ARCHEOLOGICAL RESEARCH IN GLEN CANYON, 1977

Schroedl

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Table 33. Biface Characteristics: Over Site (42SA6214)

	Maximum Edge Angle	Minimum Edge Angle	Length*	Width	Thickness	Wear Polish	Edge Grinding
Blanks							
mean	78°	59°	4.02	2.24	0.93		
standard deviation	10°	13°	1.1	0.46	0.30		
number of specimens	5	5	4	4	5	0	1
difference between mean max. and min. edge angle	19°						
Preforms							
mean	60°	42°	-	2.04	0.57		
standard deviation	14°	5.6°	-	0.24	0.10		
number of specimens	9	9	-	4	4	0	5
difference between mean max. and min. edge angle	19°						
Knives							
mean	48°	42°	-	1.84	0.35		
standard deviation	10°	11°	-	-	0.02		
number of specimens	3	3	-	2	3	0	1
difference between mean max. and min. edge angle	6°						

*All dimensions measured in centimeters

than Archaic preforms and in some instances the post Archaic preform and blank edge angle ranges may be nearly identical.

PRESSURE RETOUCHED FLAKES. The characteristics of the pressure retouched flakes are shown in Table 34. The higher edge angle range, large dimensional standard deviations, low prevalence of wear polish, and high incidence of edge grinding indicate that the pressure retouched flakes were not a completed tool.

ARROW POINTS. The characteristics of the arrow points (Fig. 108, a-g) are also shown in Table 34. The relationship between the pressure retouched flakes as the preliminary stage and the arrow points as the final tool are clearly demonstrated. In all dimensions the arrow points are smaller than the pressure retouched flakes and in addition, the arrow point edge angle range is lower. It should also be noted that the dimensional standard deviations for the arrow points are much lower than for the pressure retouched flakes which indicates, not unexpectedly, that the arrow points are more standardized morphologically.

With one exception, all of the arrow points recovered from the Over Site (42SA6214) are triangular with flat or slightly convex bases. The exception (Fig. 108e) is a stemmed arrow point with slight serrations along the blade edges.

The triangular arrow points are common in the Glen Canyon area. Sharrock (1964:86) describes Class II blades as:

> Small, broad to elongate triangular specimens very similar to Class I blades except that bases are straight or slightly convex. Fine, ribbony flaking inward from edges is characteristic Fig. 50; n, o). Range in size (whole specimens only): length 2.1-4.6 cm., width 1.3-1.8 cm., thickness 0.4 to 0.4 cm.

