CHAPTER 15

POLLEN ANALYSIS OF THE CLEARWATER SITE, AZ BB:13:6 (ASM)

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INTRODUCTION

Pollen analysis of 52 sediment samples from the Clearwater site, AZ BB:13:6 (ASM), was conducted as part of the Rio Nuevo Archaeology project. The analysis confirms some patterns in the regional archaeological pollen record and also identifies some new features. Some shifts in the represented plant taxa indicate fluctuations in water table levels related to climatic changes or intensive irrigation.

Setting

The Clearwater site is located in the historic-era floodplain of the Santa Cruz River, 730 m elevation, 32°, 13' N; 110°, 59' W. Mean annual precipitation in Tucson, Arizona, is 287 mm, mean annual (monthly) temperature is 19.2°C (Sellers and Hill 1974). Pre-urban upland vegetation of the Tucson Basin would have been classified as Arizona Upland division of the Sonoran Desert. Characteristic plants included creosotebush (*Larrea tridentata*), paloverde (*Cercidium microphyllum*), and saguaro (*Cereus gigantea*) (Brown 1982).

Prehistoric streamside vegetation of the Santa Cruz River included trees such as cottonwood (*Populus*), ash (*Fraxinus*), willow (*Salix*), sycamore (*Platinus*), and walnut (*Juglans*), and herbaceous plants such as cattail (*Typha* spp.) and bulrushes (*Scirpus* spp.) (Davis 1994b). Arid reaches were dominated by members of the Chenopodiaceae family—including saltbush (*Atriplex canescens, A. polycarpa*) and pigweed (*Chenopodium album*), as well as careless-weed (*Amaranthus palmeri).* Dry cienega vegetation may also have been dominated by ragweeds (*Ambrosia psilostachya, A. trifida*) (Martin 1963).

Previous Studies

Pollen analysis has been performed for many archaeological sites in the Tucson Basin, spanning the Archaic and Ceramic periods and the Historic era (Figure 15.1; Table 15.1). Sites near stream channels (riparian) are more common, although upland sites (far from streams) have also been studied. The upland samples generally have lower pollen concentrations and higher percentages of deteriorated pollen. The pollen assemblages of upland sites are typically dominated by bursage (*Ambrosia*) and sunflower (other Compositae) pollen types, and sites from floodplain settings are usually dominated by the Chenopodiaceae-*Amaranthus* pollen type (see Table 15.1). Although all three of these dominant pollen types are produced by various species of weeds, they are also produced by important components of the natural vegetation.

The pollen of weeds such as spiderling (*Boerhaavia*), spurge (*Euphorbia*), globemallow (*Sphaeralcea*), and tidestroemia (*Tidestroemia*) is common in pollen samples from archaeological sites in the Tucson Basin. Ordinarily, the combined abundance is less than 5 percent, with individual values over 2 percent found usually restricted to permanent habitations. However, abundances over 20 percent have been reported (Fish 1985).

The pollen of cultivated plants is often present in Tucson Basin archaeological samples. Maize (*Zea*) pollen is generally the most abundant cultigen, although it shows considerable variability among samples from the same site. Often, only one or two grains are found, but values over 40 percent have been reported from artifacts and major habitation sites (Davis 1998).

The two archaeological sites closest to Clearwater with palynological investigations are Julian Wash, AZ BB:13:17 (ASM) (Davis 1998), and Tumamoc Hill, AZ AA:16:6 (ASM) (Davis 2004) (see Figure 15.1). These follow the pattern of other southern Arizona archaeological samples in that the Julian Wash samples are dominated by Chenopodiaceae-*Amaranthus* pollen and Tumamoc Hill samples are dominated by bursage (*Ambrosia*) and sunflower (other Compositae) pollen. Both sites have occasional pollen of streamside (riparian) vegetation. Julian Wash samples contain less than 1 percent fern spores in two of 17 samples, and Tumamoc Hill samples contain less than 1 percent fern spores in seven of 41 samples.

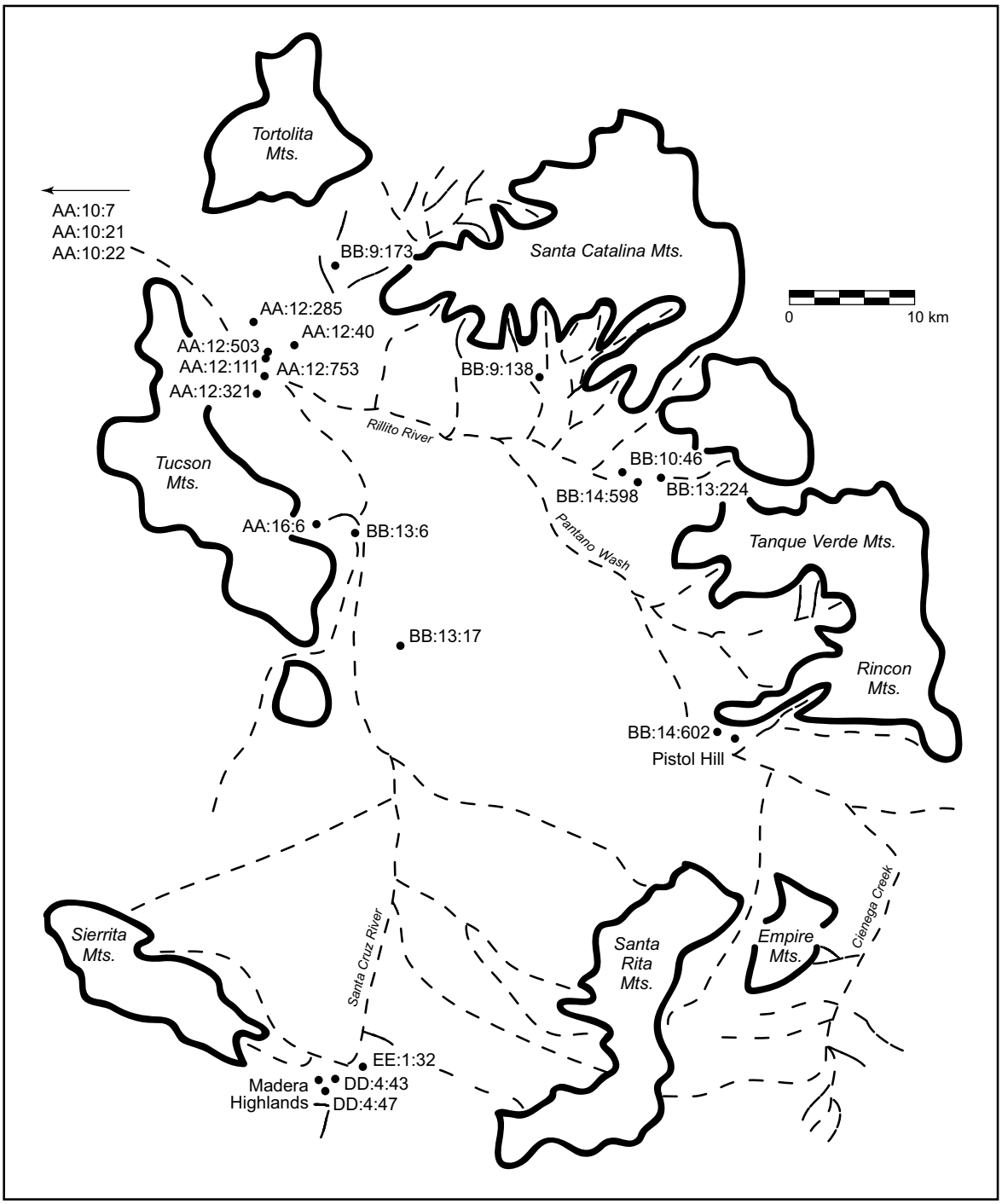

Figure 15.1. Map of the Tucson Basin, showing location of archaeological sites for which pollen analyses have been completed.

