1             |              |                     |               |                  |                       | +               | +                              | 1                             |                 | 1                  |                  | 3            | +               | 2               |                   |
| 65                  | 4                  |                 | 1             |              |                     |               |                  | +                     |                 | +                              |                               |                 |                    |                  | 3            |                 |                 |                   |
| 60                  | 3                  |                 |               |              |                     |               |                  | +                     |                 |                                |                               |                 |                    |                  | 1            |                 |                 |                   |
| 55                  | 5                  |                 |               |              |                     |               |                  |                       |                 |                                | +                             |                 |                    |                  | +            |                 |                 |                   |
| 50                  | 1                  |                 |               |              |                     |               |                  |                       |                 |                                |                               |                 |                    |                  | 1            |                 |                 |                   |
| 45                  | 1                  |                 |               |              |                     |               |                  | +                     |                 |                                |                               |                 |                    |                  |              |                 |                 |                   |
| 40                  |                    |                 |               |              |                     |               |                  |                       |                 | +                              |                               |                 |                    |                  | 3            |                 | 1               |                   |
| 35                  | 2                  |                 |               |              |                     |               |                  |                       |                 |                                |                               |                 |                    |                  | +            |                 |                 |                   |
| 30                  |                    |                 |               |              |                     |               |                  |                       |                 |                                |                               |                 |                    |                  |              |                 |                 |                   |
| 25                  |                    |                 |               |              |                     |               |                  |                       |                 | +                              |                               |                 |                    |                  | +            |                 |                 |                   |
| 20                  |                    |                 |               |              |                     |               |                  | +                     |                 |                                |                               |                 |                    |                  | 1            |                 |                 |                   |
| 15                  |                    |                 |               |              |                     |               |                  |                       |                 |                                |                               |                 |                    |                  | 1            |                 |                 |                   |
| 10                  |                    |                 |               |              |                     |               |                  | 1                     |                 |                                |                               |                 |                    |                  | +            | +               |                 |                   |
| 5                   |                    |                 |               |              |                     |               |                  |                       |                 |                                |                               |                 | 1                  |                  | 1            |                 |                 |                   |
| Floor Contact       |                    |                 |               |              |                     |               |                  |                       |                 | +                              | +                             |                 |                    |                  | 2            |                 |                 |                   |



Table 9. Pollen Counts from Stratigraphic Columns, Miami Wash, Arizona, cont.

| Provenience                    | <u>Salix</u> | <u>Simmondsia</u> | <u>cf. Rhus</u> | <u>Eriastrum</u> | <u>Plantago</u> | <u>Scrophulariaceae</u> | <u>cf. Condalia</u> | <u>Cereus</u> | <u>cf. Linaris</u> | <u>Krameria</u> | <u>Rhamnus</u> | <u>cf. Ranunculus</u> | <u>cf. Vicia</u> | <u>Platyopuntia</u> |
|--------------------------------|--------------|-------------------|-----------------|------------------|-----------------|-------------------------|---------------------|---------------|--------------------|-----------------|----------------|-----------------------|------------------|---------------------|
| Centimeters Above Floor        |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| Runway Ruin,<br>Arizona V:9:55 |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| Feature 1                      |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 50                             |              |                   | 1               | +                |                 |                         |                     |               |                    |                 |                |                       | +                |                     |
| 45                             |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 40                             |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 35                             |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 30                             |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 25                             |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 20                             |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 15                             |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 10                             |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 5                              |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| Floor Contact                  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| Feature 3                      |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 45                             |              | 2                 | 5               |                  |                 | 1                       |                     |               |                    |                 |                |                       |                  |                     |
| 40                             |              |                   |                 |                  |                 |                         | 2                   |               |                    |                 |                |                       |                  |                     |
| 35                             |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 30                             |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 25                             |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 20                             |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 15                             |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |

Table 9 . Pollen Counts from Stratigraphic Columns, Miami Wash, Arizona, cont.

| Provenience                | <u>Salix</u> | <u>Simmondsia</u> | <u>cf. Rhus</u> | <u>Eriastrum</u> | <u>Plantago</u> | <u>Scrophulariaceae</u> | <u>cf. Condalia</u> | <u>Cereus</u> | <u>cf. Linaris</u> | <u>Krameria</u> | <u>Rhamnus</u> | <u>cf. Ranunculus</u> | <u>cf. Vicia</u> | <u>Platyopuntia</u> |
|----------------------------|--------------|-------------------|-----------------|------------------|-----------------|-------------------------|---------------------|---------------|--------------------|-----------------|----------------|-----------------------|------------------|---------------------|
| Centimeters<br>Above Floor |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 10                         |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 5                          |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| Floor Contact              |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| Feature 5                  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 30                         |              | 1                 |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 25                         |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 20                         |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 15                         |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 10                         |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 5                          |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| Floor Contact              |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| Monitor,<br>Arizona V:9:56 |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| Feature 1                  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 40                         |              |                   | +               |                  |                 |                         | +                   |               |                    |                 |                |                       |                  |                     |
| 35                         |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 30                         |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 25                         |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 20                         |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 15                         |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |

Table 9. Pollen Counts from Stratigraphic Columns, Miami Wash, Arizona, cont.

| Provenience    | <u>Salix</u> | <u>Simmondsia</u> | <u>cf. Rhus</u> | <u>Eriastrum</u> | <u>Plantago</u> | <u>Scrophulariaceae</u> | <u>cf. Condalia</u> | <u>Cereus</u> | <u>cf. Linaris</u> | <u>Krameria</u> | <u>Rhamnus</u> | <u>cf. Ranunculus</u> | <u>cf. Vicia</u> | <u>Platyopuntia</u> |
|----------------|--------------|-------------------|-----------------|------------------|-----------------|-------------------------|---------------------|---------------|--------------------|-----------------|----------------|-----------------------|------------------|---------------------|
| Centimeters    |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| Above Floor    |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 10             |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 5              |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| Floor Contact  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| Feature 3      |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 25             |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 20             |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 15             |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 10             |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 5              |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| Floor Contact  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| Columbus,      |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| Arizona V:9:57 |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| Feature 1      |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 45             |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 40             |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 35             |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 30             |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 25             |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 20             |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 15             |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 10             |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |

Table 9 . Pollen Counts from Stratigraphic Columns, Miami Wash, Arizona, cont.

| Provenience                | <u>Salix</u> | <u>Simmondsia</u> | <u>cf. Rhus</u> | <u>Eriastrum</u> | <u>Plantago</u> | <u>Scrophulariaceae</u> | <u>cf. Condalia</u> | <u>Cereus</u> | <u>cf. Linaris</u> | <u>Krameria</u> | <u>Rhamnus</u> | <u>cf. Ranunculus</u> | <u>cf. Vicia</u> | <u>Platyopuntia</u> |
|----------------------------|--------------|-------------------|-----------------|------------------|-----------------|-------------------------|---------------------|---------------|--------------------|-----------------|----------------|-----------------------|------------------|---------------------|
| Centimeters                |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| Above Floor                |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 5                          |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| Floor #2 Contact           |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| Feature 6                  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 30                         |              |                   | +               |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 25                         |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 20                         |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 15                         |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 10                         |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 5                          |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| Floor #2 Contact           |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| Refugia, Arizona V:9:59    |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| Feature 1                  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 25                         |              |                   | +               |                  |                 |                         |                     |               |                    | +               |                |                       |                  |                     |
| 20                         |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 15                         |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 10                         |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 5                          |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| Floor #2 Contact           |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| Multigrade, Arizona V:9:60 |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| Feature 2                  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 30                         |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 25                         |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 20                         |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 15                         |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |

Table 9. Pollen Counts from Stratigraphic Columns, Miami Wash, Arizona, cont.

| Provenience                | <u>Salix</u> | <u>Simmondsia</u> | <u>cf. Rhus</u> | <u>Eriastrum</u> | <u>Plantago</u> | <u>Scrophulariaceae</u> | <u>cf. Conzalia</u> | <u>Cereus</u> | <u>cf. Linaris</u> | <u>Krameria</u> | <u>Rhamnus</u> | <u>cf. Ranunculus</u> | <u>cf. Vicia</u> | <u>Platyopuntia</u> |
|----------------------------|--------------|-------------------|-----------------|------------------|-----------------|-------------------------|---------------------|---------------|--------------------|-----------------|----------------|-----------------------|------------------|---------------------|
| Centimeters<br>Above Floor |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 10                         |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 5                          |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| Floor Contact              |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| Feature 9                  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 75                         |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 65                         |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 55                         |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 45                         |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 35                         |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 25                         |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 15                         |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 5                          |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| Tinhorn,<br>Arizona V:9:62 |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| Feature 10                 |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 28                         |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 25                         |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 20                         |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 15                         |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 10                         |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 5                          |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| Floor Contact              |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| -4                         |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |

Table 9 . Pollen Counts from Stratigraphic Columns, Miami Wash, Arizona, cont.

| Provenience         | <u>Salix</u> | <u>Simmondsia</u> | <u>cf. Rhus</u> | <u>Eriastrum</u> | <u>Plantago</u> | <u>Scrophulariaceae</u> | <u>cf. Condalia</u> | <u>Cereus</u> | <u>cf. Linaris</u> | <u>Krameria</u> | <u>Rhamnus</u> | <u>cf. Ranunculus</u> | <u>cf. Vicia</u> | <u>Platyopuntia</u> |
|---------------------|--------------|-------------------|-----------------|------------------|-----------------|-------------------------|---------------------|---------------|--------------------|-----------------|----------------|-----------------------|------------------|---------------------|
| Centimeters         |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| Above Floor         |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| East Ruin,          |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| Arizona, V:9:58     |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| Feature A           |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 65                  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 60                  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 55                  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 50                  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 45                  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 40                  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 35                  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 30                  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 25                  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 20                  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 15                  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 10                  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 5                   |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| Floor Contact       |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| Feature B, Column 1 |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 65                  |              |                   |                 |                  |                 |                         |                     |               |                    |                 | 1              |                       |                  |                     |
| 60                  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                | 1                     | +                |                     |
| 55                  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  | 1                   |
| 50                  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 45                  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 40                  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
|                     |              | 2                 |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
|                     |              | +                 |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |

Table 9 . Pollen Counts from Stratigraphic Columns, Miami Wash, Arizona, cont.

| Provenience         | <u>Salix</u> | <u>Simmondsia</u> | <u>cf. Rhus</u> | <u>Eriastrum</u> | <u>Plantago</u> | <u>Scrophulariaceae</u> | <u>cf. Condalia</u> | <u>Cereus</u> | <u>cf. Linaris</u> | <u>Krameria</u> | <u>Rhamnus</u> | <u>cf. Ranunculus</u> | <u>cf. Vicia</u> | <u>Platyopuntia</u> |
|---------------------|--------------|-------------------|-----------------|------------------|-----------------|-------------------------|---------------------|---------------|--------------------|-----------------|----------------|-----------------------|------------------|---------------------|
| Centimeters         |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| Above Floor         |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 35                  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 30                  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 25                  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 20                  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 15                  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 10                  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 5                   |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| Floor Contact       |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| Feature B, Column 2 |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 68                  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 65                  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 60                  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 55                  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 50                  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 45                  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 40                  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 35                  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 30                  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 25                  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 20                  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 15                  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 10                  |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| 5                   |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |
| Floor Contact       |              |                   |                 |                  |                 |                         |                     |               |                    |                 |                |                       |                  |                     |

It might be helpful to examine some individual cheno-am profiles in order to better understand the complexities involved. At Runway, Arizona V:9:55, three stratigraphic columns were collected from features 1, 3, and 5. All of the profiles in these features have three cheno-am peaks, but feature 1 has a maximum on the floor, feature 2 has a maximum at 10 centimeters above the floor, and in feature 3 the maximum is near the surface. At Multigrade, Arizona V:9:60, features 2 and 9 have, respectively, two and one peaks of cheno-ams. The profiles from feature B in East Ruin, Arizona V:9:68, are especially instructive because they were taken about one meter apart in the same structure. Even here, localized differences are apparent. Columns B<sup>1</sup> and B<sup>2</sup> have maxima of cheno-ams at, respectively, 45 and 50 centimeters, above the floor. In column B<sup>1</sup>, the cheno-ams increase again at the surface, while in B<sup>2</sup> there is a continuous decline. Considering the close proximity of these columns, such differences are surprising.

Additional differences are apparent in the profiles for Ambrosia-type and arboreal pollen types. The number of peaks for Ambrosia-types varies from two to four (East Ruin, Feature A has six peaks, but the variation between peaks and troughs is small and probably not significant) and the placement of the maxima varies from 5 centimeters above the floor to surface contact. The changes in the arboreal pollen profiles are of lower magnitude than the previously mentioned types, yet some differences are apparent. While most of



the profiles have one obvious peak, two profiles have two peaks that are above 5 percent.

Though there are other dissimilarities among the profiles the ones mentioned above are most readily apparent and sufficient for discussion.

Interpretation and Discussion. The data support both the prediction and the hypothesis that the pollen rain in the stratigraphic columns does not predominantly reflect climatic change. The pollen profiles vary both within and between sites and appear to be quite individualized.

Previously, three factors other than climatic change were suggested as possible contributors to the pollen found in the stratigraphic columns. Is it possible to decide which factor or factors in any one profile or part of a profile is dominant?

Feature 2 at Multigrade, Arizona V:9:60, and Feature 10 at Tinhorn Wash, Arizona V:9:62, contained cultural trash in a large part of the fill (Doyel, personal communication). The trash could have been washed in, or the house may have served as a garbage dump during site occupation. The pollen profiles must reflect this disturbance.

The possibility that pollen from eroded house walls could be mixed with post-occupational pollen deposition was recognized prior to excavation. An attempt was made to minimize this effect by establishing the stratigraphic columns in the center of the floors. It was hoped that wall fall would be concentrated at the perimeter of the room,

leaving the center clear. It is not possible at this time to make an accurate estimate of the actual effect of the wall fall. In the future it would be advisable to collect a pollen sample from any identifiable wall material in order to get some idea of what pollen types and frequencies it is contributing to the pollen deposition.

If cheno-ams are the plants favored by disturbance in this area, then they should be replaced by a more natural pollen rain after site abandonment. Thus the cheno-am pollen frequency should decrease and the other non-cultural pollen types rise as one proceeds from the floor to the surface.

Trees and shrubs (arboreal plants) may have been gathered for firewood or used in building houses. This would result in a reduction in the number of trees and shrubs, and a complementary reduction in their pollen frequencies. Upon abandonment of a site, the arboreal pollen types should increase.

A decrease of cheno-am pollen in samples above the floor appears in eight of the fourteen samples, but there are subsequent increases of cheno-ams in most of them. Final decreases in cheno-ams close to the surface appear in ten of the samples. Increases in arboreal types are most evident toward the surface, i.e., in the top 10 to 15 centimeters of the columns. I might conclude that in the samples from Miami Wash the effect of plant succession is most apparent close to the surface, though no definitive evidence is present.

Lithologic differences could also have an effect on local depositional patterns. Five of the sites exist on the same rock type,

Gila conglomerate. This should minimize local lithologic factors, but the conglomerate is variable, and some local effect cannot be discounted. Four of the sites, two of which have pollen samples collected from stratigraphic columns, are on diabase bedrock. Some variational effect between the diabase and the conglomerate might be present. Investigation on a micro-environmental scale may thus prove fruitful.

Slope variability is another factor which affects local erosion and deposition. Increased slope will increase the ability (capacity and capability) of rain water to carry its sediment load. The sediment size analysis, to be discussed, may also be pertinent here. In any case, more intensive investigation is necessary.

With reference to the effect of climatic change on the pollen rain, some independent indicator with which to compare the pollen record is required. There are no complete tree-ring records available for the Miami Wash area, nor is the stratigraphic control tight enough for comparative analysis of dendroclimatic with palynologic data. Another independent indicator of climate which is associated with the stratigraphy is needed. Theoretically, sediment deposited in pit-house floors should reflect precipitation or available moisture, as well as surrounding vegetation after abandonment. Such sediment would probably be transported as sheet-wash (Hadley and Schumm 1961:144), "...the removal of soil and weathered rock material as a thin sheet by surface flow that is not concentrated in well-defined channels" or in rivulets of varying size (Haynes, personal communication). The quantity of water in sheet-wash appears to be controlled primarily by

vegetation--in terms of both type of cover and density--and secondarily by sediment characteristics such as grain size and infiltration capacities (Hadley and Schumm 1961). The sizes of sediment affected are not apparently known, because little research on present rates of erosion and deposition has been done. LaMarche (1968:341) states: "Despite the importance in comparing past with present rates of soil erosion, natural rates of slope degradation during the past several thousand years are little known." The sediment sizes commonly found in the samples that are most affected by changes in flow in streams and rivers are gravel and clay sizes. It is assumed that these are the sizes affected by changes in sheet-wash and rivulet flow. If both sediment size and pollen frequency are dependent on available water and vegetation, then there should be a statistically significant relationship, whether direct or inverse, in their changes in relative frequencies. Data are in Figure 7 (in pocket).