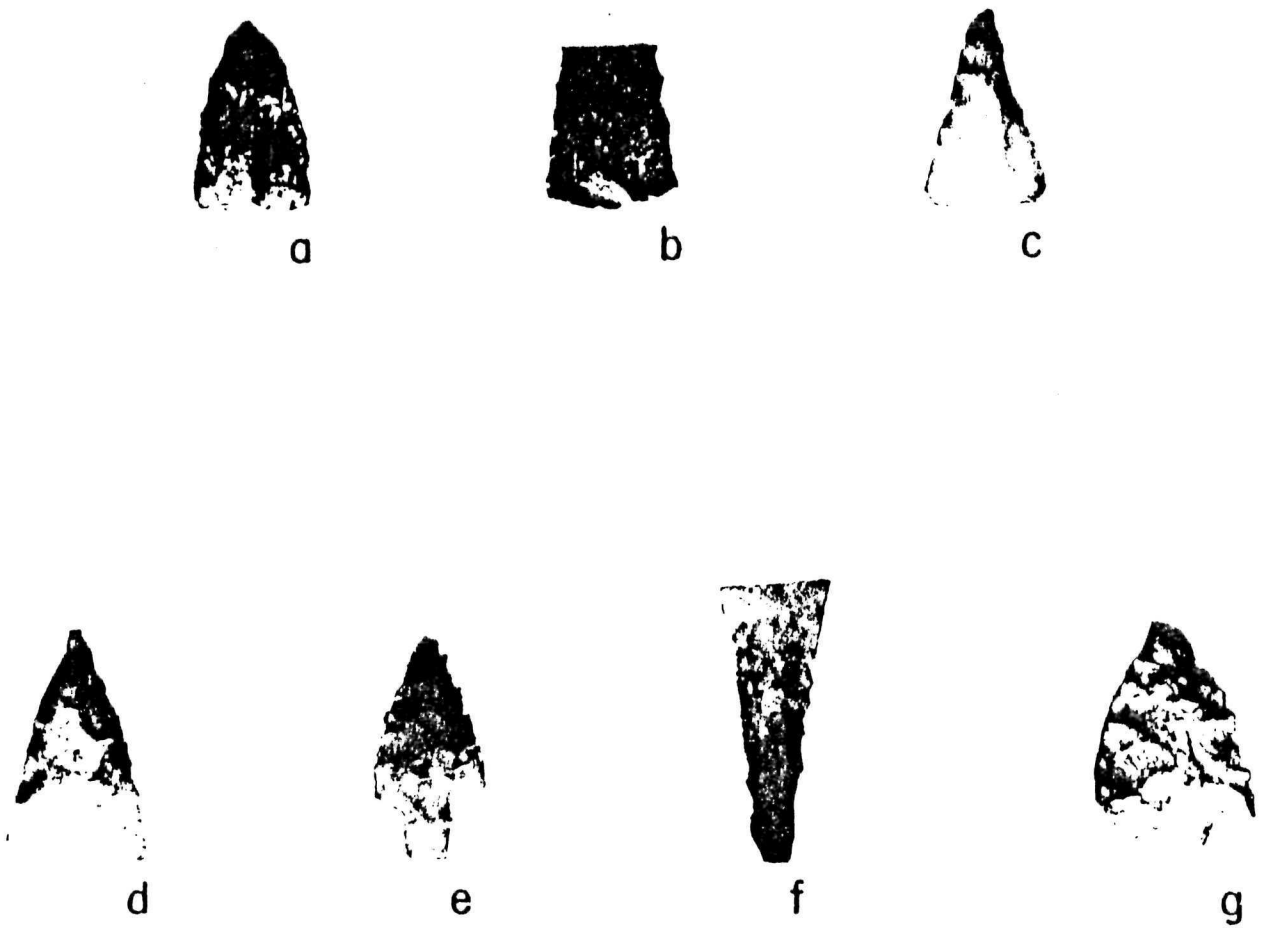
Class II blades were recovered from 1962 excavations at Benchmark Cave (42KA433), Widows Ledge (42SA633), The Watchtower (42SA323), Steer Palace (42SA454), Coyote Ridge (42SA315), and 42SA314 (Sharrock 1964). All of the Class II blades were found in association with Kayenta and/or San Juan ceramics.

Table 34. Pressure Retouched Flake and Arrow Point Characteristics: Over Site (42SA6214)

	Maximum Edge Angle	Minimum Edge Angle	Length*	Width	Thickness	Wear Polish	Edge Grinding
Pressure Retouched Flakes							
mean	60°	42°	2.80	1.90	0.44		
standard deviation	10°	6.3°	0.52	0.42	0.07		
number of specimens	25	25	3	18	25	1	9
difference between mean max. and min. edge angle	18°						
Arrow Points							
mean	50°	45°	2.02	1.34	0.33		
standard deviation	8°	7°	0.19	0.17	0.07		
number of specimens	12	12	4	8	13	0	2
difference between mean max. and min. edge angle	5°						

*All dimensions measured in centimeters.

Figure 108. Lithic artifacts. Arrow points, a-e, g; drill fragment, f. All artifacts are from the Over Site (42SA6214) with the exception of g which is from 42SA740.


a
b
c
d
e
f
g
0
5 Cm.