METHODS

Pollen was extracted from the sediment samples by routine acid digestion (Table 15.2). One *Lycopodium* tablet (13,911 spores) was added to each sample (volume = 5 cm^{-3}) to permit calculation of pollen concentration.

Quantification

The pollen sum—the divisor for calculating pollen percentages—includes all upland plants. Pollen of aquatic plants, spores of ferns and fungi, algae, charcoal, and other microfossils are not included in this sum. Although 300 grains, the desired goal, could

Table 15.1. Comparative pollen statistics for southern Arizona archaeological sites. (The samples are arranged by site number, riparian sites first and upland sites last.)

AZ (ASM) Site No.	Habitat	Reference	Age	Concentration (grains/cc)	Deterioration (percent)	Cheno-am (percent)	Ambrosia (percent)	Composites (percent)
AA:12:111	Riparian	Davis 2001	Archaic-modern	800-285,200	3-54	28-86	1-11	0-25
AA:12:285	Riparian	Fish 1992	Pioneer	–	–	14-74	–	6-32
AA:12:40	Riparian	Davis 1997b	Rincon	2,700-10,500	22-50	11-45	5-44	2-10
AA:12:503	Riparian	Davis 1999c	Archaic-modern	19,000-613,000	0-10	65-97	1-5	1-19
AA:12:736	Riparian	Cummings and Mou-toux 2000	Archaic-modern	390-33,600	0-8	20-90	1-25	3-55
AA:12:753	Riparian	Davis 2000	Archaic-modern	790-49,000	5-35	25-90	1-8	5-25
BB:9:120	Riparian	Davis 1983	Tanque Verde	43,100-214,500	31-72	10-54	0-10	9-17
BB:9:138	Riparian	Davis 1994a	Rincon	2,000-15,000	5-28	28-61	1-22	5-19
BB:9:173	Riparian	Davis 1996c	Rincon	300-1,000	11-17	18-31	5-15	11-19
BB:10:46	Riparian	Davis 1984a	Archaic	100-38,000	48-75	2-23	0-3	3-9
BB:13:17	Riparian	Davis 1998	Colonial-Sedentary	5,000-120,000	5-30	45-91	1-3	1-4
BB:13:224	Riparian	Davis 1984b	Rincon	11,000-82,500	10-34	30-57	1-7	12-25
BB:14:598	Riparian	Davis 1996d	Rincon	322	18	22	1	27
BB:14:602	Riparian	Davis 1997a	Classic	600-6,000	11-18	2-10	0-6	50-70
DD:4:43	Riparian	Davis 1999a	–	9,500	10	76	5-30	1-70
DD:4:47	Riparian	Davis 1999b	–	9,700-22,000	6-13	72-87	0-5	1-2
EE:1:32	Riparian	Davis 1995	Contem-porary	493,000	7	87	1	1
EE:1:32	Riparian	Davis 1995	Tanque Verde	12,000-430,000	1-40	46-97	0-1	1-8
AA:10:21	Upland	Davis 1997a	Pioneer	5,900-105,400	3-29	2-49	1-80	2-50
AA:10:22	Upland	Davis 1997a	Rillito	3,100-70,250	1-47	1-53	0-71	0-51
AA:10:7	Upland	Davis 1997a	Proto-historic	3,500-24,000	1-22	1-14	1-49	9-50
AA:12:321	Upland	Davis 1996a	Pioneer	950-1,225	9-17	19-22	1-2	30-44
AA:16:6	Upland	Davis 2004	Hohokam	850- 22,730	1-14	11-43	3-27	13-47
BB:14:15	Upland	Davis 1999d	–	1,000-6,000	20-60	10-50	10-35	11-45
Modern	Upland	Davis 1995	Contem-porary	3,300	0	17	22	16

not be counted for all samples, more than 1,000 microfossils are routinely recorded for each sample. Pollen clumps (aggregates) were counted as four grains, and clumps were not recorded separately. Clumps may indicate local occurrence of the plant, local processing of the plant, or animal transport of the pollen (Davis and Buchmann 1994).

The pollen concentration is calculated for the pollen sum, based on *Lycopodium* tracers added to the sample at the beginning of the extraction process. The pollen concentration is an index of preservation and the sediment accumulation rate. Low concentration, combined with poor preservation, may indicate loss of pollen through deterioration, making interpretation of the pollen assemblage questionable. Alternately, good preservation and low concentration might result from rapid accumulation of the clastic sediment matrix.

Table 15.2. Pollen extraction procedure.

(1) Add one *Lycopodium* tablet (batch #710961; 13,911 grains/tablet)
(2) Swirl solution, let stand 15-20 seconds, and screen (180-micron mesh, stainless steel) into 50-ml test tubes; rinse
(3) Add 10 ml concentrated HCl; mix; add 30 ml H_2O; mix; centrifuge; decant; water rinse
(4) Add 40 ml HF overnight or 1 hour in boiling water bath; centrifuge; decant; water rinse; transfer to 15-ml glass tubes
(5) Acetolysis[a]: centrifuge, decant, water rinse
(6) Add 10 ml 10-percent KOH 2 minutes boiling water bath; centrifuge; decant; water rinse with hot water until clear
(7) Stain with safranin "O"
(8) Transfer to labeled 1-dram shell vials
(9) Add a few drops of glycerin

[a]Acetolysis: (1) 5 ml glacial acetic acid, centrifuge and decant; (2) stir sample, add 5 ml acetic anhydride (volumetric dispenser); (3) add 0.55 ml H_2SO_4 to acetic anhydride solution (volumetric pipet), mix, centrifuge, decant into glacial acetic acid; and (4) 5 ml glacial acetic acid, centrifuge and decant.

RESULTS AND INTERPRETATION

The pollen preservation in Clearwater samples is variable and frequently poor; 300 grains of upland pollen could be counted for only nine samples (Table 15.3). The pollen concentration is also quite variable; it averages a low-moderate value of 2,690 grains/cc (grains cm^{-3}), but it ranges from 35-64,000 grains/cc. Contexts and dating of the pollen samples are provided in Table 15.4.

The diversity of pollen types is moderate considering the number of samples counted (n = 52). A total of 48 different pollen types and spore types are identified (Figures 15.2-15.3; see Table 15.3). The pollen assemblage is dominated by Chenopodiaceae-*Amaranthus* (average = 41 percent; range = 0-78 percent), sunflower (*Ambrosia)* (average = 16 percent), and other Compositae (average = 18 percent). The values reported here are typical for Santa Cruz floodplain sites.

The pollen of weeds (*Boerhaavia,* average <1 percent; *Eriogonum; Euphorbia; Kallstroemia;* and *Sphaeralcea*) is present in all samples, indicating constant disturbance of the site. The disturbance was likely caused by a combination of human and natural processes (periodic flooding).