Samples from the stratigraphic columns which contained sufficient sediment for sieving after pollen analysis were placed in nested sieves in a Ro-tap machine and sieved for 10 minutes. the sieve sizes used were:

|      |   |   |       |                         |
|------|---|---|-------|-------------------------|
| -1.5 | ø | = | 2.828 | mm                      |
| -1.0 | ø | = | 2.00  | mm                      |
| -0.5 | ø | = | 1.414 | mm                      |
| 0    | ø | = | 1.00  | mm                      |
| 1.0  | ø | = | 0.50  | mm                      |
| 1.5  | ø | = | 0.345 | mm                      |
| 2.0  | ø | = | 0.250 | mm                      |
| 2.5  | ø | = | 0.177 | mm                      |
| 3.0  | ø | = | 0.125 | mm                      |
| 3.5  | ø | = | 0.088 | mm                      |
| 4.0  | ø | = | 0.088 | mm = silt and clay size |

Using the Spearman Rank Correlation Coefficient test, relative frequencies of sediment sizes greater than or equal to 2.828 millimeters and less than 0.88 millimeters in samples from stratigraphic columns were compared individually with relative frequencies of cheno-ams, other non-arboreal pollen types (NAP's) and arboreal pollen types (AP's).

#### Spearman's Coefficient of Rank Correlation

$$r_s = 1 - \frac{6 \sum d_i^2}{(n-1)n(n+1)}$$

$r_s$  = Spearman's rank correlation coefficient

$d_i$  = difference for the  $i$ th pair

$n$  = number of  $d$ 's

This test determines both direct and inverse relationships between two variables. If two curves are directly related, i.e., they have similar shapes, a positive decimal results from the calculations. If, on the other hand, the two pollen types are acting in an opposite manner--i.e., are inversely related--a negative decimal is the result. The calculations are corrected for ties where necessary (Gibbons 1971:232:235) and are compared with the critical values at the 0.05 level of significance.

Of the 54 comparisons, only one is statistically significant. In column Arizona V:9:55-1, the changes in the relative frequencies of arboreal pollen and sediment sizes less than 0.088 millimeters were significantly different at the 0.05 level (Table 10).

Table 10. Spearman's Coefficient of Rank Correlation

| Column         | 2.828 mm      |        |        | 0.088 mm      |        |        | Critical<br>value<br>± |
|----------------|---------------|--------|--------|---------------|--------|--------|------------------------|
|                | Cheno-<br>ams | NAP*   | AP     | Cheno-<br>ams | NAP*   | AP     |                        |
| Arizona<br>V:9 |               |        |        |               |        |        |                        |
| 55-1           | -0.309        | 0.236  | 0.402  | -0.534        | 0.573  | 0.768  | 0.736                  |
| 55-5           | 0.788         | -0.439 | 0.091  | -0.045        | 0.538  | 0.091  | 0.893                  |
| 56-1           | 0.381         | -0.095 | -0.565 | -0.690        | 0.178  | 0.750  | 0.833                  |
| 57-1           | 0.371         | -0.175 | -0.683 | -0.517        | -0.588 | 0.196  | 0.783                  |
| 59-1           | -0.100        | -0.625 | -0.300 | -0.275        | -0.300 | -0.275 | 0.900                  |
| 60-2           | -0.786        | -0.750 | 0.259  | 0.384         | -0.312 | 0.098  | 0.893                  |
| 62-10          | 0.143         | -0.125 | -0.149 | -0.042        | 0.036  | 0.208  | 0.833                  |
| 68-A           | 0.508         | -0.423 | -0.297 | -0.387        | -0.316 | -0.231 | 0.673                  |
| 68-B'          | -0.351        | 0.470  | 0.405  | -0.601        | 0.678  | 0.440  | 0.738                  |

The lack of correlation between the pollen frequency and the sediment size indicates that either sediment size or the pollen percentages--or both--are less influenced by vegetation and available precipitation than was hypothesized.

Conclusion. Pollen samples from stratigraphic columns reflect a complex depositional history. In order for the work and time which is spent collecting, extracting, and analyzing pollen samples from stratigraphic columns to be worthwhile, extensive micro-environmental investigation into the factors involved in deposition in an archaeological structure is needed. Until this has been accomplished, those contemplating such pollen analysis should seriously consider the problems involved and results envisioned.

## CHAPTER 5

### GEOLOGY, PALEONTOLOGY, AND BOTANY

The disciplines of geology, paleontology, and botany can be used to define the modern environment, to clarify palynological interpretation, and to offer a new source of evidence for man's relationship with his natural environment. Consideration of the location of sites and the analysis of the sources of material for lithic artifacts offers information about the relationship between the prehistoric inhabitants and their physical environment. Comparison of identifiable faunal remains with modern geographic and seasonal territories give information about possible climatic changes or seasonality of sites. Botanical collection and concurrent pollen analysis of modern samples gives insight into the variety of vegetation in a transition zone, changes in plant association, contiguous changes in the pollen rain, and increases our knowledge of the relationship between the vegetation and the pollen rain in the past. Comparison of modern vegetation with the paleobotany of the site aids in interpretation of environmental changes.

#### Geology

One geological question to be asked when examining a site is, why did the inhabitants settle in this particular location? In the

Miami Wash-Pinal Creek area there are three types of localities to be considered: terrace sites, a hillside work site, and sites on the tops of hills. The most logical reason for the placement of the terrace sites is that they were near areas of potential cultivation. This interpretation is supported by the presence of corn pollen, which indicates corn plants in close proximity to the terrace sites. There is no sign of artificial terracing around the small creeks or on the hillslopes near the sites. Each of the natural terraces is situated 11 to 22 meters (circa 25 to 50 feet) above the floodplain. If the fields were located on the floodplain, the Indians would be near their crops, yet their shelters would be high enough to escape most of the floods.

One work site--Shurban, Arizona V:9-63--with no sign of temporary or permanent shelter is located on a hillside above the terraces. Though some lithic debris is present, the amount does not justify designation of the site as a quarry. It is more likely that exploitation of the vegetal resources of the area was the primary reason for this site location.

The hill sites--in comparison with the terrace sites--are large, containing more than 25 rooms. They are located over a kilometer from potential fields on the floodplain, with elevational changes of more than 175 meters (400 feet). According to local informants, they are close (less than one kilometer) to springs that existed before the copper companies changed the water course; these springs would have been sources of permanent water. The only large storage room found during the excavation was in a hill site. Considering both



the site locations and the excavation evidence, it is probable that the hill sites were permanent dwellings, while the terrace structures were built for farming purposes and perhaps were only seasonally occupied.

Another avenue of investigation into the relationship between the Indians and their environment is through a comparison of the available raw material found in the area with the material actually used for tools. This may indicate knowledge that the inhabitants may have had about their physical environment, give insight into their resourcefulness in using this environment, and suggest possible trade or travel outside the area for exotic material. Inquiry into the chipped lithic industry should be especially productive because chipped tools require special raw materials.

Materials used for chipped tools at Miami Wash were obsidian, basalt, quartzite, indurated siltstone, indurated breccia or conglomerate, chert, jasper and other chalcedony, and limestone. Only a few small tools were made from obsidian. The quartzite used was reddish, gray, or black. The black quartzite was difficult to distinguish from the basalt and identification was based on the shape and color of the individual grains or crystals under a hand lens or microscope and/or presence of olivine crystals, which are frequently associated with basalt. Siltstone is an unusual material for chipped artifacts because it is generally too soft to be utilized for this purpose. This reddish-brown siltstone is, however, very well cemented, possibly metamorphosed, therefore suitable for

chipping. The breccia or conglomerate is, like the siltstone, suitable because of extreme induration. Though the rock was composed of a matrix with single grains of gravel size or larger, it broke across the grains, again indicating strong cementation or possible metamorphism. Few limestone artifacts, either tools or flakes, were identified. This may be because lithic material was washed in dilute hydrochloric acid before identification was made. Corrosion of surfaces by the acid would effectively destroy evidence of flaking or working.

With one possible exception all of the lithic material used for chipped artifacts is found locally (see page 11). Identification of available raw material is based on Peterson (1962) and personal observation. Basalt flows with olivine crystals (one of the traits used to distinguish basalt from black quartzite) are intrusive into the Gila conglomerate or lie directly over outcroppings of dacite. Possible sources of quartzite include the Dripping Spring quartzite, which varies in color from light gray to light brownish-gray, the brownish-gray Troy quartzite, and the various quartzites in the Pioneer formation. The indurated siltstone is most probably a fine grained constituent of the Pioneer formation. The likely source of the well-cemented conglomerate is the Barnes conglomerate, which fractures across both pebbles and matrix (Chapter 2). The breccia appears to derive from the Troy quartzite.

Chert, jasper and chalcedony are found in various formations. The Barnes conglomerate contains pebbles of jasper and chert, and both

the Mescal and Escabrosa limestones include nodules of chert; the massive Escabrosa limestone is also a likely source for any limestone tools made.

The source for the Gila conglomerate is the outcroppings of the previously formed formations. While collecting plant samples and doing preliminary pollen sampling, I noted that large and small cobbles of various rock types--limestone, quartzite, chert, basalt, and other materials suitable for artifacts--were eroding out of the Gila conglomerate. It is thus possible that the Indians could have gathered much of their raw material a few steps from their homes. This possibility limits the amount of information that can be gained from the lithic investigation, because it means that only general knowledge of the area was necessary for the collection of material suitable for chipping, and that in most cases trade was unnecessary.

One possible source material that was not locally obtained is the obsidian. Peterson (1962:37) mentions both a Tertiary perlite which when fresh "is black, has luster and conchoidal fracture" and a "black vitrophyre" from a subsequent eruption which looks like "clearglass" in some places (Peterson 1962:40). No obsidian is mentioned by name and now was found in the vicinity during field reconnaissance. Considering the small size (less than 3 by 3 centimeters) of the obsidian artifacts it is possible that the source was "Apache tears" from the Superior area.

The Miami Wash-Pinal Creek area offers a variety of physical attributes including flat, watered areas suitable for fields, springs

with fresh water, raw material suitable for chipping, locations for habitation sites close to the fields, and flat areas for larger sites on the hills. The extensive prehistoric habitation of this area was at least partly due to the physical advantages it offered.

### Paleontology

Faunal<sup>1</sup> remains from sites give information about the nature of the environment and seasonal use of areas. Discrepancies between modern territories and past occurrences may have environmental significance..

Four of the vertebrate remains identified are environmental indicators. Lophortyx gambelii (Gambel's quail) which was found in three sites, is (Lowe 1964:192), "resident in all areas where mesquite occurs, locally higher (along foot of Mogollon Plateau.)" Kinosternon sp. (mud turtle) and Bufo cf. woodhousei (Woodhouse's toad) are associated with permanent or semi-permanent water or streams. Woodhouse's toads are "rarely found at any great distance from their channels or floodplains" (Lowe 1964:156). Antilocarpa americana (pronghorned antelope), an inhabitant of grasslands (Lowe 1964), is found at two sites.

The fauna--with the exception of the antelope, a highly mobile animal which could have wandered or been carried to the sites--indicates an environment which is like that described by natives of the region for the recent past (e.g., before the extensive modern mining

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1. Faunal identification was done by Sparling, no date.

operations). Running water was present in Miami Wash and Pinal Creek most or all of the year and mesquite bosques were abundant near the edge of the floodplain.

The examination of seasonal indicators found in the terrace sites does not support the hypothesis that these sites were seasonally occupied. A cf. Meleagris gallopavo (possible turkey) was found at Monitor. Lowe (1964) says that turkeys are usually found in forested areas, but descend to valleys in the winter. Three birds--Cathartes aura (turkey vulture), Aquila chrysaetos (golden eagle), and Aphelocoma coerulescens (scrub jay)--excavated at Columbus are today found in this area at different seasons. The turkey vulture is more common in summer, the golden eagle is more common in winter, while the scrub jay "migrates across the Mogollon Plateau some autumns (Lowe 1964:215)." Three other birds--Buteo cf. regalis (Ferruginous hawk), Colaptes cf. "cafer" (red-shafted flicker), and Buteo jamaicensis (redtailed hawk)--found at Tin Horn are more common to this area in winter than at other seasons. The tooth eruptions of the jaws of an immature Odocoileus hemionus (mule deer) indicate that death occurred around September. The faunal evidence thus supports the supposition of habitation of the terrace sites beyond spring and summer, and possibly year round.

Four fauna types whose presence do not coincide with their modern distribution were found during excavation. Thomomys umbrinus (valley pocket gopher) is presently found (Lowe 1964) in the Santa Rita, Patagonia, Huachuca, and Pajarito mountains in the southeast

part of the state from circa 1310 to 1890 meters (4,300 to 6,200 feet). Sparling (no date) feels that they may be intrusive into the area. Falco mexicanus (prairie falcon) is now scarce (Lowe 1964), but was formerly more common. Neither cf. Vulpes vulpers (red fox) nor the cf. Ammospermophilous harrissii (Yuma antelope squirrel) are mentioned by Lowe (1964). Their presence in the sites could either be due to misidentification or to correct identification of species formerly more common in the eastern part of the state.

Over 85 percent of the species recovered during excavation are found in the area today, according to Lowe (1964). The presence of four anomalous species could be due to minor climatic changes or to other causes, such as a decrease in distribution due to the encroachment of man into their natural territories or to human transport. Faunal evidence on the whole does not support any obvious climatic or environmental shift.

#### Botanical and Modern Pollen Rain Analysis

Plant collections and plant transects correlated with sampling of the surface pollen rain were made for the following reasons:

(1) in order to make potential ethnobotanical comparisons which might indicate environmental or climatic change, it is necessary to know the variety of vegetation in the area of the sites, (2) I wished to learn about plant associations in a transitional zone, and (3) for better interpretation of the archaeological pollen samples, it is necessary to study the variation of relative frequencies of the modern pollen and their relationship with plant associations.

To study the variety of vegetation near the sites in the time allotted, plants were collected on the surfaces of sites before excavation, near the sites, and as part of transect plots across Miami Wash and Pinal Creek. The composite list thus created is not totally representative of the flora which potentially could be in the area, because the winter and spring rains were below average, thereby reducing the number and variety of spring and early summer annuals. Plants were identified by Caryl L. Busman and the author (marked by \*). They are alphabetized according to whether they are herbaceous or woody.<sup>1</sup>

|   |                       |
|---|-----------------------|
| Herbs: * <u>Allionia incarnate</u> (Standl.) Standl.      | Trailing four-o'clock |
| <u>Ambrosia</u> sp.                                       | Ragweed               |
| * <u>Amaranthus palmeri</u> Wats.                         | Careless weed         |
| * <u>Argemone</u> sp.                                     | Prickly poppy         |
| * <u>Artemisia</u> ?                                      | Sage                  |
| <u>Aristida</u> ?   | Three awn grass       |
| * <u>Asclepius asperula</u> (Decne.) Woodson              | Milkweed              |
| <u>Atriplex</u> cf. <u>canescens</u> (Pursh.) Nutt.       | Saltbush              |
| <u>Baccharis sarothroides</u> Gray                        | Desert-broom          |
| <u>Berberina encelioides</u> (not in Kearney and Peebles) |                       |
| <u>Brickellia</u> sp. ?                                   |                       |
| * <u>Bromus rubens</u> L.                                 | Brome grass           |
| <u>Chenopodium</u> sp.                                    | Goosefoot             |
| * <u>Cirsium</u> sp.                                      | Thistle               |
| <u>Groton texensis</u> (Klotzsch) Muell, Art.             | Dove-weed             |
| * <u>Cucurbita</u> cf. <u>foetidissima</u> H.B.K.         | Buffalo-gourd         |
| * <u>Datura</u> sp.                                       | Thorn apple           |
| <u>Encelia frutescens</u> Gray                            |                       |
| * <u>Eriastrum diffusum</u> (Gray) Mason                  |                       |
| <u>Eriogonum</u> sp.                                      | Wild-buckwheat        |
| <u>Eriogonum trichopes</u> Torr.                          | Wild-buckwheat        |
| * <u>Erodium cicutarium</u> (L.) L'Her                    |                       |

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1. The designation of herbaceous or woody was based on Kearney and Peebles (1960) with seven exceptions. Atriplex, Baccharis, Encelia, Hymenoclean, Menodora, Trixis, and Zinnia are woody plants, but their pollen is considered to be non-arboreal.