Sharrock et al. (1961) reported additional Class II blades from 1960 excavations in the Glen Canyon area. The Class II blades from the 1960 excavations have the following dimensions: length 1.5 to 2.7 cm., width 1.1 to 1.6 cm., and thickness 0.3 to 0.4 cm. The 1960 excavations in Lake Canyon recovered Class II blades from the Fortress (42SA316), Dead Tree Flats (42SA627), Lyman Flat (42SA623), Stevens Terrace (42SA695), Surrey Terrace (42SA550), Weirs Mural (42SA620), and Gourd House (42SA619). With the exception of Surrey Terrace, from which no ceramics were recovered, all of the Class II blades were found in association with Kayenta and/or San Juan ceramics.

The arrow points from the Over Site (42SA6214), although generally smaller than those reported by Sharrock, fall within the ranges described.

UTILIZED FLAKES. Ten utilized flakes were also recovered. The mean minimum edge angle for the specimens is 45^{o} (standard deviation = 16^{o}) and the mean maximum edge angle is 49^{o} (standard deviation = 18^{o}).

HAMMERSTONES. Two hammerstones were recovered from the Over Site. One hammerstone weighted 87 grams and the other weighted 154 grams.

DEBITAGE. Table 35 shows the recovered debitage by provenience and material type. Material types C1, C2, and C7 were the most common types. Table 36 shows the correlation between material types and selected tool groups. With the exception of the projectile point category, material type C7 was the most frequently utilized material.

CORES. Twenty-nine cores were recovered during the excavation of the Over Site. All of the cores were small pebble cores of material type C7 with a mean weight of 11 grams (standard deviation = 5.2 grams).

Table 35. Debitage Provenience by Material Type: the Over Site (42SA6214)

Provenience	Material Type C1 Number	C1 Weight	C2 Number	C2 Weight	C3 Number	C3 Weight	C4 Number	C4 Weight	C5 Number	C5 Weight	C6 Number	C6 Weight	C7 Number	C7 Weight	Misc. Number	Misc. Weight	Total Number	Total Weight
Structure 1, Fill	8	9	3	1									3	3	6	3	20	16
Structure 2, Fill	7	6	9	15	5	78							2	1			23	100
Structure 3, Fill			5	2									6	2			11	4
Structure 3, Floor	8	11	8	18			3	7					17	17	3	10	39	63
Midden	19	78	44	100	4	12	8	13					19	21	4	41	98	265
Surface	71	145	99	252	23	121	17	23	2	3	3	13	150	178	38	232	403	967
Total	113	249	168	388	32	211	28	43	2	3	3	13	197	222	51	286	594	1415
Weight/flake	2.20		2.31		6.6		1.5		1.5		4.3		1.13		5.6		2.38	
Percent	19		28		5		5		.3		.5		33		9			

Table 36. Lithic Material Types and Tool Groups: the Over Site (42SA6214)

Tool type	Material Type									Total
	C1	C2	C3	C4	C5	C6	C7	Q	Misc.	
Bifaces	1	2	4	1	1		7	1		17
Pressure Retouch Flakes	2	8					13		2	25
Projectile Points	6	63	1				3			13
Utilized Flakes	3	1	1				3		2	10
Cores							29			29
Debitage	113(19%)	168(28%)	35(5%)	28(5%)	2(.3%)	3(.5%)	198(33%)		51(9%)	594
Total	125	182	38	29	3	3	252	1	55	688

MISCELLANEOUS TOOLS. Five smoothers were also recovered (see Table 30). The smoothers are large pebbles of quartzite or basalt which have one or more polished areas with parallel striations. One stone graver, a drill tip (Fig. 108f), and a drill (Fig. 107d) were recovered from this site along with a chopper and an irregularly broken cobble of material type C4.

42SA740

BIFACE MANUFACTURING SEQUENCE. Only twelve bifaces were recovered from 42SA740. A summary of their dimensional characteristics is shown in Table 37. Even though the sample size is very small, the expected dimensional trends are still apparent.