Maize (*Zea*) pollen is sporadically present, and its percentages are very high in four Cienega phase samples (FN 8894, 21.9 percent; FN 8513, 10.8 percent; FN 8910, 6.9 percent; FN 8590, 4.2 percent) and one Hohokam sample (FN 6929, RNA-8, 21.7 percent) (see Figures 15.2-15.3; see Table 15.3). The eight samples containing maize pollen have slightly higher percentages (4.7 percent versus 4.3 percent) of weed pollen than the other samples from the Clearwater site.

The spores of the maize smut, *Ustilago maydis*, are present in two samples—FN 8513, 1 percent *Zea*, 2 percent *Ustilago* (Cienega phase); and FN 8064, 0 percent *Zea*, 6 percent *Ustilago* (Hohokam periods). The spores are a delicacy in Mexico, said to have been eaten by the Aztecs, called *Huitlacoche* (Gourmet Sleuth 2001). This may be the first report of this pathogen in an archaeological context. If the spores can be routinely identified in archaeological samples, they might become a supporting indicator of maize cultivation. The spore is spherical, 20-25 microns in diameter, with a relatively thick, light brown, verrucate wall. One portion of the wall is distinctly thinned.

The pollen of riparian plants and aquatic spores is present in six samples, at less than 1 percent. These abundances are similar to what has been found in other sites on the Tucson Basin floodplain (see Figure 15.1). However, fern spores are unusually abundant (average = 2 percent in 11 of 52 samples). Fern spores are more abundant than the pollen or spores of riparian plants, and the fern spores do not occur in the samples containing the pollen of riparian plants.

Nearly all the ferns in the Arizona flora are rocky-slope and cliff-face plants except species of *Dryopteris*, *Athyrium,* and *Woodwardia*, which occur in wet areas of canyons generally above 5,000 ft (to 10,000 ft) elevation (Kearney and Peebles 1951). Stream transport of fern spores from a higher elevation to the Clearwater site is possible. However, this process should also deposit the pollen and spores of riparian plants, and the fern spores do not occur in the samples containing the pollen of riparian plants. Further, other floodplain archaeological sites in the Tucson Basin (see Figure 15.1) do not record such high abundances of fern spores. The shaded north slope of A-Mountain may have once harbored ferns.

Table 15.3. Pollen counts for the Clearwater site, AZ BB:13:6 (ASM), and canal feature AZ BB:13:481 (ASM), by locus.

	San Agustín Mission (RNA-2) Features						Congress Street (RNA-8/8a) Nonfeatures			
	Cienega Phase			Spanish Period			Stratum 504			
Feature Number	32.01	62.01	65.01	177	178	203	0	0	0	0
Sample (Field Number)	5846	6673	6189	6561	6525	6627	7459	7557	7559	7563
SUM	90	247	28	303	301	301	115	3	15	60
TRACERS	345	1,230	713	190	123	437	1,017	113	106	292
CONC (grains/cc)	726	559	109	4,437	6,808	1,916	315	74	394	572
DETERIORATED	17	15	6	8	15	8	2	0	2	7
UNIDENTIFIED	0	7	5	8	1	0	0	0	0	0
Cupressaceae	1	0	0	0	0	0	0	0	0	0
Cercidium	0	0	0	0	0	0	0	0	0	0
Pinus	0	3	0	3	1	3	0	0	0	0
Prosopis	0	0	0	0	0	0	1	0	0	0
Quercus	0	0	0	0	0	0	0	0	0	0
Acacia	0	0	0	0	0	0	0	0	0	0
Agave	0	0	0	0	0	1	0	0	0	0
Cylindropuntia	0	0	0	3	0	0	0	0	0	0
Ephedra	0	0	0	0	1	0	0	0	0	1
Ericaceae	0	0	0	0	0	0	0	0	0	0
Lycium	1	11	0	0	0	0	1	0	0	0
Rhus	0	0	0	0	0	0	0	0	0	0
Rosaceae	0	0	0	0	0	0	0	0	0	0
Yucca	0	0	0	0	0	0	0	0	0	0
Ambrosia	14	31	8	26	25	14	8	0	1	3
Artemisia	0	5	0	2	0	0	0	0	0	0
Liguliflorae	0	0	0	0	2	3	1	0	0	0
Other Compositae	44	28	1	16	35	41	25	2	9	8
Gramineae	2	9	1	4	2	6	0	0	0	0
Chenopodiaceae-*Amaranthus*	20	137	7	233	216	222	69	0	2	38
Sarcobatus	0	0	0	0	0	0	0	0	0	0
Abutilon	0	0	0	0	0	0	0	0	0	0
Boerhaavia	0	0	0	0	0	1	0	0	0	2
Convolvululus	0	0	0	0	2	0	0	0	0	0
Cruciferae	0	0	0	0	1	0	0	0	1	0
Eriogonum	0	1	0	0	0	1	0	1	0	1
Euphorbia	0	0	0	0	0	0	2	0	0	0
Kallstroemia	0	0	0	0	0	0	0	0	0	0
Leguminosae	0	0	0	0	0	0	0	0	0	0
Lilliaceae	1	0	0	0	0	0	0	0	0	0
Malvaceae	0	0	0	0	0	0	6	0	0	0
Nyctaginaceae	0	0	0	0	0	0	0	0	0	0
Phacelia	0	0	0	0	0	0	0	0	0	0
Plantago	0	0	0	0	0	1	0	0	0	0
Polygonum	0	0	0	0	0	0	0	0	0	0
Sphaeralcea	0	0	0	0	0	0	0	0	0	0
Tribulus	0	0	0	0	0	0	0	0	0	0
Zea	0	0	0	0	0	0	0	0	0	0
Cyperaceae	0	0	0	0	1	0	0	0	0	0
Typha	0	0	0	0	0	0	0	0	0	0
Fraxinus	0	0	0	0	0	0	0	0	0	0
Salix	0	0	0	0	1	0	0	0	0	0
Populus	0	0	0	0	0	0	0	0	0	0
Equisetum	0	0	0	0	0	0	0	0	0	0
Fern Spores	5	4	1	1	0	0	1	0	0	0
Concentricystes	0	0	0	0	0	2	0	0	0	0
Ustilago	0	0	0	0	0	0	0	0	0	0
Thecaphora	4	4	0	3	16	15	6	1	1	12
Fungal spores	277	411	123	587	597	966	297	1	124	355
Arthropod feces	25	7	0	1	26	57	2	0	42	69
Charcoal	91	2,771	1,866	792	42	340	182	0	27	51

Table 15.3. Continued.