|   |                    |
|---|--------------------|
| * <u>Euphorbia</u> sp.                            | Spurge             |
| * <u>Erysium capitatum</u> (Dougl.) Greene        | Western wallflower |
| cf. <u>Festuca octoflora</u> ? Walt.              | Fescue grass       |
| <u>Gutierrezia sarothrae</u> (Pursh.) Britt.      | Snakeweed          |
| Rusby   |                    |
| <u>Gutierrezia microcephala</u> (DC.) Gray        | Snakeweed          |
| ( <u>G. Sarothrae</u> var. <u>microcephala</u> L. | Benson)            |
| <u>Haplopappus gracilis</u> (Nutt.) Gray          |                    |
| * <u>Hymenoclea</u> sp.                           | Burro-brush        |
| <u>Menodora scabra</u> Gray                       |                    |
| * <u>Mentzelia</u> sp.                            |                    |
| * <u>Penstemon parryi</u> Gray                    |                    |
| cf. <u>Perezia Wrightii</u> Gray                  |                    |
| * <u>Phacelia</u> sp.                             |                    |
| * <u>Psoralea tenuiflora</u> Pursh.               | Scruf-pea          |
| * <u>Rumex</u> sp.                                | Dock               |
| * <u>Salvia</u> sp.                               | Mint               |
| * <u>Solanum</u> cf. <u>Xanti</u> Gray            | Nightshade         |
| * <u>Sphaeralcea</u> sp.                          | Globe-mallow       |
| <u>Stephanomeria pauciflora</u> (Torr.) A. Nels   | Stickweed          |
| <u>Trixis californica</u> Kellogg                 |                    |
| * <u>Zinnia pumila</u> Gray                       |                    |

|        |  |                              |
|--------|--|------------------------------|
| Woody: | * <u>Acacia constricta</u> Benth.                  | White-thorn                  |
|        | <u>Acacia gregii</u> Gray                          | Catclaw                      |
|        | * <u>Berberis</u> sp.                              | Barberry, holly grape        |
|        | * <u>Caesalpinia billiesii</u> Wall                | Bird-of-paradise flower      |
|        | <u>Calliandra eriophylla</u> Benth.                | Flase mesquite               |
|        | <u>Calliandra</u> sp.                              |                              |
|        | <u>Canotia holacantha</u> Torr.                    | "Paloverde"                  |
|        | * <u>Cercocarpus betuloides</u> Nutt.              | Birch-leaf mountain mahogany |
|        | <u>Cercidium floridum</u> Benth.                   | Blue palo verde              |
|        | <u>Condalia lycioides</u> (Gray) Webert.           | Gray thorn                   |
|        | * <u>Dasyliirion wheeleri</u> Wats.                | Sotol                        |
|        | <u>Ephedra</u> sp.                                 |                              |
|        | <u>Ephedra trifurca</u> Torr.                      | Joint-fir                    |
|        | * <u>Ferocactus</u> cf. <u>Wizlizeni</u> (Engelm.) | Barrel cactus                |
|        | Britt. and Rose                                    |                              |
|        | <u>Juniperus</u> ?                                 | Juniper                      |
|        | * <u>Juniperus</u> cf. <u>osteosperma</u> (Torr.)  | Utah juniper                 |
|        | Little   |                              |
|        | <u>Krameria</u> cf. <u>lanceolata</u> Torr.        | Ratany                       |
|        | <u>Krameria parviflora</u> Benth.                  | Ratany                       |
|        | <u>Mimosa</u> cf. <u>biuncifera</u> Benth.         | Wait-a-minute                |
|        | * <u>Nicotiana glauca</u> Graham                   | Tree tobacco                 |
|        | <u>Nolina</u> sp.                                  | Tree tobacco                 |
|        | <u>Opuntia</u> cf. <u>engelmannii</u> Salm-Dyck    | Prickly-Pear                 |
|        | * <u>Opuntia</u> cf. <u>phaecantha</u> Engelm      | Prickly-Pear                 |



|   |                 |
|---|-----------------|
| <u>Opuntia</u> sp.  |                 |
| <u>Opuntia</u> cf. <u>spinosior</u> (Englem and Bigel.) <u>Toumey</u> | Cholla          |
| * <u>Opuntia</u> cf. <u>Whipplei</u> Englem, and Bigel.               | Cholla          |
| * <u>Populus</u> <u>fremontii</u> Wats.                               | Cottonwood      |
| * <u>Prosopis</u> <u>juliflora</u> (Swartz) DC                        | Common mesquite |
| <u>Quercus</u> sp.  | Oak             |
| <u>Quercus</u> cf. <u>turbinella</u>                                  | Oak             |
| * <u>Rhus</u> <u>trilobata</u> Nutt.                                  | Squaw bush      |
| * <u>Salix</u> sp.  | Willow          |
| <u>Sapindus</u> <u>saponaria</u> L. var. <u>drummondii</u>            | Soapberry       |
| * <u>Simmondsia</u> <u>chinensis</u> (Link.) Schneid.                 | Jojoba          |
| * <u>Tamarix</u> <u>pentandra</u> Pall.                               |                 |
| * <u>Typha</u> sp.  | Cattail         |
| <u>Yucca</u> <u>baccata</u> Torr. ???                                 | Datil           |

Four of the plants on the list--Caesalpinia, Bromus rubens, Nicotiana, and Tamarix--are not native to Arizona (Kearney and Peebles 1960). Of the remaining plants, a wide variety of both herbaceous and woody types, many of which have been used during historic times by Indians, are present (Castetter and Underhill 1935; Whiting 1939). Some other herbs, especially grasses, are present in the area, but the specimens were dry when collected and lack features necessary for identification.

The variety of woody plants, ranging from cacti to mesquite to juniper, indicates an equally wide range of environments. Different environments are often correlated with different plant groups or plant associations.

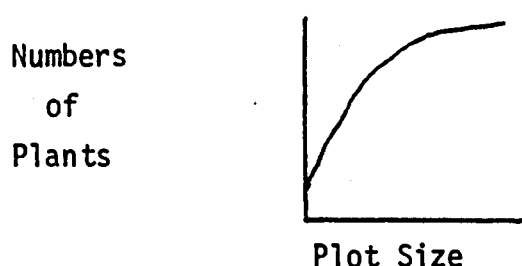
Are there any plant associations at Miami Wash, and, if so in what environment do they occur and what effect do they have on the pollen rain? From personal experience I hypothesize that, due to changing elevation, differences in exposure to sunlight and the presence of the floodplain, different plant associations are variations

occur across the valley. Specific differences include concentration of mesquite near the floodplain, more mesic plants on the north facing slopes, and a dominance of desert vegetation on the south and southeast facing slopes.

### Method

Location of plots. Two transects with a total of nineteen plots were planned with consideration toward proximity to archaeological sites and to differences in elevation, aspect, slope, and valley size, all of which should produce plant variation. A variety of vegetation is more likely to contain plants which might have been used by the Indians (Chapter 4), to be useful in comparing changes in pollen with changes in vegetation, and to provide more complete information about the vegetation in the transition zone. Transect AC (ten plots) crosses the northern section of the floodplain below the junction of Miami Wash and Pinal Creek. Transect B (nine plots) crosses the valley of Miami Wash and a smaller valley east of Miami Wash.

Plot size. Originally I had planned to determine an ideal plot size which would ensure maximum variety of vegetation with minimal plot size (Solomon, personal communication). This is done by starting with a square of a given size, counting all occurring types within it, doubling the side of the square, counting new types, until few or no new types occur. If graphed, the relationship between size and number of new plant types per plot would appear as follows:



I started with a plot 2 by 2 meters, which contained 6 different species of plants. Each time the plot size doubled, 2 or 3 new plants were added. When the plot size was doubled 5 times and was 16 by 16 meters, one new variety was added. If the dimensions had been further enlarged, it would not have been possible to complete all the plots in the time allowed. Some variety was sacrificed because of the time factor; how much is not known. However, it might be difficult to have the ideal curve as discussed previously because of the variety of vegetation found in all of the plots, i.e., each time the plot is enlarged new plants are added.

In Transect A, Plot 1A was located on the side of a promontory above Shurban (Arizona V:9:63). Because Shurban was thought to be a food collecting site, it was necessary to know what vegetation occurred on the hillside. Plots 2A and 3A were located near Shurban and Columbus (Arizona V:9:57) respectively. Plot 4A was located across the floodplain between the modern stream channel and the mesquite bosques progressively further northeast of the floodplain. Plot 7A was located in the low hills northeast of the floodplain on top of a northwest facing terrace. One more plot, 8A, was located in the low hills further northeast of 7A.

A second leg of Transect A west of Pinal Creek was added, with plots 1C and 2C located, respectively, above and around Refugia. Visually, Refugia (Arizona V:9:59), had a vegetation distinct from that of other locations on the west side of the creeks, and accordingly more information was desired.

Transect B was located east of Runway, across the Miami Wash floodplain to the low east facing hills on the other side. The plot locations chosen included two hilltops--Plot 1B, circa 800 meters east of Runway, and 3B, circa 300 meters east of Runway--three east-facing hillsides (Plots 2B, 8B, and 9B), one valley (Plot 5B), a floodplain (Plot 7B), and Runway Ruin itself (Plot 6B). The vegetation in each plot is presented in Table 11.

#### Data

The predominant herbs identified are Compositae--particularly Gutierrezia sarothrae--and various grasses. Chenopodiaceae are locally abundant. Woody plants are locally dominant, though a few types of trees are found in numerous plots. Acacia spp., particularly A. constricta, are not only locally abundant, but are also almost ubiquitous, being absent from only two plots. Prosopis juliflora is also found in many plots. Woody plants which are dominant in specific plots are Dasyliirion wheeleri, Condalia lycioides, Krameria spp., Quercus sp., and Mimosa cf. biuncifera. Juniperus sp. and Canotia holocantha rarely occur in any plot.

The plant associations appear to be dependent on three environmental conditions: the attitude of the slope, the elevation and the

Table 11. Vegetation in Transect Plots

Plant # Individuals % Ground Cover

Plot 1B, northeast facing slope, elevation circa 1045 meters (3425 ft.)

|  |      |        |
|--|------|--------|
| <u>Cirsium</u> sp.                                     | 1    |        |
| Compositae: <u>Gutierrezia sarothrae</u><br>and others | 1, 3 |        |
| Gramineae: <u>Aristida</u> sp. and others              |      | 30-40% |
| <u>Sphaeralcea</u> sp.                                 | 2    |        |
| Unknown 1  | 11   |        |
| <u>Cercocarpus betuloides</u>                          | 6    |        |
| <u>Dasylirion wheeleri</u>                             | 6    |        |
| <u>Nolina</u> sp.                                      | 4    |        |
| <u>Quercus</u> sp.                                     | 3    |        |

Plot 2A, northeast facing slope, elevation circa 1015 meters (3325 ft.)

|   |    |     |
|---|----|-----|
| <u>Baileya multiradiata</u>             | 70 |     |
| <u>Euphorbia</u> sp.                    | 2  |     |
| Gramineae                               |    | 25% |
| <u>Gutierrezia sarothrae</u>            | 71 |     |
| cf. <u>Perezia wrightii</u>             | 2  |     |
| <u>Solanum</u> cf. <u>xanti</u>         | 9  |     |
| <u>Sphaeralcea</u> sp.                  | 6  |     |
| Unknown 4                               | 36 |     |
| <u>Zinnia pumila</u>                    | 1  |     |
| <u>Acacia constricta</u>                | 20 |     |
| <u>A. gregii</u>                        | 5  |     |
| <u>Condalia lycioides</u>               | 1  |     |
| <u>Juniperus</u> cf. <u>osteosperma</u> | 1  |     |
| <u>Prosopis juliflora</u>               | 2  |     |

Table 11. Vegetation in Transect Plots, cont.

| Plant | # Individuals | % Ground Cover |
|-------|---------------|----------------|
|-------|---------------|----------------|

Plot 3A, northeast facing terrace, elevation circa 1005 meters  
(3300 feet)

|  |    |                  |
|--|----|------------------|
| <u>Eriastrum diffusum</u>                | 1  |                  |
| Gramineae: <u>Festuca</u> sp. and others |    | <u>circa</u> 50% |
| <u>Gutierrezia sarothrae</u>             | 82 |                  |
| cf. <u>Perezia wrightii</u>              | 1  |                  |
| <u>Sphaeralcea</u> sp.                   | 4  |                  |
| Unknown 3                                | 1  |                  |
| Unknown 4                                | 1  |                  |
| <u>Acacia constricta</u>                 | 9  |                  |
| <u>A. gregii</u>                         | 16 |                  |
| <u>Mammillaria</u> sp.                   | 1  |                  |
| <u>Prosopis juliflora</u>                | 4  |                  |

Plot 4A, east of floodplain, elevation circa 975 meters (3200 feet)

|                                     |    |       |
|-------------------------------------|----|-------|
| Compositae                          | 10 |       |
| <u>Erodium cicutarium</u>           |    | 5%    |
| Gramineae                           |    | 5-10% |
| <u>Gutierrezia wrightii</u>         | 2  |       |
| <u>Mentzelia</u> sp.                | 6  |       |
| <u>Salvia</u> sp.                   | 2  |       |
| <u>Solanum</u> cf. <u>xanti</u>     | 1  |       |
| Unknown 4                           | 5  |       |
| Unknown 6                           | 4  |       |
| <u>Acacia gregii</u>                | 4  |       |
| <u>Caesalpinia gilliesii</u>        | 1  |       |
| <u>Condalia lycioides</u>           | 3  |       |
| <u>Mimosa</u> cf. <u>biuncifera</u> | 1  |       |
| <u>Prosopis juliflora</u>           | 1  |       |

Table 11. Vegetation in Transect Plots, cont.

| Plant | # Individuals | % Ground Cover |
|-------|---------------|----------------|
|-------|---------------|----------------|

Plot 5A, bosque east of floodplain, elevation circa 985 meters  
(3225 feet)

|                                 |    |      |
|---------------------------------|----|------|
| <u>Compositae</u>               | 11 |      |
| <u>Crucifera</u>                | 1  |      |
| <u>Eriastrum diffusum</u>       | 1  |      |
| <u>Erodium cicutarium</u>       |    | 1-2% |
| <u>Solanum cf. xanti</u>        | 13 |      |
| Unknown 4                       | 1  |      |
| Unknown 9                       | 1  |      |
| <u>Acacia constricta</u>        | 2  |      |
| <u>A. gregii</u>                | 2  |      |
| <u>Caesalpinia gilliesii</u>    | 5  |      |
| <u>Prosopis juliflora</u>       | 11 |      |
| <u>Sambucus cf. neomexicana</u> | 1  |      |

Plot 6A, bosque east of floodplain, elevation circa 990 meters  
(3250 feet)

|                           |    |                   |
|---------------------------|----|-------------------|
| <u>Argemone sp.</u>       | 1  |                   |
| <u>Gramineae</u>          |    | <u>circa</u> 1-2% |
| <u>Mentzelia sp.</u>      | 2  |                   |
| <u>Solanum cf. xanti</u>  | 1  |                   |
| Unknown A                 |    | <u>circa</u> 5%   |
| Unknown J                 |    | 1%                |
| Unknown K                 |    | 1%                |
| Unknown L                 |    | 1%                |
| Unknown M                 |    | 1%                |
| <u>Acacia constricta</u>  | 5  |                   |
| <u>Prosopis juliflora</u> | 16 |                   |

Table 11. Vegetation in Transect Plots, cont.

Plant # Individuals % Ground Cover

Plot 7A, west facing slope, terrace top, elevation circa 1005  
meters (3300 feet)

|                                       |                 |    |
|---------------------------------------|-----------------|----|
| <u>Allionia incarnata</u>             | 1               |    |
| <u>Eriastrum difffusum</u>            |                 | 1% |
| <u>Gutierrezia sarothrae</u>          | <u>circa</u> 50 |    |
| <u>Penstemon parryi</u>               | 1               |    |
| <u>Sphaeralcea</u> sp.                | 2               |    |
| Unknown 14                            | 20              |    |
| <u>Acacia constricta</u>              | 7               |    |
| <u>A. gregii</u>                      | 2               |    |
| <u>Berberis</u> sp.                   | 2               |    |
| <u>Calliandra</u> sp.                 | 6               |    |
| <u>Condalia lycioides</u>             | 1               |    |
| <u>Dasyllirion wheeleri</u>           | 3               |    |
| <u>Krameria</u> sp.                   | 8               |    |
| <u>Nolina</u> sp.                     | 8               |    |
| <u>Opuntia</u> cf. <u>engelmannii</u> | 1               |    |
| <u>Prosopis juliflora</u>             | 6               |    |
| <u>Quercus</u> sp.                    | 6               |    |
| <u>Rhus trilobata</u>                 | 4               |    |

Plot 8A, southwest facing slope, broad valley, elevation circa  
1020 meters (3340 feet)

|                                 |    |     |
|---------------------------------|----|-----|
| cf. <u>Encelia frutescens</u>   | 1  |     |
| Gramineae: <u>Bromus rubens</u> |    | 1%  |
| <u>Aristida</u> sp.             |    | 15% |
| Others                          |    | 33% |
| <u>Gutierrezia sarothrae</u>    | 35 |     |
| cf. <u>Menodora scabra</u>      | 1  |     |
| <u>Acacia constricta</u>        | 9  |     |
| <u>Berberis</u> sp.             | 2  |     |
| <u>Canotia holocantha</u>       | 1  |     |
| <u>Simmondsia chinensis</u>     | 4  |     |
| <u>Yucca baccata</u> ???        | 6  |     |



Table 11. Vegetation in Transect Plots, cont.

| Plant | # Individuals | % Ground Cover |
|-------|---------------|----------------|
|-------|---------------|----------------|

Plot 1C, east facing, steep slope, elevation circa 1070 meters  
(3500 feet)

|                                 |    |    |
|---------------------------------|----|----|
| <u>Euphorbia</u> sp.            | 5  |    |
| Gramineae: <u>Bromus rubens</u> |    | 1% |
| <u>Aristida</u> sp.             |    | 4% |
| Others                          |    | 7% |
| cf. <u>Perezia wrightii</u>     | 1  |    |
| <u>Sphaeralcea</u> sp.          | 4  |    |
| <u>Calliandra</u> sp.           |    | 2% |
| <u>Canotia holocantha</u>       | 1  |    |
| <u>Dasyllirion wheeleri</u>     | 5  |    |
| <u>Ephedra</u> sp.              | 1  |    |
| <u>Prosopis juliflora</u>       | 1  |    |
| <u>Simmondsia chinensis</u>     | 25 |    |