PRESSURE RETOUCHED FLAKES. Five pressure retouched flakes were recovered from 42SA740 and their characteristics are shown in Table 38.

ARROW POINTS. One complete arrow point (Fig. 108g) and the midsection of an arrow point were found at this site. Neither of the two points are diagnostic.

UTILIZED FLAKES. Nineteen utilized flakes were recovered from 42SA740. The mean minimum edge angle for the specimens is 41^{o} (standard deviation = 13^{o}) and the mean maximum edge angle is 44^{o} (standard deviation = 13^{o}).

HAMMERSTONES. One complete hammerstone and five hammerstone fragments were recovered from 42SA740.

DEBITAGE. Table 39 shows the recovered debitage by provenience and debitage material type. Types C1 and C2 were the most common lithic materials. Table 40 shows the correlation between material types and selected tool groups. Although the majority of the tools and debitage were of lithic types C1 and C2, the majority of the cores were of lithic type C7.

Table 37. Biface Characteristics: 42SA740

	Maximum Edge Angle	Minimum Edge Angle	Length*	Width	Thickness	Wear Polish	Edge Grinding
Blanks							
mean	81°	55°	4.75	3.62	1.18		
standard deviation	11°	11°	0.23	0.48	0.31		
number of specimens	4	4	2	3	4	0	3
difference between mean max. and min. edge angle	26°						
Preforms							
mean	61°	40°	-	3.05	0.68		
standard deviation	8.6°	8.4°	-	1.08	0.19		
number of specimens	6	6	0	4	6	0	4
difference between mean max. and min. edge angle	21°						
Knives							
mean	45°	35°	-	2.24	0.44		
standard deviation	21°	7°	-	0.45	0.11		
number of specimens	2	2	0	2	2	2	0
difference between mean max. and min. edge angle	10°						

*All dimensions measured in centimeters

Table 38. Pressure Retouched Flake Characteristics: 42SA740

	Maximum Edge Angle	Minimum Edge Angle	Length*	Width	Thickness	Wear Polish	Edge Grinding
Pressure Retouched Flakes							
mean	56°	43°	1.99	1.68	.34		
standard deviation	6.5°	4.5°	-	.18	.09		
number of specimens	5	5	1	2	5	0	1
difference between mean max. and min. edge angle	13°						

*All dimensions in centimeters

Table 39. Debitage Provenience by Material Type: 42SA740

	Material Type																			
	C1		C2		C3		C4		C5		C6		C7		Q		Misc.		TOTAL	
Provenience	Number	Weight	Number	Weight	Number	Weight	Number	Weight	Number	Weight	Number	Weight	Number	Weight	Number	Weight	Number	Weight	Number	Weight
Structures	98	123			6	4					1	8	2	1			9	60	96	196
Midden	65	204	42	61	15	40	5	23			11	164	5	18			23	207	166	717
Surface	133	151	119	222	7	18	6	5	3	2	63	705	36	44	3	14	71	254	441	1415
Total	276	478	161	283	28	62	11	28	3	2	75	877	43	63	3	14	103	521	703	2328
Weight/Flake	1.73		1.76		2.2		2.5		0.67		12		1.5		4.7		5.06		3.31	
Percent	39.3		22.9		4.0		1.6		0.4		10.7		6.1		0.4		14.7			

*Weight in grams

Table 40. Lithic Material Type and Tool Groups: 42SA740

Tool Type	Material Type									TOTAL
	C1	C2	C3	C4	C5	C6	C7	Q	Misc.	
Biface	5	4		1	1		1			12
Pressure Retouched Flakes	3	2								5
Projectile Points		2								2
Utilized Flakes	8		2	3			2	2	2	19
Cores		1	1	1	3		8			14
Debitage	276 (39%)	161 (23%)	28 (4%)	11 (2%)	3 (.4%)	75 (11%)	43 (6%)	3 (.4%)	103 (15%)	703
Total	292	170	31	16	7	75	54	5	105	755

CORES. A total of 14 cores were recovered from 42SA740. Six of the cores were large with a mean weight of 62 grams (standard deviation = 60 grams). The remaining eight cores were small pebble cores of material type C7 with a mean weight of 17 grams (standard deviation = 6 grams).