	Congress Street (RNA-8/8a) Nonfeatures (Continued)			Congress Street (RNA-8/8a) Features				
	Stratum 503	Stratum 502		Stratum 504				
Feature Number	0	0	0	506	516	581	584	599
Sample (Field No.)	7,562	7,560	7,561	6,879	6,927	7,487	7,497	7,517
SUM	38	57	68	18	5	55	16	279
TRACERS	112	88	100	99	142	866	475	1,091
CONC (grains/cc)	944	1,802	1,892	506	98	177	94	711
DETERIORATED	2	3	6	1	0	7	5	9
UNIDENTIFIED	0	0	0	0	0	0	2	8
Cupressaceae	0	0	0	0	0	0	0	0
Cercidium	0	0	0	0	0	0	0	0
Pinus	2	5	4	0	0	0	0	0
Prosopis	0	0	0	0	0	0	0	0
Quercus	0	0	0	0	0	0	0	0
Acacia	0	0	0	0	0	0	0	0
Agave	0	0	0	0	0	0	0	0
Cylindropuntia	0	0	0	0	0	0	0	0
Ephedra	0	0	0	0	0	0	0	0
Ericaceae	0	1	0	0	0	0	0	0
Lycium	0	0	1	0	0	0	0	0
Rhus	0	0	0	0	0	0	0	0
Rosaceae	0	0	0	0	0	0	0	0
Yucca	0	0	0	0	0	0	0	0
Ambrosia	10	13	12	5	1	5	1	55
Artemisia	0	0	1	0	0	0	1	0
Liguliflorae	0	0	1	0	0	0	0	0
Other Compositae	2	4	5	1	2	10	2	23
Gramineae	3	0	0	1	0	3	0	1
Chenopodiaceae-*Amaranthus*	18	31	28	8	1	29	5	172
Sarcobatus	0	0	0	0	0	0	0	0
Abutilon	0	0	0	0	0	1	0	0
Boerhaavia	0	0	0	0	1	0	0	0
Convolvululus	0	0	0	0	0	0	0	0
Cruciferae	0	0	0	0	0	0	0	0
Eriogonum	0	0	1	0	0	0	0	1
Euphorbia	0	0	4	2	0	0	0	0
Kallstroemia	0	0	0	0	0	0	0	0
Leguminosae	1	0	0	0	0	0	0	0
Lilliaceae	0	0	0	0	0	0	0	0
Malvaceae	0	0	5	0	0	0	0	10
Nyctaginaceae	0	0	0	0	0	0	0	0
Phacelia	0	0	0	0	0	0	0	0
Plantago	0	0	0	0	0	0	0	0
Polygonum	0	0	0	0	0	0	0	0
Sphaeralcea	0	0	0	0	0	0	0	0
Tribulus	0	0	0	0	0	0	0	0
Zea	0	0	0	0	0	0	0	0
Cyperaceae	0	0	0	0	0	0	0	0
Typha	0	0	0	0	0	0	0	0
Fraxinus	0	0	0	0	0	0	0	0
Salix	0	0	0	0	0	0	0	0
Populus	0	0	0	0	0	0	0	0
Equisetum	0	0	0	0	0	0	0	0
Fern Spores	0	1	1	0	0	0	0	1
Concentricystes	1	0	0	0	0	0	0	0
Ustilago	0	0	0	0	0	0	0	0
Thecaphora	2	5	2	2	0	0	0	0
Fungal spores	778	1,320	1,279	31	55	47	98	267
Arthropod feces	18	106	50	0	0	0	15	1
Charcoal	46	32	50	4	3	3	15	27

Table 15.3. Continued.

	Congress Street (RNA-8/8a) Features (Continued)							
	Stratum 504							Hohokam Periods
Feature Number	580	580.02	580.03	608	613	624	626	308
Sample (Field No.)	7,611	7,612	7,613	7,616	7,624	7,653	7,664	6,929
SUM	32	69	104	20	31	17	71	143
TRACERS	575	1,044	1,313	582	695	1,133	1,200	613
CONC (grains/cc)	155	184	220	96	124	42	165	649
DETERIORATED	7	6	9	2	5	1	9	19
UNIDENTIFIED	4	5	4	1	5	3	5	5
Cupressaceae	0	0	0	0	0	0	0	0
Cercidium	0	0	0	0	0	0	0	0
Pinus	0	0	0	3	0	0	3	0
Prosopis	0	0	0	0	0	0	0	0
Quercus	0	0	0	0	0	0	0	0
Acacia	0	0	0	0	0	0	0	0
Agave	0	0	0	0	0	0	0	0
Cylindropuntia	0	0	6	0	1	0	0	0
Ephedra	0	0	0	0	0	0	0	0
Ericaceae	0	0	0	0	0	0	0	0
Lycium	0	0	0	0	0	0	0	0
Rhus	0	0	0	0	0	0	0	0
Rosaceae	0	0	0	0	0	0	0	0
Yucca	0	0	0	0	0	0	0	0
Ambrosia	5	16	14	0	6	3	17	19
Artemisia	1	1	1	3	0	0	2	10
Liguliflorae	0	0	0	0	0	0	0	0
Other Compositae	3	20	18	1	3	3	7	17
Gramineae	0	3	3	1	0	0	0	1
Chenopodiaceae-*Amaranthus*	11	16	34	8	10	7	14	32
Sarcobatus	0	0	1	0	0	0	2	0
Abutilon	1	1	0	0	0	0	0	0
Boerhaavia	0	0	0	0	0	0	0	0
Convolvululus	0	0	0	0	0	0	0	0
Cruciferae	0	0	0	0	0	0	0	0
Eriogonum	0	0	11	1	1	0	2	6
Euphorbia	0	0	0	0	0	0	0	0
Kallstroemia	0	0	0	0	0	0	0	0
Leguminosae	0	0	0	0	0	0	0	0
Lilliaceae	0	0	0	0	0	0	0	0
Malvaceae	0	1	0	0	0	0	0	0
Nyctaginaceae	0	0	0	0	0	0	9	3
Phacelia	0	0	0	0	0	0	0	0
Plantago	0	0	0	0	0	0	0	0
Polygonum	0	0	0	0	0	0	0	0
Sphaeralcea	0	0	1	0	0	0	1	0
Tribulus	0	0	0	0	0	0	0	0
Zea	0	0	2	0	0	0	0	31
Cyperaceae	0	0	0	0	0	0	0	0
Typha	0	0	0	0	0	0	0	0
Fraxinus	0	0	0	0	0	0	0	0
Salix	0	0	0	0	0	0	0	0
Populus	0	0	0	0	0	0	0	0
Equisetum	0	0	0	0	0	0	0	1
Fern Spores	0	0	0	0	0	0	0	0
Concentricystes	0	0	0	0	0	0	0	0
Ustilago	0	0	0	0	0	0	0	0
Thecaphora	0	0	0	0	0	1	0	0
Fungal spores	72	98	283	259	127	162	170	428
Arthropod feces	0	1	0	0	0	0	0	10
Charcoal	67	39	106	47	117	111	75	118

Table 15.3. Continued.