Plot 2C, east facing terrace top, elevation circa 1020 meters  
(3350 feet)

|  |    |                 |
|--|----|-----------------|
| Gramineae: <u>Bromus rubens</u>        |    | <u>circa</u> 1% |
| <u>Festuca</u> sp.                     |    | 1%              |
| Others                                 |    | 5%              |
| <u>Gutierrezia sarothrae</u>           | 34 |                 |
| <u>Acacia constricta</u>               | 4  |                 |
| <u>A. greggii</u>                      | 10 |                 |
| <u>Berberis</u> sp.                    | 3  |                 |
| <u>Canotia holocantha</u>              | 6  |                 |
| <u>Condalia lycioides</u>              | 2  |                 |
| <u>Ferocactus</u> cf. <u>wizlizeni</u> | 1  |                 |
| <u>Juniperus</u> cf. <u>utahensis</u>  | 2  |                 |
| <u>Prosopis juliflora</u>              | 5  |                 |
| <u>Simmondsia chinensis</u>            | 7  |                 |
| <u>Yucca</u> sp.                       | 1  |                 |

Table 11: Vegetation in Transect Plots, cont.

| Plant | # Individuals | % Ground Cover |
|-------|---------------|----------------|
|-------|---------------|----------------|

Plot 1B, west facing slope, flat area, elevation circa 1130 meters  
(3700 feet)

|                                 |    |    |
|---------------------------------|----|----|
| <u>Artemisia ?</u>              | 3  |    |
| <u>Mentzelia sp.</u>            | 15 |    |
| <u>Psoralea tenuiflora</u>      | 10 |    |
| <u>Stephanomeria pauciflora</u> | 4  |    |
| <u>Trixis californica</u>       | 9  |    |
| Unknown 9B                      |    | 1% |
| <u>Acacia constricta</u>        | 2  |    |
| <u>Cercidium floridum</u>       | 14 |    |
| <u>Dasyliirion wheeleri</u>     | 15 |    |
| <u>Kromeria cf. lanceolata</u>  | 11 |    |
| <u>Krameria sp.</u>             | 5  |    |
| <u>Nolina sp.</u>               | 2  |    |

Plot 2B, steep valley, east facing slope, elevation circa 1110 meters  
(3650 feet)

|                               |    |                 |
|-------------------------------|----|-----------------|
| <u>Ambrosia sp.</u>           |    | 1%              |
| <u>Baccharis sarothroides</u> | 10 |                 |
| <u>Briellia sp.</u>           | 3  |                 |
| <u>Eriogonum sp.</u>          | 2  |                 |
| Unknown 9                     | 8  |                 |
| <u>Acacia constricta</u>      | 2  |                 |
| <u>Calliandra sp.</u>         | 1  |                 |
| <u>Canotia holocantha</u>     | 1  |                 |
| <u>Cercidium floridum</u>     | 1  |                 |
| <u>Dasyliirion wheeleri</u>   | 24 |                 |
| <u>Prosopis juliflora</u>     | 2  |                 |
| <u>Sapindus saponaria</u>     |    | <u>circa</u> 1% |

Table 11. Vegetation in Transect Plots, cont.

| Plant | # Individuals | % Ground Cover |
|-------|---------------|----------------|
|-------|---------------|----------------|

Plot 3B, top of hill, elevation circa 1135 meters (3725 feet)

|   |     |  |
|---|-----|--|
| <u>cf. Ambrosia sp.</u>                   | 29  |  |
| <u>Baccharis cf. sarothroides</u>         | 2   |  |
| <u>Compositae</u>                         | 2   |  |
| <u>Eriogonum sp.</u>                      | 3   |  |
| <u>Gutierrezia sarothrae</u>              | 1   |  |
| <u>Menodora scabra</u>                    | 23  |  |
| <u>Psoralea tenuiflora</u>                | 4   |  |
| <u>Acacia constricta</u>                  | 1   |  |
| <u>Calliandra sp.</u>                     | 21  |  |
| <u>Dasyliirion wheeleri</u>               | 17  |  |
| <u>Ephedra trifurca</u>                   | 5   |  |
| <u>Krameria sp.</u>                       | 2   |  |
| <u>Mammillaria sp.</u>                    | 2   |  |
| <u>Nolina sp.</u>                         | 3   |  |
| <u>Opuntia cf. engelmannii</u>            | 2   |  |
| <u>O. cf. spinosior</u>                   | 2   |  |
| <u>Sapindus saponaria var. drummondii</u> | 30. |  |

Plot 4B, west facing slope, elevation circa 1050 meters (3450 feet)

|                                 |    |                 |
|---------------------------------|----|-----------------|
| <u>Artemisia ?</u>              |    | <u>circa 5%</u> |
| <u>Eriastrum diffusum</u>       | 10 |                 |
| <u>Gutierrezia microcephala</u> | 22 |                 |
| <u>Menodora scabra</u>          | 1  |                 |
| <u>Sphaeralcea sp.</u>          | 6  |                 |
| <u>Acacia constricta</u>        | 29 |                 |
| <u>Calliandra eriophylla</u>    | 6  |                 |
| <u>Krameria cf. lanceolata</u>  | 1  |                 |
| <u>Krameria sp.</u>             | 1  |                 |
| <u>Opuntia engelmannii</u>      |    | <u>circa 5%</u> |
| <u>O. cf. spinosior</u>         | 1  |                 |
| <u>Prosopis juliflora</u>       | 3  |                 |

Table 11. Vegetation in Transect Plots, cont.

| Plant | # Individuals | % Ground Cover |
|-------|---------------|----------------|
|-------|---------------|----------------|

Plot 5B, narrow valley east of Runway Ruin, elevation circa 1030 meters (3375 feet)

|                              |        |    |
|------------------------------|--------|----|
| <u>Compositae</u>            | 22     |    |
| <u>Encelia frutescens</u>    | 5      |    |
| <u>Eriastrum diffusum</u>    |        | 1% |
| <u>Erysium capitatus</u>     | 6      |    |
| Gramineae: <u>Brumus</u> sp. |        | 1% |
| <u>Gutierrezia sarothrae</u> | 40     |    |
| <u>Phacelia</u> sp.          | 1      |    |
| <u>Sphaeralcea</u> sp.       | 2      |    |
| Unknown 16                   | 11     |    |
| <u>Zinnia pumila</u>         | 2      |    |
| <br><u>Acacia constricta</u> | <br>23 |    |
| <u>A. greggii</u>            | 2      |    |
| <u>Berberis</u> sp.          | 1      |    |
| <u>Calliandra</u> sp.        | 1      |    |
| <u>Condalia lycioides</u>    | 1      |    |
| <u>Dasyliirion wheeleri</u>  | 1      |    |
| <u>Opuntia engelmannii</u>   |        | 1% |
| <u>O. cf. spinosior</u>      | 8      |    |
| <u>Prosopis juliflora</u>    | 2      |    |
| <u>Quercus</u> sp.           | 3      |    |
| <u>Rhus trilobata</u>        | 2      |    |
| <u>Yucca</u> sp.             | 4      |    |

Plot 6B, Runway Ruin, west facing terrace top, elevation circa 1035 meters (3400 feet)

|                                |        |                  |
|--------------------------------|--------|------------------|
| <u>Eriastrum diffusum</u>      |        | <u>circa</u> 2%  |
| <u>Eriogonum trichopes</u>     | 18     |                  |
| <u>Erodium</u> sp.             |        | <u>circa</u> 1%  |
| <u>Gutierrezia sarothrae</u>   |        | <u>circa</u> 20% |
| <u>Phacelia</u> sp.            |        | 1%               |
| <br><u>Acacia constricta</u>   | <br>20 |                  |
| <u>Opuntia cf. phaeacantha</u> | 1      |                  |
| <u>O. cf. spinosior</u>        | 7      |                  |
| <u>O. whipplei</u> ?           | 2      |                  |
| <u>Prosopis juliflora</u>      | 2      |                  |

Table 11. Vegetation in Transect Plots, cont.

| Plant | # Individuals | % Ground Cover |
|-------|---------------|----------------|
|-------|---------------|----------------|

Plot 7B, Mesquite bosque, elevation circa 990 meters (3250 feet)

|                                 |    |        |
|---------------------------------|----|--------|
| <u>Atriplex cf. canescens</u>   | 2  |        |
| <u>Berbesina encelioides</u> ?  | 1  |        |
| <u>Chenopodium</u> sp           |    | 35-40% |
| <u>Croton texensis</u>          |    | 1/2%   |
| <u>Gramineae</u>                |    | 1%     |
| <u>Happlopappus gracilis</u>    | 4  |        |
| <u>Hymenoclea</u> sp.           | 2  |        |
| <u>Mentzelia</u> sp.            | 3  |        |
| <u>Solanum</u> cf. <u>xanti</u> | 15 |        |
| <u>Acacia constricta</u>        | 2  |        |
| <u>A. greggii</u>               | 7  |        |
| <u>Condalia lycioides</u>       | 3  |        |
| <u>Prosopis juliflora</u>       | 15 |        |

Plot 8B, east facing slope, elevation circa 1010 meters (3300 feet)

|                                      |    |
|--------------------------------------|----|
| <u>Menodora scabra</u>               | 1  |
| <u>Acacia greggii</u>                | 6  |
| <u>Berberis</u> sp.                  | 2  |
| <u>Krameria parviflora</u>           | 29 |
| <u>Prosopis juliflora</u>            | 3  |
| <u>Quercus</u> cf. <u>turbinella</u> | 15 |

Plot 9B, east facing slope, elevation circa 1020 meters (3350 feet)

|  |    |
|--|----|
| <u>Baccharis</u> cf. <u>sarothroides</u> | 1  |
| <u>Acacia constricta</u>                 | 1  |
| <u>A. greggii</u>                        | 1  |
| <u>Berberis</u> sp.                      | 1  |
| <u>Mimosa</u> cf. <u>biuncifera</u>      | 45 |
| <u>Quercus</u> sp.                       | 8  |
| <u>Rhus trilobata</u>                    | 3  |

topography. The more mesic vegetation is found on northeast-, east- and north-facing slopes at elevations above 1130 meters (3700 feet). Drier environments occur at lower elevations on southwest- and west-facing slopes. In addition, the shape of the valley, (i.e., broad or narrow) must be considered because the narrow valleys offer more shade and produce more mesic vegetation than do open slopes with a similar elevation and altitude.

### Interpretation

From the plant associations certain indicators of micro-environmental conditions can be discerned. Juniperus sp., Canotia holocantha, Dasyilirion wheeleri, Cercocarpus betuloides, Quercus sp., and Berberis sp. indicate more mesic conditions, though Juniperus sp. and Canotia holocantha seem to demand the most specialized of these environments. Abundant Prosopis juliflora is associated with bosques near floodplains, and abundant Mimosa cf. biuncifera with specialized conditions of unknown parameters. Acacias are predominant on the drier west- and south-west facing slopes at elevations less than 1035 meters (3400 feet), but are also found in almost every micro-environment, as are the cacti; this was the most surprising development of the plant association study. The indicators for potentially dry conditions are not as obvious as those for the cooler, moister conditions.

In comparing these results with the hypothesis and predictions, it can be seen that the first two predictions--that mesquite will maximize on the floodplains and more mesic plants like juniper will be found on north facing slopes--are supported, but the third

prediction--that drier, more desert-like vegetation appears on the south- and west-facing slopes--is not supported. The vegetation on these slopes is indeed different, but the definition of "desert-like vegetation" is not specific enough. Acacia spp. is found in a variety of locations, and though cacti are prevalent on south- and west-facing slopes, they are present in other areas as well.

### Pollen Rain

Several general predictions concerning variation in the pollen rain associated with changing environments are based on previous studies of a similar nature. Hevly, Mehringer and Yocum (1965), in a 10 mile transect with 20 stations extending from the top of a desert peak near Tucson, Arizona to the center of a valley, found differences of: cheno-ams (maximum frequency minus minimum frequency), 76.5 percent; low-spine Compositae (Ambrosia-type and Asterae-type), 71 percent; Gramineae, 33 percent; and high-spine Compositae (Asterae-type and Helianthus-type), 28.25 percent. Arboreal differences were much lower: Simmondsia, 13.25 percent; Quercus, 61.75 percent; Ephedra, 2.2 percent; Juniperus, 1.25 percent; and Acacia-Mimosa-Krameria, 0.5 percent. Because the relief in the Miami Wash area was less than the 1130 meters (circa 2800 feet) in the desert transect, the difference in relative frequencies should probably be subdued. The frequencies of herbaceous pollen types will vary more than the frequencies of woody pollen types. Cheno-ams and Ambrosia-type will reach maximum frequencies near and on the floodplains. Animal-pollinated types, both

arboreal and non-arboreal, will be high in transect plots which contain the contributing plants.

Additional predictions of pollen rain variation can be made by examining the plant transects themselves. One would expect wind-pollinated types (such as Ambrosia-type) which occur in many transects to be consistently high (> 10 percent), while those which occur less frequently, like Gramineae and cheno-ams, to be variable, but still present in the background. Of the six woody plants which dominate the area or are locally abundant, only Quercus sp. is wind-pollinated and therefore everpresent in the background, though locally abundant. Because the other arboreal types are animal-pollinated, their relative frequencies will not be greater than 10 percent and probably closer to 2 percent. Pollen of Juniperus and Ephedra spp., both wind-pollinated, should contribute to the background rain and will be high, though not dominant, where the plants are present.

In comparing the relative frequencies of the pollen samples with the vegetation, some predictions are fulfilled, although differences from what was expected also occur (Table 12). Animal-pollinated herbs are not well represented in the pollen rain. Of the wind-pollinated types, Ambrosia-type pollen is present in all samples and generally higher frequencies occur with greater numbers of plants. Asteraceae-type frequencies are much lower than Ambrosia-type and there is little apparent association with the numbers of plants. In one case, 70 Baileya plants are associated with less than 2 percent Asteraceae-type pollen. Data are in Table and 13 and Figure 5.



Table 12. Pollen Counts from Plant Transects, Miami Wash, Arizona

| Provenience     | <u>Cheno-ams</u> | <u>Ambrosia-type</u> | <u>Gramineae</u> | <u>Juniperus</u> | <u>Quercus</u> | <u>Artemisia</u> | <u>Asterae-type</u> | <u>Caryophyllaceae</u> | <u>cf. Croton</u> | <u>Cruciferae</u> | <u>Cuscuta</u> | <u>Eriastrum</u> | <u>Eriogonum</u> | <u>cf. Eriogonum</u> | <u>Erodium-type</u> | <u>Euphorbia</u> | <u>Helianthus-type</u> | <u>Labiatae</u> | <u>Liguliflorae</u> | <u>Malvaceae</u> | <u>Nyctaginaceae</u> |
|-----------------|------------------|----------------------|------------------|------------------|----------------|------------------|---------------------|------------------------|-------------------|-------------------|----------------|------------------|------------------|----------------------|---------------------|------------------|------------------------|-----------------|---------------------|------------------|----------------------|
| Transects C & A |                  |                      |                  |                  |                |                  |                     |                        |                   |                   |                |                  |                  |                      |                     |                  |                        |                 |                     |                  |                      |
| Plot 1C         | 16               | 39                   | 14               | 24               | 21             |                  | 1                   |                        |                   |                   | +              |                  | 1                |                      |                     | +                |                        | 13              | +                   | 2                |                      |
| Plot 2C         | 32               | 43                   | 13               | 27               | 16             | 4                | 1                   |                        |                   | 1                 | 3              |                  | +                |                      | 1                   |                  |                        | 5               |                     |                  |                      |
| Plot 1A         | 24               | 32                   | 13               | 10               | 69             | 13               | 1                   |                        |                   | 1                 |                |                  |                  |                      |                     | 1                |                        | +               |                     | +                |                      |
| Plot 2A         | 79               | 49                   | 8                | 11               | 29             | +                | 1                   |                        |                   | 1                 | +              | 1                | +                |                      | 1                   | 3                |                        |                 | +                   | +                |                      |
| Plot 3A         | 50               | 74                   | 8                | 9                | 18             |                  | 5                   |                        | +                 |                   | 4              |                  | 2                | 1                    | 3                   | 2                |                        |                 |                     | +                | +                    |
| Plot 4A         | 160              | 16                   | 10               | 4                | 2              |                  |                     |                        | 1                 |                   |                |                  | +                |                      |                     | +                |                        |                 |                     |                  | +                    |
| Plot 5A         | 135              | 18                   | 7                | 3                | 10             |                  | 2                   |                        | +                 |                   | 1              |                  | 2                |                      | 1                   |                  |                        |                 |                     |                  |                      |
| Plot 6A         | 113              | 25                   | 11               | 1                | 6              | +                | 1                   | +                      | 4                 | +                 |                |                  | +                | +                    | +                   |                  | 21                     |                 |                     | 1                |                      |
| Plot 7A         | 84               | 34                   | 11               | 14               | 15             |                  | 2                   |                        |                   |                   | 5              | 1                | 2                |                      | 2                   | 1                | 3                      |                 |                     |                  |                      |
| Plot 8A         | 13               | 44                   | 31               | 24               | 12             | 3                | 2                   |                        |                   |                   |                |                  | 7                |                      | 2                   |                  |                        | 13              | 1                   |                  |                      |
| Transect B      |                  |                      |                  |                  |                |                  |                     |                        |                   |                   |                |                  |                  |                      |                     |                  |                        |                 |                     |                  |                      |
| Plot 1B         | 16               | 60                   | 17               | 20               | 19             | 2                | 2                   |                        |                   | 1                 |                |                  | +                |                      |                     | 4                | +                      | 2               | 1                   | 1                |                      |
| Plot 2B         | 10               | 48                   | 16               | 15               | 18             | 2                | 2                   |                        | +                 |                   |                |                  |                  |                      | +                   | 2                |                        | 1               |                     | 1                |                      |
| Plot 3B         | 14               | 61                   | 20               | 11               | 17             | 2                | 5                   |                        |                   |                   | 2              |                  | 2                |                      |                     |                  |                        |                 | 2                   |                  | +                    |
| Plot 4B         | 10               | 99                   | 22               | 15               | 12             | 1                | 1                   |                        |                   |                   | 7              | 1                |                  | +                    | +                   |                  |                        | 4               | 1                   | 1                | +                    |
| Plot 5B         | 21               | 70                   | 13               | 19               | 15             | 1                | 4                   |                        |                   |                   |                | +                | 1                |                      | 5                   |                  |                        | 14              | +                   | 1                | 1                    |
| Plot 6B         | 59               | 47                   | 11               | 5                | 13             | 1                | 3                   |                        |                   | 4                 | 10             |                  | 2                |                      | 6                   | 5                |                        | 1               | 1                   |                  | 1                    |
| Plot 7B         | 137              | 16                   | 8                | 7                | 13             | 1                |                     |                        |                   |                   | 1              |                  |                  | 1                    |                     | 1                |                        |                 |                     |                  |                      |
| Plot 8B         | 21               | 36                   | 11               | 17               | 93             | 1                | 1                   | 1                      |                   |                   | 1              |                  |                  |                      |                     |                  |                        |                 |                     |                  |                      |
| Plot 9B         | 13               | 32                   | 7                | 14               | 86             | +                | 3                   |                        |                   | +                 |                |                  |                  | +                    |                     | 1                |                        |                 |                     | 1                |                      |

Table 12. Pollen Counts from Plant Transects, Miami Wash, Arizona, cont.

| Provenience     | <u>Onagraceae, Gaura-</u><br><u>type</u> | <u>Onagraceae, Oenithera-</u><br><u>type</u> | <u>Plantago</u> | <u>Rumex</u> | <u>Tidestromia</u> | <u>Tribulus</u> | <u>cf. Vivia</u> | <u>Acacia</u> | <u>Alnus</u> | <u>Canotia-type</u> | <u>Sarcobatus</u> | <u>Cercidium</u> | <u>cf. Cleome</u> | <u>Cylindropuntia</u> | <u>Dodonaea</u> | <u>Ephedra nevadensis-type</u> | <u>Ephedra torreyana-type</u> | <u>Ericaceae</u> | <u>Fraxinus</u> | <u>Fouquieria</u> |
|-----------------|--|--|-----------------|--------------|--------------------|-----------------|------------------|---------------|--------------|---------------------|-------------------|------------------|-------------------|-----------------------|-----------------|--------------------------------|-------------------------------|------------------|-----------------|-------------------|
| Transects C & A |  |  |                 |              |                    |                 |                  |               |              |                     |                   |                  |                   |                       |                 |                                |                               |                  |                 |                   |
| Plot 1C         |  |  |                 |              |                    |                 |                  | +             |              |                     |                   |                  |                   | +                     | 1               |                                | 3                             |                  | 1               |                   |
| Plot 2C         |  |  |                 |              |                    |                 |                  | 1             |              | 4                   |                   |                  | 1                 |                       |                 | 1                              | 5                             | +                |                 |                   |
| Plot 1A         |  |  |                 |              |                    |                 |                  |               |              |                     |                   |                  |                   |                       |                 |                                | +                             |                  |                 |                   |
| Plot 2A         |  |  |                 |              |                    |                 |                  | +             |              |                     |                   |                  |                   |                       |                 | +                              |                               | +                | +               | +                 |
| Plot 3A         |  |  |                 |              |                    |                 |                  | 5             |              |                     | +                 | 1                | 1                 |                       |                 |                                |                               |                  |                 |                   |
| Plot 4A         |  |  |                 |              |                    |                 |                  | 1             |              |                     |                   |                  |                   |                       | +               |                                |                               |                  |                 |                   |
| Plot 5A         |  |  |                 |              |                    |                 |                  | +             |              |                     |                   | 1                |                   |                       |                 | 1                              | +                             |                  |                 |                   |
| Plot 6A         |  |  |                 |              | +                  |                 |                  | +             |              |                     |                   |                  |                   | +                     |                 | +                              |                               |                  |                 |                   |
| Plot 7A         |  |  |                 |              | 1                  | 1               |                  | 4             |              | 2                   |                   |                  |                   |                       |                 |                                |                               |                  | +               |                   |
| Plot 8A         |  |  |                 |              | 1                  |                 |                  | 6             |              | 8                   |                   | +                |                   |                       | 1               | 3                              | 4                             |                  |                 |                   |
| Transect B      |  |  |                 |              |                    |                 |                  |               |              |                     |                   |                  |                   |                       |                 |                                |                               |                  |                 |                   |
| Plot 1B         | 1  | +  |                 |              |                    |                 |                  | 2             | +            | 7                   | 1                 | 8                |                   |                       | 2               | 1                              | +                             |                  | +               | 1                 |
| Plot 2B         |  |  |                 | +            |                    | +               |                  | +             |              | +                   |                   | 1                |                   |                       | 1               |                                | +                             |                  |                 |                   |
| Plot 3B         | +  | 1  |                 |              |                    |                 |                  | 2             |              |                     |                   | 1                |                   |                       |                 | 2                              |                               | 4                | 1               |                   |
| Plot 4B         |  |  | 2               |              |                    | +               |                  | 2             | 1            | 1                   |                   | +                |                   |                       | +               | +                              | 2                             |                  |                 |                   |
| Plot 5B         |  | +  | 2               |              |                    | +               |                  | 10            |              |                     |                   | 1                |                   |                       | 1               | 1                              | +                             | +                | 2               |                   |
| Plot 6B         |  |  |                 | 1            | +                  |                 | 1                | 5             |              |                     |                   | 1                |                   |                       | 2               | 1                              |                               |                  |                 |                   |
| Plot 7B         |  |  |                 |              |                    |                 | +                |               |              |                     |                   |                  |                   |                       | 1               |                                |                               |                  |                 |                   |
| Plot 8B         |  |  |                 |              |                    |                 |                  | 1             |              |                     |                   | 2                |                   |                       | 1               | +                              | +                             |                  |                 |                   |
| Plot 9B         |  |  |                 |              | 1                  |                 |                  | 1             | +            |                     |                   |                  |                   |                       | 1               | +                              | 1                             |                  |                 |                   |

Table 12. Pollen Counts from Plant Transects, Miami Wash, Arizona, cont.

| Provenience     | <u>Juglans</u> | <u>Leguminosae</u> | <u>Liliaceae</u> | <u>Mimosa</u> | <u>Pinus</u> | <u>Prosopis</u> | <u>Rhamnus</u> | <u>Rhus glabra-type</u> | <u>Rosaceae</u> | <u>Salix</u> | <u>Simmondsia</u> | <u>Solonaceae</u> | <u>Unknown 17</u> | <u>Rubiaceae</u> | <u>Cereus</u> | <u>Cassia</u> | <u>Rhus</u> | <u>Populus</u> | <u>Boraginaceae</u> | <u>Betula</u> | <u>Abies</u> |
|-----------------|----------------|--------------------|------------------|---------------|--------------|-----------------|----------------|-------------------------|-----------------|--------------|-------------------|-------------------|-------------------|------------------|---------------|---------------|-------------|----------------|---------------------|---------------|--------------|
| Transects C & A |                |                    |                  |               |              |                 |                |                         |                 |              |                   |                   |                   |                  |               |               |             |                |                     |               |              |
| Plot 1C         | +              |                    | 22               |               | 2            | 4               |                |                         |                 | 1            | 32                | +                 | 3                 |                  |               |               |             |                |                     |               |              |
| Plot 2C         |                |                    |                  | 1             | 7            | 27              |                |                         |                 |              | 3                 | +                 | 3                 | +                |               |               |             |                |                     |               |              |
| Plot 1A         |                | 1                  | 8                |               | 4            | 2               |                |                         | 4               |              | 17                |                   |                   |                  | +             |               |             |                |                     |               |              |
| Plot 2A         |                | 1                  | 1                |               | 8            | 1               |                | +                       |                 | 2            | 1                 |                   |                   |                  |               | 1             | 2           |                |                     |               |              |
| Plot 3A         |                |                    |                  |               | 1            | 15              | +              |                         | +               |              |                   | +                 |                   |                  |               |               |             |                |                     |               |              |
| Plot 4A         |                |                    |                  |               | +            | 2               |                |                         | 1               |              | 3                 |                   |                   |                  |               |               |             |                |                     |               |              |
| Plot 5A         |                |                    |                  |               | 1            | 18              |                |                         |                 |              | 1                 |                   | 1                 |                  |               |               |             |                |                     |               |              |
| Plot 6A         |                |                    | +                |               | 1            | 14              |                |                         |                 |              | 2                 |                   |                   |                  |               |               |             |                |                     |               |              |
| Plot 7A         | +              |                    | 11               |               | 1            | 3               |                |                         | 1               |              |                   | 2                 |                   |                  |               |               |             | 1              |                     |               |              |
| Plot 8A         |                | 13                 |                  |               | 6            |                 |                |                         |                 | 1            | 2                 |                   |                   |                  |               |               |             |                | 1                   |               |              |
| Transect B      |                |                    |                  |               |              |                 |                |                         |                 |              |                   |                   |                   |                  |               |               |             |                |                     |               |              |
| Plot 1B         | 1              |                    | 20               |               | 2            | 1               |                |                         |                 | 7            | +                 | +                 |                   |                  |               |               |             |                |                     | 1             |              |
| Plot 2B         |                |                    | 66               |               | 1            | 7               |                |                         |                 | 7            |                   |                   |                   |                  |               |               |             |                |                     |               |              |
| Plot 3B         |                |                    | 42               |               | 4            |                 |                |                         | 1               | 2            | 1                 |                   |                   |                  |               |               |             |                |                     |               |              |
| Plot 4B         | +              |                    | 8                |               | 4            | 4               |                |                         |                 | 1            | 1                 |                   |                   |                  |               |               |             |                |                     |               |              |
| Plot 5B         |                |                    | 3                | 1             | 6            | 5               |                |                         |                 |              | 3                 |                   |                   |                  |               |               |             |                |                     |               | +            |
| Plot 6B         |                | 3                  | 1                | +             | 8            | 7               |                |                         |                 |              | +                 |                   |                   |                  |               |               |             |                |                     |               |              |
| Plot 7B         |                |                    |                  |               | 1            | 3               | 5              |                         |                 |              |                   | 1                 |                   |                  |               |               |             |                |                     |               |              |
| Plot 8B         |                |                    |                  |               | 7            | 4               | 2              |                         |                 | +            |                   | 1                 |                   |                  |               |               |             |                |                     |               |              |
| Plot 9B         |                |                    |                  | 33            | 2            | +               |                | +                       | 1               | 1            | 1                 |                   |                   |                  |               |               |             |                |                     |               |              |

Table 12. Pollen Counts from Plant Transects, Miami Wash, Arizona, cont.

| Providence      | Scrophulariaceae | cf. <u>Krameria</u> | <u>Ulmus</u> | <u>Celtis</u> |
|-----------------|------------------|---------------------|--------------|---------------|
| Transects C & A |                  |                     |              |               |
| Plot 1C         |                  |                     |              |               |
| Plot 2C         |                  |                     |              | 1             |
| Plot 1A         |                  |                     |              |               |
| Plot 2A         |                  |                     |              |               |
| Plot 3A         |                  |                     |              | 1             |
| Plot 4A         |                  |                     |              |               |
| Plot 5A         |                  |                     |              |               |
| Plot 6A         |                  |                     |              |               |
| Plot 7A         |                  |                     |              |               |
| Plot 8A         |                  |                     |              | 1             |
| Transect B      |                  |                     |              |               |
| Plot 1B         |                  |                     |              |               |
| Plot 2B         |                  |                     |              | 2             |
| Plot 3B         |                  |                     |              | 3             |
| Plot 4B         |                  |                     |              |               |
| Plot 5B         |                  |                     |              |               |
| Plot 6B         | 1                |                     |              | 2             |
| Plot 7B         |                  |                     |              | 4             |
| Plot 8B         |                  |                     |              |               |
| Plot 9B         |                  | 1                   | +            |               |

Table 13. Pollen Counts from Surface Samples, Miami Wash, Arizona

| Provenience                                     | Cheno-ams | <u>Ambrosia-type</u> | Gramineae | <u>Juniperus</u> | <u>Quercus</u> | <u>Artemisia</u> | Asterae-type | cf. <u>Croton</u> | Cruciferae | <u>Cuscuta</u> | <u>Ephedra-nevadensis-type</u> | <u>Ephedra-torreyana-type</u> | <u>Eriastrum</u> | <u>Erodium-type</u> | <u>Eriogonum</u> | <u>Euphorbia</u> | <u>Helianthus-type</u> | Labiatae | Malvaceae | Nyctaginaceae | <u>Plantago</u> | <u>Tidestromia</u> | <u>Tribulus</u> | <u>Acacia</u> | <u>Alnus</u> | <u>Canotia-type</u> | <u>Carya</u> | Ceanothus |
|---|-----------|----------------------|-----------|------------------|----------------|------------------|--------------|-------------------|------------|----------------|--------------------------------|-------------------------------|------------------|---------------------|------------------|------------------|------------------------|----------|-----------|---------------|-----------------|--------------------|-----------------|---------------|--------------|---------------------|--------------|-----------|
| 74-5-8-3,180 meters<br>east of Multi-<br>grade  | 134       | 15                   | 9         | 11               | 2              |                  | 3            | 4                 |            | 1              |                                | +                             |                  | +                   |                  |                  | 2                      | 1        |           |               |                 |                    |                 |               | +            |                     |              |           |
| 74-5-8-4,180 meters<br>south of Multi-<br>grade | 45        | 66                   | 11        | 21               | 17             | 1                |              | 1                 |            | 2              | 1                              | +                             | +                | +                   |                  | 2                | +                      | +        | +         | +             | 1               |                    | +               |               | 8            |                     |              |           |
| 74-5-8-5,90 meters<br>west of Monitor           | 108       | 31                   | 11        | 7                | 14             | 1                | 1            | +                 | +          | +              | +                              | +                             | +                | 1                   | +                | 1                | +                      | 2        | +         | +             | 2               |                    |                 |               | 2            |                     |              |           |
| 74-5-8-6,180 meters<br>south of<br>Monitor      | 50        | 49                   | 26        | 10               | 21             | 1                | 1            |                   |            | 17             | +                              | +                             |                  | +                   | +                |                  |                        | 1        |           | +             | 2               |                    |                 |               | 9            | 1                   |              |           |
| 74-5-8-7,180 meters<br>east of Monitor          | 17        | 69                   | 29        | 20               | 27             | 2                |              |                   |            | 2              | +                              |                               | +                | 2                   | 5                | 1                |                        | 5        | +         | +             | 1               |                    |                 |               | 5            |                     |              |           |
| 74-5-8-8,180 meters<br>north of Monitor         | 57        | 47                   | 9         | 8                | 20             | +                | 6            |                   |            | 4              | +                              |                               |                  | 2                   |                  | 1                |                        | 1        |           | 1             | +               |                    | +               | 2             |              | +                   |              |           |
| 74-5-8-12,180 meters<br>south of Refugia        | 29        | 54                   | 19        | 21               | 24             | +                | 3            | +                 |            | 3              | 1                              | 4                             | +                | 4                   | 1                | 10               |                        | 8        | +         | +             |                 | 1                  |                 |               | 4            |                     |              | 1         |
| 74-5-8-13,180 meters<br>east of Refugia         | 120       | 31                   | 6         | 4                | 7              | +                | 3            |                   | 1          |                | 1                              |                               |                  | 3                   |                  |                  |                        |          | 1         | +             |                 |                    |                 | +             |              |                     |              |           |
| 74-5-8-14,180 meters<br>north of Refugia        | 109       | 30                   | 5         | 13               | 19             |                  | 1            |                   | 1          |                |                                | +                             |                  | +                   | 2                |                  |                        | 1        |           |               | +               |                    |                 |               | 2            |                     |              |           |

Table 13 Pollen Counts from Surface Samples, Miami Wash, Arizona, cont.