	Congress Street (RNA-8B) Nonfeatures						
	Stratum 504			Stratum 503		Stratum 502	
Feature Number	0	0	0	0	0	0	0
Sample (Field No.)	9,159	9,160	9,212	9,158	9,211	9,157	9,210
SUM	199	4	63	165	6	48	72
TRACERS	563	318	353	362	34	110	148
CONC (grains/cc)	983	35	497	1,268	491	1,214	1,354
DETERIORATED	25	0	9	6	0	0	1
UNIDENTIFIED	4	0	0	0	0	0	0
Cupressaceae	0	0	0	0	0	0	0
Cercidium	0	0	0	0	0	0	0
Pinus	2	0	0	1	0	2	0
Prosopis	0	0	0	0	0	0	0
Quercus	0	0	0	1	0	0	0
Acacia	0	0	0	0	0	0	1
Agave	0	0	0	0	0	0	0
Cylindropuntia	1	0	0	0	0	0	0
Ephedra	0	0	0	0	0	1	0
Ericaceae	0	0	0	0	0	0	0
Lycium	0	0	0	0	0	0	0
Rhus	0	0	0	0	0	0	2
Rosaceae	0	0	0	0	0	2	4
Yucca	0	0	0	0	0	0	0
Ambrosia	16	0	7	34	1	7	27
Artemisia	3	0	0	0	0	0	0
Liguliflorae	0	0	0	1	0	0	0
Other Compositae	24	2	42	58	4	2	4
Gramineae	5	0	0	9	1	0	0
Chenopodiaceae-*Amaranthus*	115	1	2	52	0	33	32
Sarcobatus	0	0	0	0	0	0	0
Abutilon	0	0	0	0	0	0	0
Boerhaavia	0	0	0	0	0	0	0
Convolvululus	0	0	0	0	0	0	0
Cruciferae	0	0	0	0	0	0	0
Eriogonum	3	1	0	0	0	0	1
Euphorbia	0	0	0	1	0	0	0
Kallstroemia	0	0	0	0	0	0	0
Leguminosae	0	0	0	0	0	0	0
Lilliaceae	0	0	0	0	0	0	0
Malvaceae	0	0	1	2	0	1	0
Nyctaginaceae	1	0	0	0	0	0	0
Phacelia	0	0	2	0	0	0	0
Plantago	0	0	0	0	0	0	0
Polygonum	0	0	0	0	0	0	0
Sphaeralcea	0	0	0	0	0	0	0
Tribulus	0	0	0	0	0	0	0
Zea	0	0	0	0	0	0	0
Cyperaceae	0	0	0	0	0	0	0
Typha	0	0	0	0	0	0	0
Fraxinus	0	0	0	0	0	0	0
Salix	0	0	0	0	0	0	0
Populus	0	0	0	0	0	0	0
Equisetum	0	0	0	0	0	0	0
Fern Spores	0	0	0	0	0	1	0
Concentricystes	0	0	1	0	0	0	0
Ustilago	0	0	0	0	0	0	0
Thecaphora	0	0	1	2	0	3	2
Fungal spores	104	12	373	151	48	203	332
Arthropod feces	75	0	2	6	2	67	16
Charcoal	25	5	28	6	1	7	5

Table 15.3. Continued.

	Congress Street/Brickyard (RNA-8B) Features							
	Stratum 504			Stratum 503	Cienega Phase			
Feature Number	3359	3364	3371	3374	3245.06	3270.02	3270.04	3270.05
Sample (Field No.)	9,235	9,245	9,282	9,289	8,541	8,894	8,910	8,976
SUM	8	34	159	155	21	96	72	26
TRACERS	355	374	483	648	41	271	285	400
CONC (grains/cc)	63	253	916	665	1,425	986	703	181
DETERIORATED	1	3	4	16	1	6	9	0
UNIDENTIFIED	0	0	0	1	0	3	7	0
Cupressaceae	0	0	0	0	0	0	0	0
Cercidium	0	0	0	0	0	0	0	0
Pinus	0	0	4	0	1	0	3	0
Prosopis	0	0	0	0	0	0	0	0
Quercus	0	0	0	0	0	0	0	0
Acacia	0	0	0	0	0	0	0	0
Agave	0	0	6	0	0	0	0	0
Cylindropuntia	0	0	0	0	0	0	1	0
Ephedra	0	0	0	0	0	0	0	0
Ericaceae	0	0	1	0	0	0	0	0
Lycium	0	0	0	0	0	0	0	0
Rhus	0	0	0	0	0	0	0	0
Rosaceae	0	0	1	0	0	0	0	0
Yucca	0	0	0	0	0	0	0	0
Ambrosia	0	9	9	22	4	34	29	6
Artemisia	0	0	0	2	0	0	1	0
Liguliflorae	0	0	3	0	0	0	0	0
Other Compositae	1	3	9	14	5	15	9	12
Gramineae	0	0	14	2	1	1	0	0
Chenopodiaceae-*Amaranthus*	5	15	93	97	8	16	5	2
Sarcobatus	0	0	0	0	0	0	0	0
Abutilon	0	0	0	0	0	0	0	0
Boerhaavia	0	0	0	0	0	0	0	0
Convolvululus	0	0	0	0	0	0	0	0
Cruciferae	0	0	6	0	0	0	0	0
Eriogonum	0	0	4	1	1	0	1	0
Euphorbia	0	0	0	0	0	0	0	0
Kallstroemia	0	0	0	0	0	0	0	0
Leguminosae	0	0	0	0	0	0	0	0
Lilliaceae	0	0	0	0	0	0	0	0
Malvaceae	0	3	0	0	0	0	0	6
Nyctaginaceae	0	0	0	0	0	0	2	0
Phacelia	0	0	0	0	0	0	0	0
Plantago	0	0	0	0	0	0	0	0
Polygonum	0	0	4	0	0	0	0	0
Sphaeralcea	0	0	0	0	0	0	0	0
Tribulus	1	1	0	0	0	0	0	0
Zea	0	0	1	0	0	21	5	0
Cyperaceae	0	0	0	0	0	0	0	0
Typha	0	0	0	0	0	0	0	0
Fraxinus	0	0	1	0	0	0	0	0
Salix	0	0	0	0	0	0	0	1
Populus	0	0	0	0	0	0	0	0
Equisetum	0	0	0	0	0	0	0	0
Fern Spores	0	0	0	0	0	0	0	0
Concentricystes	0	0	0	0	0	0	0	1
Ustilago	0	0	0	0	0	0	0	0
Thecaphora	0	1	1	0	3	1	0	5
Fungal spores	35	125	238	190	166	280	185	687
Arthropod feces	0	0	0	1	0	0	4	0
Charcoal	27	11	26	95	39	657	279	4,345

Table 15.3. Continued.

	Brickyard (RNA-8B) Features (Continued)					
		Cienega Phase (Continued)				Cienega Phase Canal
Feature Number	3294.01	9168	9357	9357	9372	140
Sample (Field No.)	8,917	8,590	8,504	8,416	8,513	6,825
SUM	27	120	300	122	192	72
TRACERS	158	200	436	309	201	300
CONC (grains/cc)	475	1,669	1,914	1,098	2,658	668
DETERIORATED	2	4	15	7	40	7
UNIDENTIFIED	1	0	15	6	0	0
Cupressaceae	0	0	0	0	1	0
Cercidium	0	0	0	0	0	1
Pinus	0	0	0	2	0	0
Prosopis	0	0	0	0	1	0
Quercus	0	0	0	0	0	0
Acacia	0	0	0	0	1	0
Agave	0	4	0	0	0	0
Cylindropuntia	1	0	1	7	1	1
Ephedra	0	0	0	0	0	0
Ericaceae	0	0	0	0	0	0
Lycium	0	0	0	0	0	0
Rhus	0	0	0	0	0	0
Rosaceae	0	3	0	0	0	0
Yucca	0	5	0	0	0	0
Ambrosia	7	30	143	39	5	24
Artemisia	0	0	6	4	0	0
Liguliflorae	0	3	0	0	1	0
Other Compositae	4	9	28	22	21	12
Gramineae	1	0	41	1	10	1
Chenopodiaceae-*Amaranthus*	9	46	50	32	77	23
Sarcobatus	0	0	0	0	0	0
Abutilon	0	0	0	0	0	0
Boerhaavia	0	3	0	0	6	1
Convolvululus	0	0	0	0	0	0
Cruciferae	0	0	0	0	0	0
Eriogonum	2	0	1	0	0	0
Euphorbia	0	0	0	0	0	0
Kallstroemia	0	1	0	2	0	0
Leguminosae	0	0	0	0	0	0
Lilliaceae	0	0	0	0	0	0
Malvaceae	0	6	0	0	0	0
Nyctaginaceae	0	1	0	0	0	0
Phacelia	0	0	0	0	0	0
Plantago	0	0	0	0	0	0
Polygonum	0	0	0	0	0	0
Sphaeralcea	0	0	0	0	2	0
Tribulus	0	0	0	0	0	0
Zea	0	5	0	0	20	1
Cyperaceae	0	0	0	0	0	0
Typha	0	0	0	0	0	0
Fraxinus	0	0	0	0	0	0
Salix	0	1	0	0	0	0
Populus	0	0	0	0	0	0
Equisetum	0	0	0	0	0	0
Fern Spores	1	0	0	0	0	0
Concentricystes	0	0	0	0	0	1
Ustilago	0	0	0	0	2	0
Thecaphora	0	1	0	1	6	0
Fungal spores	245	541	425	465	69	24
Arthropod feces	5	0	19	1	35	11
Charcoal	135	1,742	7	668	786	266

Table 15.3. Continued.