| Provenience                                  | <u>Cheno-ams</u> | <u>Ambrosia-type</u> | <u>Gramineae</u> | <u>Juniperus</u> | <u>Quercus</u> | <u>Artemisia</u> | <u>Asterae-type</u> | <u>cf. Croton</u> | <u>Cruciferae</u> | <u>Cuscuta</u> | <u>Ephedra-nevadensis-type</u> | <u>Ephedra-Torreyana-type</u> | <u>Eriastrum</u> | <u>Erodium-type</u> | <u>Eriogonum</u> | <u>Euphorbia</u> | <u>Helianthus-type</u> | <u>Labiatae</u> | <u>Malvaceae</u> | <u>Nyctaginaceae</u> | <u>Plantago</u> | <u>Tidestromia</u> | <u>Tribulus</u> | <u>Acacia</u> | <u>Alnus</u> | <u>Canotia-type</u> | <u>Carya</u> | <u>Ceanothus</u> |
|--|------------------|----------------------|------------------|------------------|----------------|------------------|---------------------|-------------------|-------------------|----------------|--------------------------------|-------------------------------|------------------|---------------------|------------------|------------------|------------------------|-----------------|------------------|----------------------|-----------------|--------------------|-----------------|---------------|--------------|---------------------|--------------|------------------|
| 74-5-9-1, 180 meters<br>north of Tin-horn    | 107              | 51                   | 6                | 11               | 14             | 1                | 1                   |                   |                   |                |                                |                               |                  | 3                   |                  |                  |                        |                 |                  | 1                    |                 |                    |                 | 1             |              |                     |              |                  |
| 74-5-9-2, 180 meters<br>south of Tin-horn    | 70               | 61                   | 13               | 13               | 10             | +                |                     |                   | +                 | 3              | 3                              | 2                             |                  | 1                   | 1                | +                |                        | +               | +                |                      | 1               | 4                  | +               | +             |              |                     |              | 1                |
| 74-5-9-4, 180 meters<br>north of Tin-horn    | 68               | 84                   | 5                | 7                | 14             | 2                | +                   | +                 | 1                 | +              | +                              | +                             |                  | 1                   | 2                | 1                |                        |                 | +                | +                    |                 |                    |                 |               | 3            |                     |              |                  |
| 74-5-9-5, along<br>game trail,<br>Shurban    | 42               | 43                   | 20               | 12               | 45             |                  | 8                   | 1                 |                   |                | +                              |                               |                  | +                   | +                | 2                |                        |                 |                  |                      |                 |                    |                 | 4             |              | +                   | +            |                  |
| 74-5-9-6, 180 meters<br>south of<br>Columbus | 16               | 57                   | 17               | 17               | 64             | +                | 3                   |                   |                   |                |                                |                               |                  | 1                   |                  | 3                |                        |                 | 1                |                      |                 |                    |                 |               |              | 1                   |              |                  |
| 74-5-9-7, 180 meters<br>west of<br>Columbus  | 15               | 61                   | 27               | 22               | 26             | 2                | 3                   |                   | 2                 | 2              | +                              |                               |                  | +                   | +                | 2                |                        | 2               |                  | +                    | 2               |                    |                 | 1             | +            | 8                   |              |                  |
| 74-5-9-8, 180 meters<br>north of<br>Columbus | 49               | 42                   | 10               | 17               | 51             |                  |                     |                   | +                 | 1              |                                |                               |                  | +                   |                  |                  |                        |                 | +                |                      |                 |                    |                 | 1             |              |                     |              |                  |

Table 13. Pollen Counts from Surface Samples, Miami Wash, Arizona, cont.

| Province   | <u>Cercidium</u> | <u>cf. Cleome</u> | <u>Cylindropuntia</u> | <u>Dodonaea</u> | <u>Fraxinus</u> | <u>Juglans</u> | <u>Leguminosae</u> | <u>Liliaceae</u> | <u>Celtis</u> | <u>Ericaceae</u> | <u>Mimosa</u> | <u>Pinus</u> | <u>Prosopis</u> | <u>Rhus</u> | <u>Rhus glabra-type</u> | <u>Rosaceae</u> | <u>Salix</u> | <u>Simmondsia</u> | <u>Solonaceae</u> | <u>Unknown 7</u> | <u>Scrophulariaceae</u> | <u>Berberis</u> | <u>Rhamnus</u> | <u>Cereus</u> | <u>Onagraceae,<br/>Oenothera-type</u> | <u>Abies</u> |
|--|------------------|-------------------|-----------------------|-----------------|-----------------|----------------|--------------------|------------------|---------------|------------------|---------------|--------------|-----------------|-------------|-------------------------|-----------------|--------------|-------------------|-------------------|------------------|-------------------------|-----------------|----------------|---------------|---------------------------------------|--------------|
| 74-5-8-3, 180 meters<br>east of Multi-<br>grade  | 2                |                   |                       |                 |                 |                | +                  | 1                |               |                  |               | 1            | 5               | +           |                         |                 |              | 3                 | 2                 | +                |                         |                 |                |               |                                       |              |
| 74-5-8-4, 180 meters<br>south of Multi-<br>grade | +                |                   |                       | +               |                 | +              |                    | 3                | 1             |                  | 2             | 2            | 8               |             |                         | 3               | 2            | 2                 | +                 | +                | +                       |                 |                |               |                                       |              |
| 74-5-8-5, 90 meters<br>west of Monitor           |                  |                   |                       | 1               |                 |                |                    | 6                |               |                  |               | 1            | 5               |             | +                       |                 | 1            | 2                 | 3                 |                  |                         | +               |                |               |                                       |              |
| 74-5-8-6, 180 meters<br>south of Monitor         | 2                | 1                 |                       |                 |                 |                | 1                  |                  |               |                  |               | 1            | 2               |             |                         |                 | +            | 2                 | 1                 |                  |                         |                 | 2              |               |                                       |              |
| 74-5-8-7, 180 meters<br>east of Monitor          | +                | 1                 |                       |                 |                 |                | 3                  | 1                |               | +                |               | 4            | 6               |             |                         |                 |              |                   | +                 |                  |                         |                 |                |               |                                       |              |
| 74-5-8-8, 180 meters<br>north of Monitor         | +                |                   |                       |                 |                 | +              | 1                  |                  |               | +                |               | 1            | 29              |             |                         | 1               | 3            | 2                 | 3                 | 2                |                         |                 |                | +             |                                       |              |
| 74-5-8-12, 180 meters<br>south of Refugia        | 1                |                   | 1                     | 1               |                 | +              | 1                  | 1                |               | +                |               | 3            | 2               |             |                         | +               | +            | 1                 | 1                 |                  |                         |                 |                |               |                                       |              |
| 74-5-8-13, 180 meters<br>east of Refugia         |                  |                   |                       |                 | 2               |                |                    | 1                |               |                  |               | 1            | 7               |             | 1                       |                 |              | 1                 |                   |                  |                         |                 |                |               |                                       |              |
| 74-5-8-14, 180 meters<br>north of Refugia        | 1                |                   |                       |                 |                 |                | 2                  |                  |               |                  | 1             | 2            | +               | +           |                         | 2               | 3            | 6                 | +                 |                  |                         |                 |                |               |                                       |              |

Table 13. Pollen Counts from Surface Samples, Miami Wash, Arizona, cont.

| Province                                     | <u>Cercidium</u> | <u>cf. Cleome</u> | <u>Cylindropuntia</u> | <u>Dodonaea</u> | <u>Fraxinus</u> | <u>Juglans</u> | <u>Leguminosae</u> | <u>Liliaceae</u> | <u>Celtis</u> | <u>Ericaceae</u> | <u>Mimosa</u> | <u>Pinus</u> | <u>Prosopis</u> | <u>Rhus</u> | <u>Rhus glabra-type</u> | <u>Rosaceae</u> | <u>Salix</u> | <u>Simmondsia</u> | <u>Solonaceae</u> | <u>Unknown 7</u> | <u>Scrophulariaceae</u> | <u>Berberis</u> | <u>Rhamnus</u> | <u>Cereus</u> | <u>Onagraceae,<br/>Oenothera-type</u> | <u>Abies</u> |
|--|------------------|-------------------|-----------------------|-----------------|-----------------|----------------|--------------------|------------------|---------------|------------------|---------------|--------------|-----------------|-------------|-------------------------|-----------------|--------------|-------------------|-------------------|------------------|-------------------------|-----------------|----------------|---------------|---------------------------------------|--------------|
| 74-5-9-1, 180 meters<br>north of Tinhorn     | +                |                   |                       |                 |                 | +              |                    |                  |               |                  |               | +            | +               |             |                         |                 | 3            | 1                 |                   |                  |                         |                 |                |               |                                       |              |
| 74-5-9-2, 180 meters<br>south of Tinhorn     | 1                |                   | +                     | 1               | +               | +              | +                  | 1                |               |                  |               | 5            | +               |             |                         |                 | 4            | 3                 |                   | 1                |                         |                 |                |               | +                                     | +            |
| 74-5-9-4, 180 meters<br>north of Tinhorn     | 1                |                   |                       | 1               |                 |                | 1                  | +                |               | +                | 1             | 2            | +               |             | +                       |                 | 2            | 3                 |                   | +                |                         |                 |                |               |                                       |              |
| 74-5-9-5, along<br>game trail,<br>Shurban    | 2                |                   |                       | 1               |                 |                | 1                  | 7                |               |                  |               | 2            | +               |             | 1                       | 2               | 4            |                   | 1                 |                  |                         |                 |                |               |                                       |              |
| 74-5-9-6, 180 meters<br>south of<br>Columbus | 2                | 2                 |                       | 1               | 2               | 1              |                    | +                |               |                  |               | 2            | 1               |             |                         |                 |              | 7                 |                   | 2                |                         |                 |                |               |                                       |              |
| 74-5-9-7, 180 meters<br>west of<br>Columbus  |                  |                   |                       | +               |                 | +              | 5                  |                  |               |                  |               | 2            | 6               |             |                         |                 | 1            | 2                 | +                 |                  |                         |                 |                |               |                                       |              |
| 74-5-9-8, 180 meters<br>north of<br>Columbus |                  | 2                 |                       | 3               |                 |                |                    | 3                |               |                  | 3             | 2            |                 |             |                         | 1               |              | 12                |                   |                  |                         |                 |                |               |                                       |              |



Table 13. Pollen Counts from Surface Samples, Miami Wash, Arizona, cont.

| Providence                             | cf. Ranunculaceae | Cultivated Gramineae | Fonqueria | Liguliflorae | Ulmus | Unknown Labiatae | Onagraceae, Gaura-type | Krameria | Morus | Gilia | Typha angustifolia-type |
|--|-------------------|----------------------|-----------|--------------|-------|------------------|------------------------|----------|-------|-------|-------------------------|
| 74-3-9-1, 180 meters north of Tinhorn  |                   |                      |           |              |       |                  |                        |          |       |       |                         |
| 74-5-9-2, 180 meters south of Tinhorn  |                   |                      |           |              |       |                  |                        |          |       |       |                         |
| 74-5-9-4, 180 meters north of Tinhorn  | +                 | +                    |           |              |       |                  |                        |          |       |       | 1                       |
| 74-5-9-5, along game trail, Shurban    |                   |                      |           | 1            | +     |                  |                        |          |       |       |                         |
| 74-5-9-6, 180 meters south of Columbus |                   |                      |           |              |       |                  |                        |          |       |       |                         |
| 74-5-9-7, 180 meters west of Columbus  |                   |                      |           |              |       | +                |                        |          |       |       |                         |
| 74-5-9-8, 180 meters north of Columbus |                   |                      |           |              |       |                  |                        | +        | 1     | 1     |                         |

Table 13. Pollen Counts from Surface Samples, Miami Wash, Arizona, cont.

cf. Ranunculaceae  
 Cultivated  
 Gramineae  
Fonquieria  
 Liguliflorae  
Ulmus  
 Unknown  
 Labiatae  
 Onagraceae,  
Gaura-type  
Krameria  
Morus  
Gilia  
Typha angustifolia-  
 type

Providence

74-5-8-5, 180 meters  
 east of Multi-  
 grade  
 74-5-8-4, 180 meters  
 south of Multi-  
 grade  
 74-5-8-5, 90 meters  
 west of Monitor  
 74-5-8-6, 180 meters  
 south of Monitor  
 74-5-8-7, 180 meters  
 east of Monitor  
 74-5-8-8, 180 meters  
 north of Monitor  
 74-5-8-12, 180 meters  
 south of Refugia  
 74-5-8-12, 180 meters  
 east of Refugia  
 74-5-8-14, 180 meters  
 north of Refugia

1

The association of relative frequencies of grass pollen with the presence of grasses is not consistent. An instance of 50 percent ground cover is associated with 4 percent pollen, 33 percent ground cover with 16.5 percent pollen, and zero plants with 11 percent pollen. This lack of association might be due to dry conditions during the collection year.

This same climatic factor might also have affected the cheno-am pollen/plant association. The maximum amount of pollen, 80 percent, correlates with no identified cheno-am type plants. However, the next highest relative frequency is associated with the highest number of identified plants.

Of the woody plants, Quercus is well represented in the relative pollen frequencies and its association with identified plants is generally consistent. A maximum frequency of 46.5 percent is associated with the most plants, 15, identified in a single plot. Other frequencies also correlate with plant occurrence, with the exception of one plot 15 percent Quercus pollen was found but no oak trees were identified.

Acacia pollen was found in all but two plots, but its association is not consistent; 5 percent pollen occurs with 25 plants and < 2 percent with 29 plants. Due to the lack of close association between pollen and plants and the ubiquitous nature of the plants, Acacia pollen does not seem to be a good microenvironmental indicator.

Canotia pollen is rare, as are the plants, and the correlation is not absolute. Six plants were associated with 2 percent pollen and 1 plant with both 3 percent and 0 percent pollen.

Celtis is an oddity in the pollen rain/plant association, in that it occurs in eight pollen samples but hackberry plants were not identified in any plots.

A Cercidium pollen maximum of 4 percent occurred with the maximum of 14 palo-verde plants, but a small quantity of pollen, 2 percent, was found with zero plants.

Ephedra-type associations are not clear. Eleven transects contained Ephedra pollen, but no associated plants. Seven plants were found with < 2 percent pollen and 5 plants with 2 percent and < 2 percent pollen.

Juniperus pollen appears in the count of all 19 samples, but the plant is present in only two plots associated with 13.5 percent and 5.5 percent pollen, respectively.

Krameria sp. was found in 5 plots with 1 to 29 plants, but was not associated with any pollen in these plots. A frequency of < 2 percent Krameria pollen did occur, however, in a plot with no identified plants.

One of the best correlations between relative pollen frequency and associated plants is that of the family Liliaceae. A maximum of 33 percent pollen was associated with a maximum of 24 plants. Twenty-one percent pollen correlates with 20 plants, 11 percent with 5 plants, and 10 percent with 17 plants. From the data, one could predict that if greater than 2 percent Liliaceae pollen is found, then the associated plants will be present.

Another animal-pollinated plant which produced surprisingly large amounts of pollen associated with numerous plants is Mimosa. The highest frequency, 16.5 percent, was found in a plot with 45 plants. The next highest frequency, < 2 percent, was in a plot without Mimosa. One site contained a single plant, but no associated pollen.

Though pine plants were not identified in any plot, a pollen frequency of less than 10 percent pine pollen occurs in all samples. Pine is found in the higher mountains surrounding the area, and the ability of pine to float for some distance in air is well known (Faegri and Iversen 1950).

The association of Prosopis pollen with plants is inconsistent. Fifteen plants correlate with < 2 percent pollen; a high of 13.5 percent pollen is found with five plants. Three plots which have zero mesquite plants have < 2 percent pollen, and 10 plots which have mesquite trees have no mesquite pollen. Higher frequencies of Prosopis pollen (> 5 percent) appear to indicate the presence of the trees, but lack of the pollen cannot be construed as negative evidence.

Simmondsia pollen/plant association is similar to that of Prosopis in the lack of a clear correlation, but in the opposite manner. A maximum of 18 percent pollen is associated with a maximum of 25 plants, but 7 plants were found with < 2 percent pollen and zero plants with 8.5 percent pollen. In all, 11 samples had relative pollen frequencies ranging from 0 to 8.5 percent with no associated plants.

What conclusions can be drawn concerning the hypotheses and predictions? First, the magnitude of the differences (maximum frequency

mimus mimimum frequency) for relative frequencies of the herbs is reduced from Ambrosia-type and Gramineae, but increased for cheno-ams. Cheno-am pollen does, however, indicate proximity to the floodplain. Whether this is due to a difference in available water, disturbance, or alkaline soil is not known. Ambrosia-type pollen dominates the herbaceous pollen on both northeast- and west-facing slopes, and is lowest in frequency on and near the floodplain. It is not indicative of any particular microenvironment, except that it is not found in abundance on floodplains. Martin's (1963) supposition that cheno-am pollen indicates a low water table and Compositae pollen a high water table is not supported by the evidence at Miami Wash. Both types are present in close proximity to each other, but high cheno-ams are found on the active floodplain and high Compositae on the adjacent slopes. Though the Miami Wash-Pinal Creek system is not presently flowing, springs and vegetation indicate at least localized high water tables under the floodplain. Effective precipitation must be nearly equal for both types of plants, and might be even greater for the cheno-ams, since the drainage would be into the river bed. I feel that the dependent variable in the environment is not available moisture, but disturbance. In disturbed ground in the transitional zone, the growth of cheno-am type plants is favored over that of Compositaes. Evidence in this study is suggestive, but not definitive.

The association of woody plants and their respective pollen differs from prediction. Though the frequencies of the individual types--with the exception of Quercus--vary less than the frequencies of the dominant herbaceous plants, they are not subdued when compared

with the study in the Sonoran Desert (Hevly et al. 1965). The difference (over 44.5 percent) between the maximum and minimum pollen frequencies of Quercus is second only to cheno-ams. Liliaceae differs by 33 percent, Simmondsia by 18 percent, Prosopis by 13.5 percent, Juniperus by more than 11.5 percent, Pinus by 8 percent, Acacia by 5 percent, and Celtis by 3.5 percent.

Positive correlation between plant presence and pollen frequencies is also less than predicted. Twenty types have pollen associated with plant presence, but only eight have plant and pollen maxima in the same plots. The correlation is higher for woody types (12) than for herbaceous types (8). This is probably due to the growth of fewer annuals caused by lower winter precipitation, and also to the season in which the collections were made.

The final prediction of low variation of arboreal types in the background count is not valid for this area; this is true not only of wind-pollinated types like Quercus, but also of animal-pollinated types like Liliaceae. I believe this is due mainly to the variation in microenvironments, which produces widely different plant associations both in terms of quantity and variety of vegetation, i.e., this is indeed a Transition zone.

### Conclusions

The modern pollen rain and vegetational associations are complicated by microenvironmental conditions. In general, there is no constant background of arboreal pollen types, but rather a predominance of wind-pollinated types. Individual animal-pollinated

pollen types are locally abundant. The major feature of the pollen rain is the variability of the frequencies, reflecting the diversity of the environment.

### Ethnobotany and Modern Plants

Eight of the twenty plants identified (Hall no date) from the excavation of the sites (Table 14) were not found in the survey of modern plants. These were Abies cf. concolor, Anemone tuberosa, Celtis reticulata, Cleome serulata, Dodonaea viscosa, Lotus sp., Lupinus sp., and Portulaca sp., and Quercus gambelli. Of these, Lotus might not have been present because of the low precipitation during the collection year. All of the plants with the exception of Abies could be found in the environments present in the area today. As stated in Chapter 4 (p. 76), the nearest Abies is presently found in higher mountains approximately 16 kilometers (10 miles) from the Miami Wash area. Its presence in one site is not evidence for environmental or climatic change, but is best explained as cultural introduction, especially since Abies pollen was only found in that one structure. Other proposed cultural pollen types supported by the ethnobotanical evidence are Liliaceae, Liliiflorae, and cheno-ams. Pollen found in site samples but not proposed as cultural types include Celtis, cf. Cleome, cf. Condalia, Dodonaea, Erodium-type, Juniperus, Leguminosae, Prosopis, Gramineae, and Quercus.

Comparison of the plants found in the excavation of the site with the modern collection and the pollen record shows little evidence for environmental or climatic change.



Table 14. Plants Recovered and Identified from the Miami Wash Project (after Hall, no date)

| Scientific Name               | Common Name               | Pöllen Type          |
|-------------------------------|---------------------------|----------------------|
| <u>Abies cf. concolor</u>     | White fir                 | <u>Abies</u>         |
| <u>Agave sp.</u>              | Mescal                    | <u>Liliaceae</u>     |
| <u>Amaranthus sp.</u>         | Pigweed                   | <u>Cheno-am</u>      |
| <u>Anemone tuberosa</u>       | Wind-flower               | <u>Ranunculaceae</u> |
| <u>Celtis reticulata</u>      | Netleaf hackberry         | <u>Celtis</u>        |
| <u>Cirsium sp.</u>            | Thistle                   | <u>Liguliflorae</u>  |
| <u>Cleome Serrulata</u>       | Rocky Mountain<br>beeweed | <u>Cleome</u>        |
| <u>Condalia lycioides</u>     | Gray thorn                | <u>Condalia</u>      |
| <u>Cucurbita feotidissima</u> | Buffalo-gourd             | <u>Cucurbita</u>     |
| <u>Dodonaea viscosa</u>       | Hopbush                   | <u>Dodonaea</u>      |
| <u>Erodium texanum</u>        | Heron-bill                | <u>Erodium-type</u>  |
| <u>Juniperus monosperma</u>   | One-seed juniper          | <u>Juniperus</u>     |
| <u>Lotus sp.</u>              | Deer-vetch                | <u>Leguminosae</u>   |
| <u>Lupinus sp.</u>            | Lupine                    | <u>Leguminosae</u>   |
| <u>Portulaca sp.</u>          | Purslane                  | <u>Portulacaceae</u> |
| <u>Prosopis juliflora</u>     | Mesquite                  | <u>Prosopis</u>      |
| <u>Setaria sp.</u>            | Bristle grass             | <u>Gramineae</u>     |
| <u>Sphaeralcea sp.</u>        | Globe-mallow              | <u>Malvaceae</u>     |
| <u>Quercus gambelii</u>       | Gambel's oak              | <u>Quercus</u>       |
| <u>Yucca sp.</u>              | Yucca                     | <u>Liliaceae</u>     |

## CHAPTER 6

### CONCLUSIONS

The initial goals of this study, as established in the introduction, were: (1) to test the validity of using palynology in archaeological sites in the arid Southwest for cultural and environmental interpretations; (2) to examine the modern geological and botanical environment in order to compare and amplify the archaeological and palynological interpretations; and (3) to define the ecological relationships of the prehistoric inhabitants of the Miami Wash-Pinal Creek areas with their environment. The success of this study obviously depends upon achievement of these goals.

An additional goal of any research is to amplify present knowledge in the discipline. This study contributes to environmental analysis in Southwestern archaeology in four areas: (1) it describes pollen sampling methods in detail, explaining both practical techniques and their theoretical basis; (2) it examines previously untested hypotheses upon which prior investigations were based; (3) it introduces a technique, sediment size analysis, which, though not new to geology, has not previously been used in conjunction with pollen analysis; and (4) it examines the modern pollen rain in association with plant communities in order to enhance environmental interpretations of archaeological sites.

### Goals

One primary goal was to test the application of pollen analysis to the interpretation of cultural use and introduction of plants. Previous studies such as that by Hill and Hevly (1968) assumed that plants were introduced by man and based interpretations of function and age of archaeological structures on that assumption. No attempt was made in these studies to predict pollen types or percentages. In this study predictions of pollen types--based on prior ethnobotanical analysis (Bohrer 1962)--and of relative frequencies of pollen which would define cultural types are made. Interpretations are based on comparison among pollen samples in specific cultural contexts and with pollen profiles in modern surface samples. The data confirm the value of pollen analysis for the interpretation of cultural introduction and use of plants.

Another goal was to test the validity of making pre- and post-abandonment environmental interpretations based on pollen samples collected in an area which man had occupied and therefore disturbed. Two questions are involved here: (1) can the site environment during occupation be interpreted from pollen samples found on house floors; and (2) can the site environment after occupation be interpreted from pollen samples deposited in the sediment which filled the houses after abandonment? Prior studies (Hill and Hevly 1968, Schoenwetter 1962, 1965, 1970) assumed both questions to be true.

The hypothesis of this study was that pollen deposited during occupation reflects a disturbed environment rather than a natural

one. The pollen spectra from the sites studied support this prediction. In order to interpret the natural environment from such samples, a means of characterizing and compensating for this disturbance factor must be found. At the present time no such means is available.

The next hypothesis was that the pollen in a stratigraphic column does not primarily reflect climatic change. The data support this hypothesis and suggest that microenvironmental investigation of sediment deposition on house floors is needed. A stratigraphic technique, sediment size analysis, was introduced as a possible independent indicator of environment. Comparison with the pollen samples, however, produced inconclusive results, suggesting that more empirical research is necessary.

The question of whether pollen analysis of stratigraphic columns is worthwhile may justifiably be posed. Collection, extraction, and analysis of eight sediment samples from a short stratigraphic column may take over forty research hours. Is the information gained worth the cost in time and money? There is no easy answer. I am convinced by this study that it is not possible to interpret pollen in stratigraphic columns based on single, universal variable; nor should samples be analyzed simply to find out what is in them. I would suggest, instead, two directions in which to proceed. The first involves the formulation of specific questions and predictions about each column, questions such as "was this a food processing area?" coupled with the prediction that "If this was a food processing area

then high frequencies of (a stated) cultural pollen will be present near floor level." The second direction calls for extensive micro-environmental investigation of the mechanisms which affect deposition on house floors. Though each floor to some extent represents an individual situation, it is possible that given some limitations, parameters of the variables could be established. Both of the above directions will require continual communication among the investigators involved. Such communication would be, perhaps, the principal contribution of such investigations.

The second goal was the examination of the geological and vegetal environment and their comparison with the archaeological and palynological interpretations. Geologically, the area offers land suitable for cultivation, permanent water, habitation locations, and raw material for lithic implements. The vegetal resources reflect a diverse environment, one not easily defined in terms of specific plant associations. Pollen samples were collected in conjunction with the plant transects in order to determine the extent of local and regional pollen contribution. The wide variety of pollen types and pollen frequencies indicates that the local contribution is considerable. A comparison of the modern surface pollen rain with the archaeological samples and the plant collection with the flotation specimens; indicates that the vegetation was probably as diverse then as it is now. The variety of plant groups and pollen rain makes interpretation of pollen frequencies from pre- and post-abandonment samples even more difficult, because it means that the samples reflect very limited

areas. Changes in pollen rain in one area over time could reflect microenvironmental variation due to minor channeling or sediment deposition, or natural vegetational changes associated with plants growing, maturing, and dying, and then being replaced by other plants, rather than regional environmental or climatic changes.

As stated in the introduction, it is doubtful whether the third goal, a definition of the ecological relationship of the Salados with their environment is, or will ever be, possible, but some hypotheses concerning this relationship can be made.

The transition zone of the Globe-Miami area presented an unusual variety of floral, faunal, and geological attributes. The vegetation included plants found in higher northern climes, as well as those occurring in lower, more southern deserts. The gathering potential was thus greater than in either clime alone, with a supply of grain amaranths, composites, acorns, buckthorn, cacti, and other plants easily available, as well as more mesic plants like fir at higher elevations, within walking distance. Moreover, not only were these potential resources present, they were demonstrably exploited as is indicated by both the pollen analysis and the flotation samples.

The physical environment of the area also presented a varied potential. Floodplains, with perennial streams and/or natural springs, ensured the inhabitants sufficient water for personal use and for farming. Terraces and mesa tops provided space for small- and large-scale dwellings, and there was an abundance of suitable raw material for chipped lithic tools.

It is easy to see what the environment offered the prehistoric inhabitants of this area. It is more difficult to define how that environment affected the people and how the people affected the environment. One unknown variable is population density. How many people occupied the area at any one time? By personal observation, the Globe-Miami area contains many large and small sites, few of which have been scientifically excavated. Were any of these sites contemporaneous? How many? When? At the present time it is impossible to answer these questions.

Considering the particular sites studied, how did their inhabitants affect their micro-environment? From the evidence of the pollen samples, it appears that abundant weed-type plants grew near sites while they were inhabited. There was probably little vegetation within the sites themselves due to clearing of brush and ground packed hard by daily traffic, but a dense circle of Palmer's amaranths and other "weeds" probably grew around the perimeter of the sites. These plants may have melded into the natural vegetation further (about 30 meters) from the site. The gathering of wood for fuel would have affected an even larger undefined area.

The final, hitherto unspoken question concerning the ecology of the Salados is, why did they abandon the area? This same question has been asked of every early culture in the Southwest, and a convincing answer for either the Salados or for the other groups, has yet to be found.

The ecology of any single organism is a complex study. The ecology of a people, especially an extinct culture, is of greater complexity. In order to study the ecological relationship of a culture to its environment, that environment must be well known, and well defined. And in order to define it, the tools and techniques used must be tested and honed to a fine degree of precision and accuracy. In answer to Butzer's question, "are we really trying?" I would answer, "yes, we are trying, but perhaps too hard." We have been trying to test hypotheses without knowing whether or not our assumptions and hence our techniques for testing these hypotheses are valid. If cultural ecology is to achieve its goal, it must be based upon sound knowledge of the environment of the past, and this knowledge is impossible without sound methods based upon assumptions verified by empirical testing.

Three of the four original contributions of this study have been discussed. The fourth contribution--the how and why of sample collection--is, to me, one of the major contributions. Ideally, the palynologist should be present during any pollen sample collection. This is not usually possible. Archaeologists often ask palynologists how samples should be taken; how many are necessary; and where should they be located? A reasonable response is, "Why do you want to take pollen samples?" Once this question is addressed it is possible to make some generalizations about specific aspects of pollen sampling. A general understanding of the basis for sample collection will better enable the archaeologist to formulate questions for each specific excavation.



Heretofore I have mainly discussed the findings of my investigations and their specific contributions to knowledge in the discipline. But perhaps the greatest value of this work derives from the process which was used to arrive at these findings. My participation as an environmental scientist began in the formative phases of the excavation and continued with an active role in the excavation and field analyses. The interpretation of the findings was enhanced by further discussion and communication with the archaeologists. The rewards of this process have been multiple. Not only has archaeological and environmental knowledge been increased, but there has been increased comprehension by the investigators of mutual and individual problems. This comprehension has been of obvious benefit to this particular investigation, and will continue to benefit any future investigation.

## APPENDIX A<sup>1</sup>

### POLLEN ANALYSIS AT USHKLISH

In 1972, I conducted a pollen study at Ushklish, a Hohokam site in Tonto Basin, Arizona. The hypothesis for the analysis was that one sample per archaeological structure does not reflect the average pollen rain in that structure or in the site and is therefore not sufficient for accurate interpretation of the environment, either cultural or natural. To test that hypothesis two or more samples from areas of the same floor were analyzed and tested, using a chi square test (p. ). The statistical test was applied to the Compositae, chenopods, and "all other types" in the samples of each structure. Nine houses--2, 3, 5, 7, 8, 9, 10, 11, and 12--were included in the study. Houses 1 and 6 were excluded because one of the samples from each structure was collected from under an artifact and was therefore inherently biased. The following table gives the calculated chi square value for the samples in each house:

| <u>House</u> | <u><math>\chi^2</math></u> |
|--------------|----------------------------|
| 2            | 2.313                      |
| 3            | 1.440                      |
| 5            | 19.064                     |
| 7            | 4.451                      |
| 8            | 4.145                      |
| 9            | 16.901                     |
| 10           | 33.572                     |
| 11           | 0.067                      |
| 12           | 11.219                     |

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1. From Lytle-Webb in press.

The sets of samples from houses 5, 9, 10, and 12 were significantly different at the 0.05 level of significance. Houses 9 and 10 were especially notable, in that one sample from each house was high in Compositae pollen and low in cheno-am pollen and the other sample was high in cheno-am pollen and low in Compositae. In either case, opposing interpretations could have been made if only one sample had been analyzed.

It is obvious from this study that a single sample from a floor is not sufficient for interpretation. How many samples are necessary is not known. At the present time some experimentation is necessary. Theoretically, however, a composite sample which includes pollen from many points should be acceptable as reflecting the pollen rain over the whole floor.

## APPENDIX B

### POLLEN ANALYSES OF CONTEMPORARY INDIAN VILLAGES AND FIELDS

With the help of Dr. Bernard Fontana (Department of Anthropology, University of Arizona), samples were taken from structures in the Papago villages surrounding San Xavier Mission on the floodplain of the Santa Cruz River southwest of Tucson, Arizona. The native vegetation is a typical lower Sonoran creosotebush-bursage community. Near the roads and villages saltbush (Atriplex sp.), careless weed (Amaranthus palmeri) and Russian thistle (Salsola kali) are common. Dense mesquite thickets (Prosopis juliflora) grow close to the river bed. Introduced plants in and around the villages include salt cedar (Tamarix pentandra) and Aleppo pine (Pinus halepensis).

For the pollen study, three samples were collected from occupied houses (two from one house), one each from two abandoned houses, one from a storage room, four from areas around one house, one from a nearby cotton field, and one from beneath a ramada. Floor samples were taken by sweeping large parts of the rooms with wisk brooms in order to obtain enough material for analysis and to produce composite samples. Samples outside of houses were also composite samples, collected by combining trowel tips of dirt taken in a circle as described by Hevly et al. (1965). The general locality of the mission is becoming urbanized; a freeway transects the reservation and the mission is bordered by residential subdivisions on three sides. It was therefore not possible to take a control sample which would

reflect an undisturbed environment. The control sample used is from "Modern Pollen Rain in the Sonoran Desert" (Hevly et al. 1965). The sample consists of two pollen spectra (19 and 20) from a floodplain in the Avra Valley, circa 10 miles northwest of San Xavier. There is a possibility for error in comparing this control with the village samples, but the results of the comparison are so dramatic that the implications are inescapable. In all but one area, the samples from San Xavier contained over 20 percent more cheno-ams than did the control sample. Around Tucson, plants which contribute cheno-am type pollen to the pollen rain are those which are favored by disturbance. They include careless weed and saltbush which, as previously mentioned, are found near roads and houses on the mission.

Another study which supports an increase in pollen from disturbance plants which grow near inhabited areas involves a comparison of field samples from the fields. In the spring of 1974, Drs. Allen Solomon and Gerald Kelso and I analyzed samples from nineteenth and twentieth century fields near Tesuque and Nambe Pueblos, north of Santa Fe, New Mexico. In almost all cases the percentage of non-arboreal (disturbance) pollen was much greater in the field samples than in the control samples (up to 47 percent at both Nambe and Tesuque Pueblos). In no instance was the ratio of arboreal pollen to non-arboreal pollen greater in the field samples than in the control samples for either pueblo.