	Mission Gardens (RNA-11) Features				Presidio (RNA-12) Feature
	Agua Caliente Phase	Hohokam Periods			Hohokam Periods
Feature Number	3014	3001	3005	3067	380
Sample (Field No.)	7,859	7,908	8,064	7,807	3,137
SUM	302	322	317	360	301
TRACERS	296	14	83	74	149
CONC (grains/cc)	2,839	63,991	10,626	13,535	5,620
DETERIORATED	6	39	20	57	7
UNIDENTIFIED	4	0	0	0	2
Cupressaceae	0	0	0	0	0
Cercidium	0	1	0	0	0
Pinus	2	0	3	7	1
Prosopis	0	1	0	0	0
Quercus	0	1	0	2	0
Acacia	0	0	0	0	0
Agave	0	0	0	0	0
Cylindropuntia	2	3	90	16	0
Ephedra	0	0	0	0	0
Ericaceae	0	1	0	0	0
Lycium	0	0	0	0	0
Rhus	0	0	0	0	1
Rosaceae	0	0	0	0	1
Yucca	0	0	0	0	0
Ambrosia	58	8	1	3	23
Artemisia	0	0	0	0	0
Liguliflorae	0	0	0	0	0
Other Compositae	6	8	11	28	7
Gramineae	0	4	2	3	2
Chenopodiaceae-*Amaranthus*	216	250	182	230	234
Sarcobatus	0	0	0	0	0
Abutilon	0	0	0	0	0
Boerhaavia	0	2	3	3	0
Convolvululus	0	0	0	0	0
Cruciferae	0	0	0	0	0
Eriogonum	0	0	0	0	8
Euphorbia	5	1	0	0	0
Kallstroemia	0	0	0	0	0
Leguminosae	0	0	0	0	0
Lilliaceae	0	0	0	0	0
Malvaceae	0	0	0	0	0
Nyctaginaceae	3	0	0	0	13
Phacelia	0	1	0	0	0
Plantago	0	0	0	0	0
Polygonum	0	0	0	0	0
Sphaeralcea	0	0	4	9	0
Tribulus	0	0	0	0	2
Zea	0	0	0	0	0
Cyperaceae	0	0	0	0	0
Typha	0	2	0	0	0
Fraxinus	0	0	0	0	0
Salix	0	0	0	0	0
Populus	0	0	1	0	0
Equisetum	0	0	0	0	0
Fern Spores	0	0	0	0	0
Concentricystes	0	0	0	0	0
Ustilago	0	0	6	0	0
Thecaphora	0	0	0	3	2
Fungal spores	157	83	41	255	157
Arthropod feces	3	8	8	1	1
Charcoal	258	237	224	482	200

Table 15.4. Loci, contexts, and dating of pollen samples from the Rio Nuevo Archaeology project.

Field Number	Feature Number	Feature Type	Context	Comments
RNA-2 Mission Locus, Clearwater Site, AZ BB:13:6 (ASM)				
Cienega phase features (800 B.C.-A.D. 50)				
5846	32.01	Intramural feature	30	Collected from base of bell pit in pit structure
6673	62.01	Intramural feature	30	Collected from base of small pit in pit structure
6189	65.01	Intramural feature	30	Collected from base of bell pit in pit structure
Spanish period features (A.D. 1775-1821)				
6561	177	Large extramural pit	50	Collected from base of large extramural pit
6525	178	Large extramural pit	50	Collected from base of large extramural pit
6627	203	Large extramural pit	50	Collected from base of large extramural pit
RNA-8 and 8A Congress Street and Brickyard Loci, Clearwater Site, AZ BB:13:6 (ASM)				
Stratum 504 nonfeature (circa 2100 B.C.)				
7459	0	Natural stratum	504	Collected from natural stratum
7557	0	Natural stratum	504	Collected from natural stratum
7559	0	Natural stratum	504	Collected from natural stratum
7563	0	Natural stratum	504	Collected from natural stratum
Stratum 503 nonfeature (circa 2100-1200 B.C.?)				
7562	0	Natural stratum	503	Collected from natural stratum
Stratum 502 nonfeature (circa 1200 B.C.-A.D. 50?)				
7560	0	Natural stratum	502	Collected from natural stratum
7561	0	Natural stratum	502	Collected from natural stratum
Stratum 504 features (circa 2100 B.C.)				
6879	506	Possible pit structure	10	Collected from fill of possible pit structure
6927	516	Pit structure	10	Collected from fill of pit structure
7487	581	Pit structure	10	Collected from fill of pit structure
7497	584	Small extramural pit	50	Collected from fill of small extramural pit
7517	599	Small extramural pit	50	Collected from base of small extramural pit
7611	580	Pit structure	20	Collected from floor of pit structure
7612	580.02	Intramural feature	30	Collected from base of small pit in pit structure
7613	580.03	Intramural feature	30	Collected from base of small pit in pit structure
7624	608	Pit structure	20	Collected from floor of pit structure
7616	613	Small extramural pit	50	Collected from base of small extramural pit
7653	624	Small extramural pit	50	Collected from base of small extramural pit
7664	626	Small extramural pit	50	Collected from base of small extramural pit
Hohokam periods features (A.D. 750-1450)				
6929	308	Pit structure	20	Collected from floor of pit structure
RNA-8B Congress Street and Brickyard Loci, Clearwater Site, AZ BB:13:6 (ASM)				
Stratum 504 nonfeature (circa 2100 B.C.)				
9159	0	Natural stratum	504	Collected from natural stratum
9160	0	Natural stratum	504	Collected from natural stratum
9212	0	Natural stratum	504	Collected from natural stratum
Stratum 503 nonfeature (circa 2100-1200 B.C.?)				
9158	0	Natural stratum	503	Collected from natural stratum
9211	0	Natural stratum	503	Collected from natural stratum

Table 15.4. Continued.