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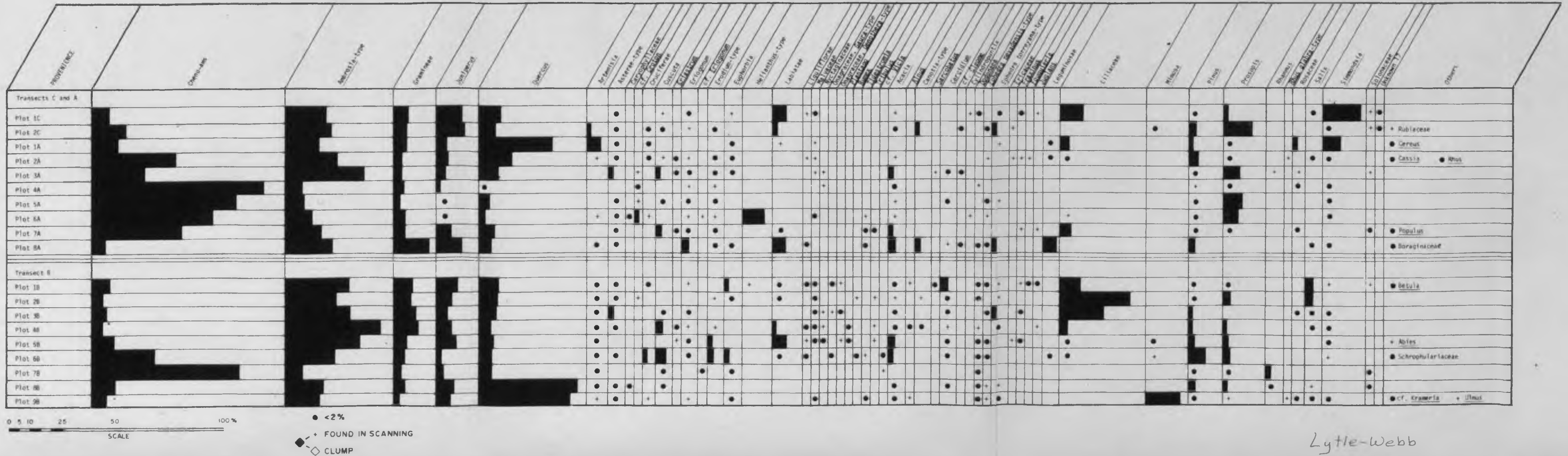
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Fig.5 POLLEN FROM PLANT TRANSECTS, MIAMI WASH, ARIZONA



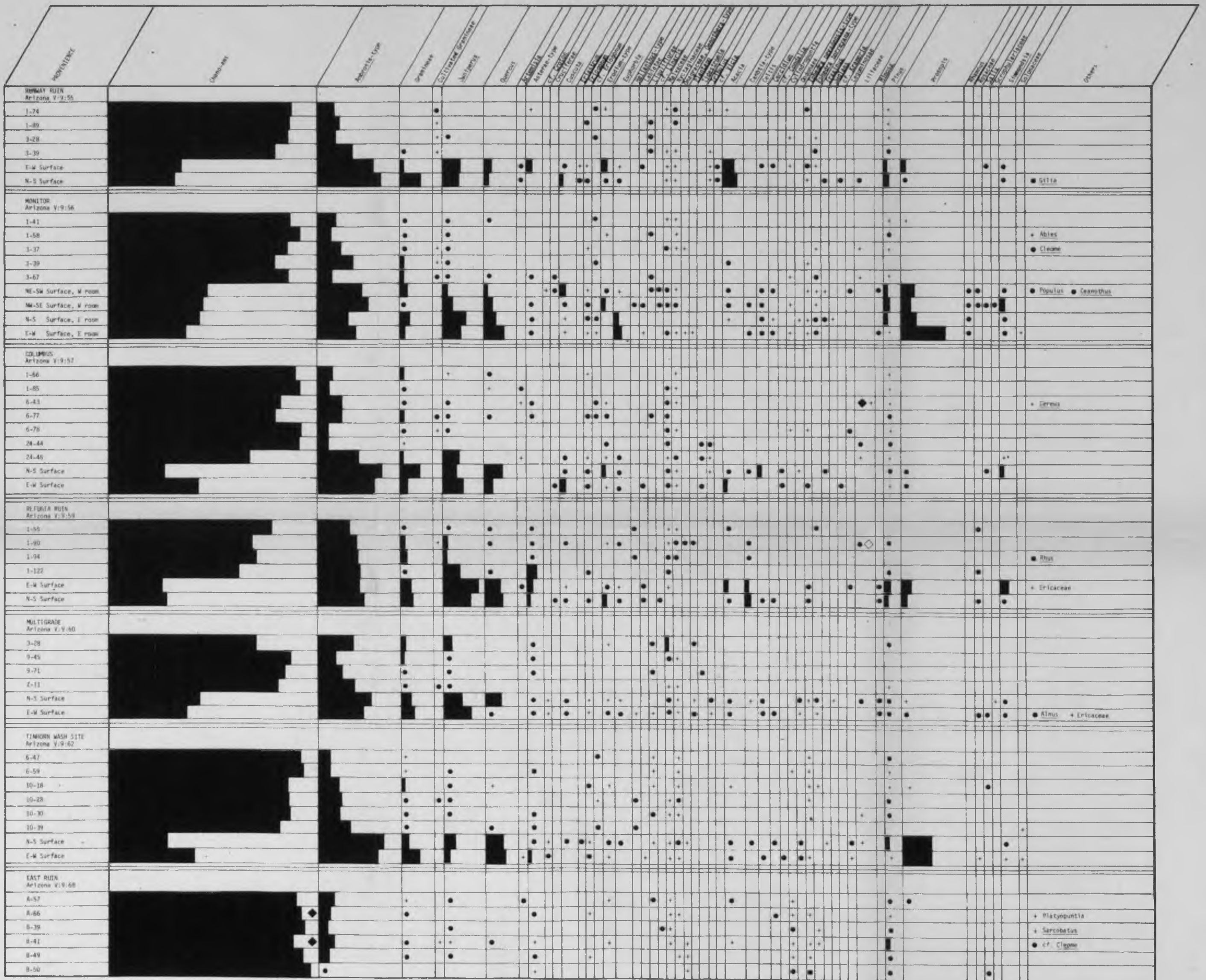
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Fig.2 POLLEN IN FLOOR SAMPLES, MIAMI WASH, ARIZONA

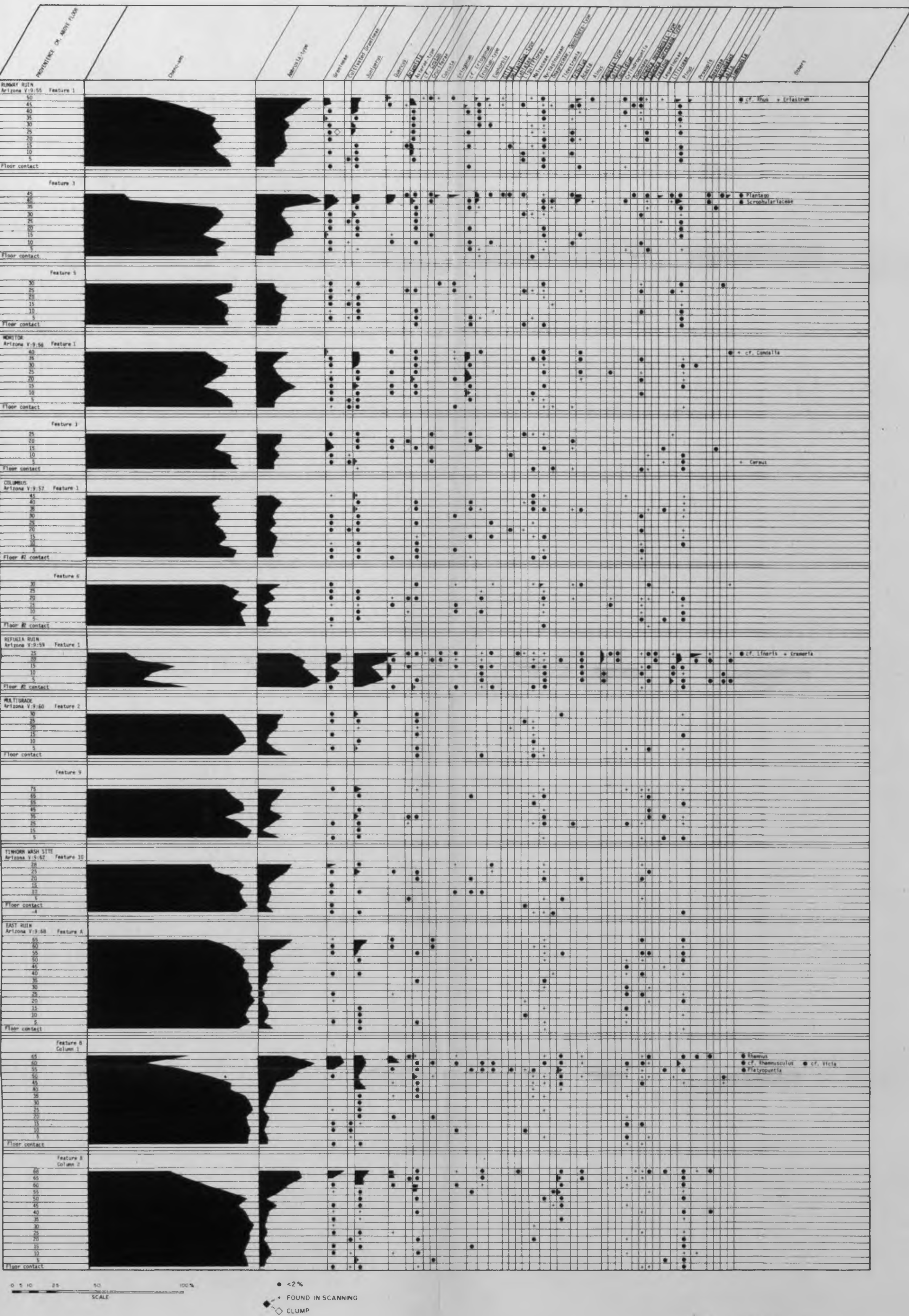


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Fig.6 POLLEN FROM STRATIGRAPHIC COLUMNS, MIAMI WASH, ARIZONA

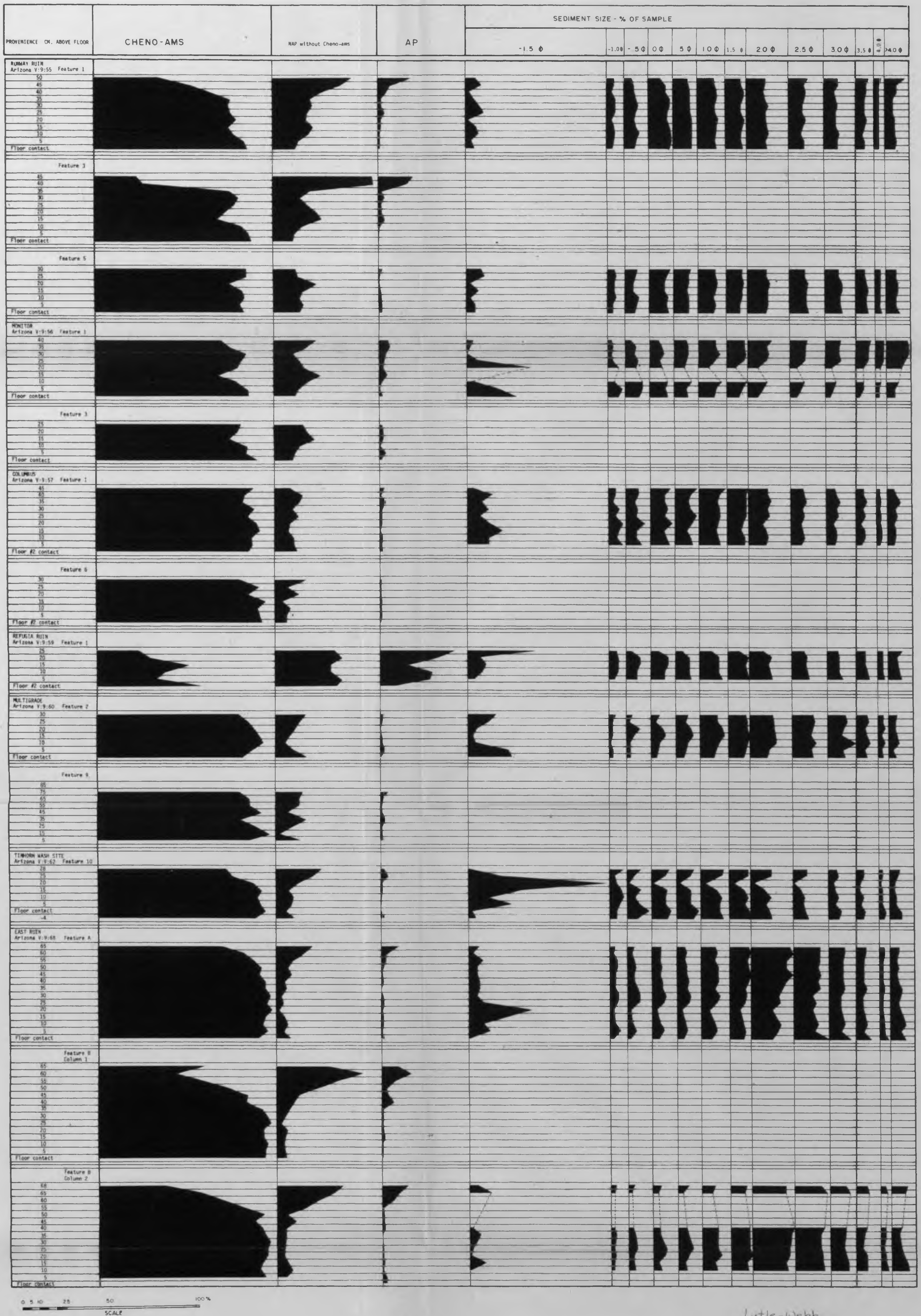


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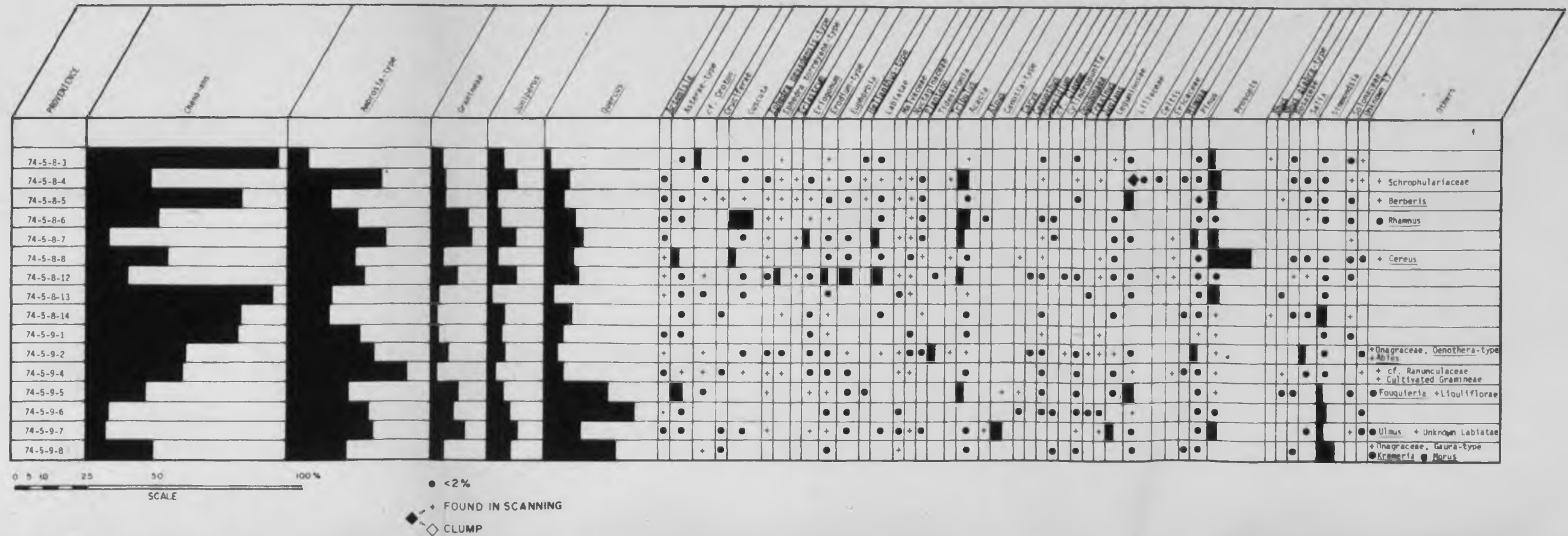
Fig.7 POLLEN AND SEDIMENT PARTICLE SIZE FROM STRATIGRAPHIC COLUMNS, MIAMI WASH, ARIZONA



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Fig.8 POLLEN FROM SURFACE SAMPLES, MIAMI WASH, ARIZONA



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