Field Number	Feature Number	Feature Type	Context	Comments
RNA-8B Congress Street and Brickyard Loci, Clearwater Site, AZ BB:13:6 (ASM) (continued)				
Stratum 502 nonfeature (circa 1200 B.C.-A.D. 50?)				
9157	0	Natural stratum	502	Collected from natural stratum
9210	0	Natural stratum	502	Collected from natural stratum
Stratum 504 features (circa 2100 B.C.)				
9235	3359	Pit structure	20	Collected from floor of pit structure
9245	3364	Pit structure	20	Collected from floor of pit structure
9282	3371	Pit structure	20	Collected from floor of pit structure
Stratum 503 features (circa 2100-1200 B.C.?)				
9289	3374	Small extramural pit	50	Collected from base of small extramural pit
Cienega phase features (800 B.C.-A.D. 50)				
8541	3245.06	Intramural feature	30	Collected from base of possible small pit in pit structure
8894	3270.02	Intramural feature	30	Collected from base of bell pit in pit structure
8910	3270.04	Intramural feature	30	Collected from base of bell pit in pit structure
8976	3270.05	Intramural feature	30	Collected from base of bell pit in pit structure
8917	3294.01	Intramural feature	30	Collected from base of possible hearth in pit structure
8590	9168	Pit structure	20	Collected from floor of pit structure
8504	9357	Pit structure	20	Collected from floor of pit structure
8416	9357	Pit structure	20	Collected from floor of pit structure
8513	9372	Pit structure	20	Collected from floor of pit structure
RNA-8B Canal at Brickyard Locus, AZ BB:13:481 (ASM)				
Cienega phase features (800 B.C.-A.D. 50)				
6825	140	Canal	59	Collected from canal sediments
RNA-11 Mission Gardens Locus, Clearwater Site, AZ BB:13:6 (ASM)				
Agua Caliente phase features (A.D. 50-500)				
7859	3014	Pit structure	20	Collected from floor of pit structure
Hohokam periods features (A.D. 750-1450)				
7908	3001	Large extramural pit	50	Collected from base of large extramural pit
8064	3005	Pit structure	20	Collected from floor of pit structure
7807	3067	Large extramural pit	50	Collected from base of large extramural pit
RNA-12 Presidio Locus, Tucson Presidio, AZ BB:13:13 (ASM)				
Hohokam periods features (A.D. 750-1450)				
3137	380	Possible pit structure	20	Collected from floor of possible pit structure

Pollen diagrams from stratigraphic sequences of the Congress Street/Brickyard loci (RNA-8) are shown in Figure 15.2. Three strata are identified at each of three loci and are dated (uncalibrated radiocarbon ages): Stratum 502, 2600-2000 ^{14}C yr b.p.; Stratum 503, 3300-3200 ^{14}C yr b.p.; and Stratum 504, 3700-3600 ^{14}C yr b.p. (Chapter 19, this report). The combined diagram for all three strata and all three loci (see Figure 15.2) shows higher percentages of deteriorated pollen and weed pollen in Stratum 504, and a greater abundance of *Pinus* and *Ambrosia* pollen in strata 503 and 502. Gramineae (grass) pollen is most frequent in Stratum 503, as are the spores of the aquatic algae *Concentricystes*.

The samples from Block 5 and Trench 277 show transitions from "Other Compositae" dominance in

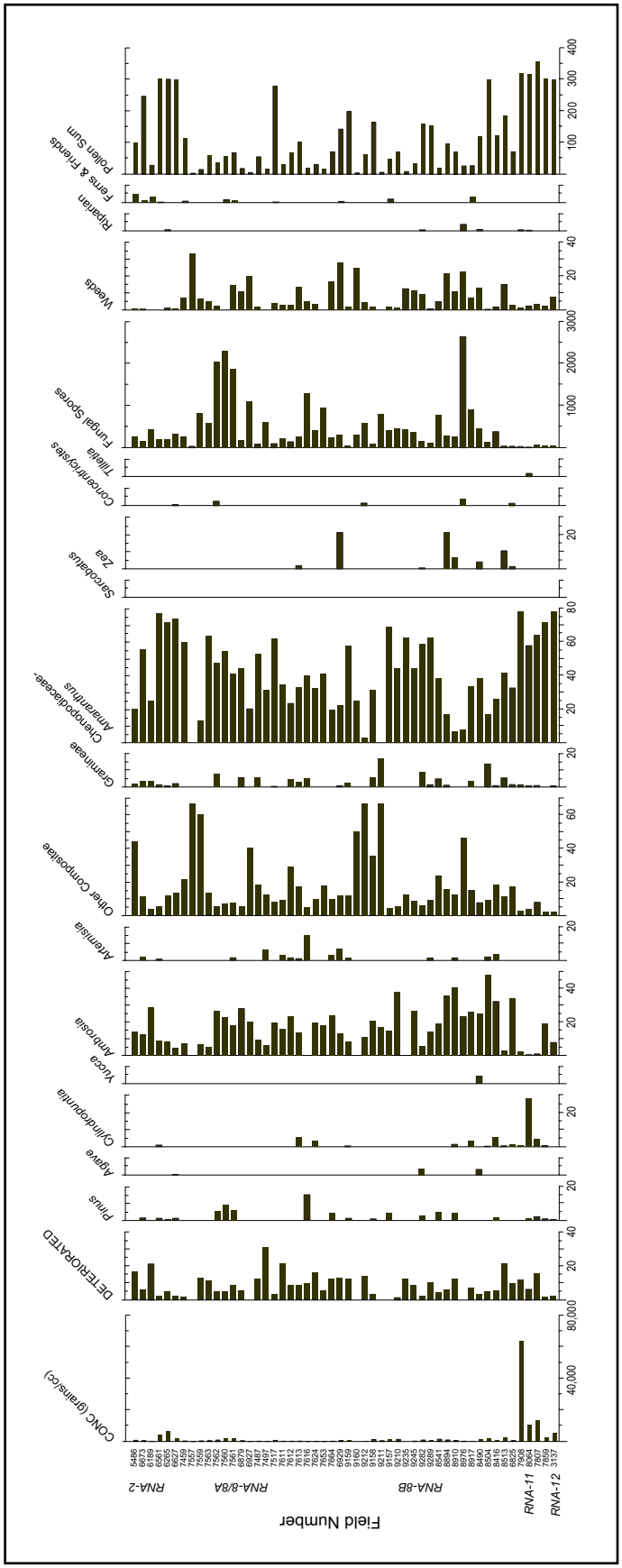

Figure 15.2. Pollen diagram for the Clearwater site, AZ BB:13:6 (ASM), Tucson, Pima County, Arizona. (Only the most abundant of the 48 types are shown; combined values for riparian-aquatic and for fern spores are shown at left.)

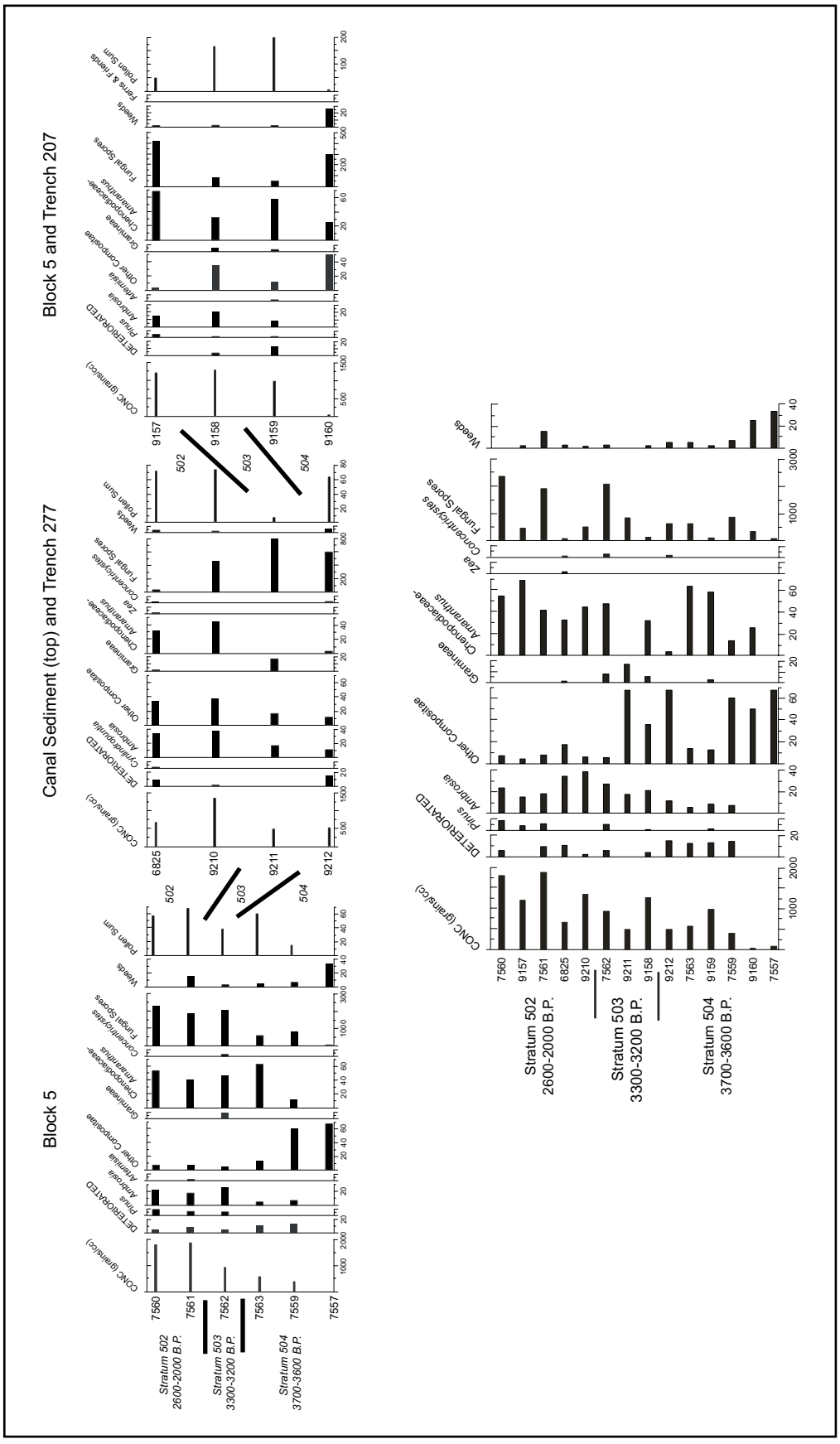

Figure 15.3. Pollen diagrams for selected loci at RNA-8, the Clearwater site, AZ BB:13:6 (ASM), Tucson, Pima County, Arizona. (Each profile spans the three Early Agricultural period stratigraphic units of the site: strata 502, 503, and 504; note uncalibrated radiocarbon ages of each stratum at left.)

strata 504 and 503 to Chenopodiaceae-*Amaranthus* dominance in Stratum 502 (see Figure 15.2). The Trench 207 profile does not show this same transition, possibly due to vegetation patterns specific at that location. However, the combined diagram (see Figure 15.2) shows the transition occurring within Stratum 503. Although the "Other Compositae" versus Chenopodiaceae-*Amaranthus* contrast characterizes the difference between upland and floodplain sites (see Table 15.2), within the floodplain, Chenopodiaceae-*Amaranthus* dominance is associated with a dry floodplain surface. For example, in the Empire Cienega, in an undissected floodplain, Chenopodiaceae-*Amaranthus* frequencies drop to less than 10 percent where *Ambrosia* or other Compositae plants dominate (Martin 1963).

According to the Santa Cruz River alluvial chronology (Waters and Haynes 2001; Chapter 20, this report), strata 504 and 503 were deposited during a period of channel filling in many reaches of the floodplain, separated from Stratum 502 by a cycle of incision dated about 2600 ^{14}C yr b.p. Elevated "Other Compositae" values in Strata 504 and 503 could reflect vegetation on an unentrenched floodplain, and high Chenopodiaceae-*Amaranthus* percentages might reflect vegetation on an entrenched floodplain during upper Stratum 502 channel filling.

However, upper Stratum 502 is a cienega deposit, which indicates the presence of a high water table. The elevated abundance of grass pollen in Stratum 503, and the sporadic appearance of *Concentricystes* spores (see Figure 15.2), may indicate greater available moisture 3300-3200 ^{14}C yr b.p. This wet period may correlate with the high stand of Lake Cochise, southeastern Arizona, dated circa 4000-3000 ^{14}C yr b.p. (3190±60 ^{14}C yr b.p.) (Waters 1989), and with the high stand of Silver Lake, southeastern California (3620±70 ^{14}C yr b.p.) (Enzel et al. 1989). In addition to this evidence of increased effective moisture in southwestern North America, an important, non-climatic cause of the higher water table and soil moisture levels during the time of deposition of Stratum 503 is canal irrigation, attested to by the canal found originating in this stratum and crossing Block 5 (Feature 152 of AZ BB:13:481 [ASM]).

SUMMARY

Pollen analysis is reported for 52 sediment samples from four loci within the Clearwater site. The pollen preservation is variable and frequently poor; 300 grain counts were possible for only nine samples. The pollen concentration is also quite variable (average = 2,690; range = 35-64,000 grains/cc). A total of 48 different pollen and spore types have been identified.

The pollen assemblage is dominated by Chenopodiaceae-*Amaranthus* pollen (average = 41 percent; range = 0-78 percent) and sunflower pollen, *Ambrosia* (average = 16 percent) and other Compositae (average = 18 percent). The pollen of weeds (*Boerhaavia,* average <1 percent; *Eriogonum; Euphorbia; Kallstroemia;* and *Sphaeralcea*) is present in all samples, indicating constant disturbance of the site. Maize (*Zea*) pollen is sporadically present, and very high percentages are associated with four Cienega phase samples (FN 8894, 21.9 percent; FN 8513, 10.8 percent; FN 8910, 6.9 percent; FN 8590, 4.2 percent) and one Hohokam sample (FN 6929, RNA-8, 21.7 percent). The spores of the corn smut, *Ustilago maydis*, are present in two samples—FN 8513, 1 percent *Zea*, 2 percent *Ustilago* (Cienega phase), and FN 8064, 0 percent *Zea*, 6 percent *Ustilago* (Hohokam periods). The pollen of riparian plants and aquatic spores is present in six samples, at less than 1 percent. Fern spores are more common (average = 2 percent in 11 samples) than the pollen or spores of riparian plants, and they do not co-occur with the pollen of riparian plants.

The analysis of three stratigraphic sequences indicates Stratum 503 in Block 5 (dated to 3300-3200 ^{14}C yr b.p.) was deposited during a wet interval, or was kept saturated by irrigation from a nearby canal (Feature 152, BB:13:481) in use at the time.

CONCLUSIONS

The analysis of pollen samples from the Clearwater site provides a valuable addition to the archaeological palynology of the Tucson Basin. It confirms the general features found in other Tucson Basin sites, and documents, through weed pollen, the continued disturbance on the upland and streamside vegetation in the area. The abundance of maize (*Zea*) pollen, particularly in Cienega phase contexts, demonstrates ongoing agriculture near Clearwater. The analysis also provides two unique findings. The spores of the maize smut, *Ustilago maydis*, are recorded for the first time in an archaeological context, and the abundance of fern spores is greater at Clearwater than at any previously investigated Tucson Basin site. Analysis of stratigraphic sequences indicates Stratum 503, dated to 3300-3200 ^{14}C yr b.p., was deposited on an unentrenched floodplain during a wet interval, or during a period of intensive irrigation.

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