MISCELLANEOUS TOOLS. Two complete smoothers and three smoother fragments were recovered from 42SA740. Three of the smoothers were made of quartzite, one of basalt, and one of material type C5.

Two drills, two scrapers, a chopper, and a small basalt grinding tool were recovered. A quartzite cobble with crenated fractures was also recovered.

Rappel Ruin (42SA683)

The lithic artifacts from 42SA683 are few in number. Three utilized flakes, two blanks, one preform, and two pressure retouched flakes were recovered. The debitage provenience and material type distribution are shown in Table 41.

Steury Ledge (42SA533)

A drill, one hammerstone fragment, one scraper, one knife, and one pressure retouched flake were recovered from this site. The debitage provenience and material type distribution are shown in Table 41.

42SA5486

One utilized flake and one hammerstone were recovered from 42SA5486. The debitage provenience and material type distribution are shown in Table 41.

42SA684

One hammerstone was recovered from 42SA684. The debitage provenience and material type distributuion are shown in Table 41.

Table 41. Debitage Provenience by Material Type: Miscellaneous Sites

Provenience	Material Type																			
	C1		C2		C3		C4		C5		C6		C7		Q		Misc.		TOTAL	
	Number	Weight	Number	Weight	Number	Weight	Number	Weight	Number	Weight	Number	Weight	Number	Weight	Number	Weight	Number	Weight	Number	Weight
42SA683																				
Structure 1, Fill	1	-	4	-			2	-	1	-	1	-	1	-	2	-			12	26
Structure 2, Fill	2	-	7	-	1	-									2	-			12	29
Structure 5, Fill			1	1															1	1
Rat Midden	2	-	5	-															7	5
Total	5		17		1		2		1		1		1		4				32	61
42SA533																				
Structure 1, Fill	8	11	2	9													2	4	12	24
Structure 2, Fill																	2	4	2	4
Total	8	11	2	9													4	8	14	28

Table 41 — Continued

Provenience	Material Type																			
	C1		C2		C3		C4		C5		C6		C7		Q		Misc.		TOTAL	
	Number	Weight	Number	Weight	Number	Weight	Number	Weight	Number	Weight	Number	Weight	Number	Weight	Number	Weight	Number	Weight	Number	Weight
42SA5486																				
Total	3	1																	3	1
42SA684																				
Total	7	2	5	4															12	6
42SA551																				
Total	5	20	13	25	1	3	1	1					1	1					21	50
42SA5485																				
Structure 1, Fill	31	38	7	3	6	19	6	3											50	64
Structure 2, Fill	5	3	4	19			3	21											12	42
Total	36	41	11	22	6	19	9	24											62	106

Table 41 — Continued

Provenience	Material Type																					
	C1		C2		C3		C4		C5		C6		C7		Q		Misc.		TOTAL	
	Number	Weight	Number	Weight	Number	Weight	Number	Weight	Number	Weight	Number	Weight	Number	Weight	Number	Weight	Number	Weight	Number	Weight
								42SA5379												
Total			2	6			3	29									4	78	9	113
GRAND TOTAL	64	75	50	66	8	22	15	54	1		1		2	1	4		8	86	153	365

LAKE CANYON

42SA551

One preform and one knife were recovered from 42SA551. The debitage provenience and material type distribution are shown in Table 41.

Angry Ridge (42SA5485)

One hammerstone, two hammerstone fragments, two cores, and three preforms were recovered from 42SA5485. The debitage provenience and material type distribution are shown in Table 41.

GYPSUM CANYON

Carols House (42SA5379)

Two cores, one blank, and one utilized flake were recovered from 42SA5379. The debitage provenience and material type distribution are shown in Table 41.

GROUND STONE

by

Nancy Coulam

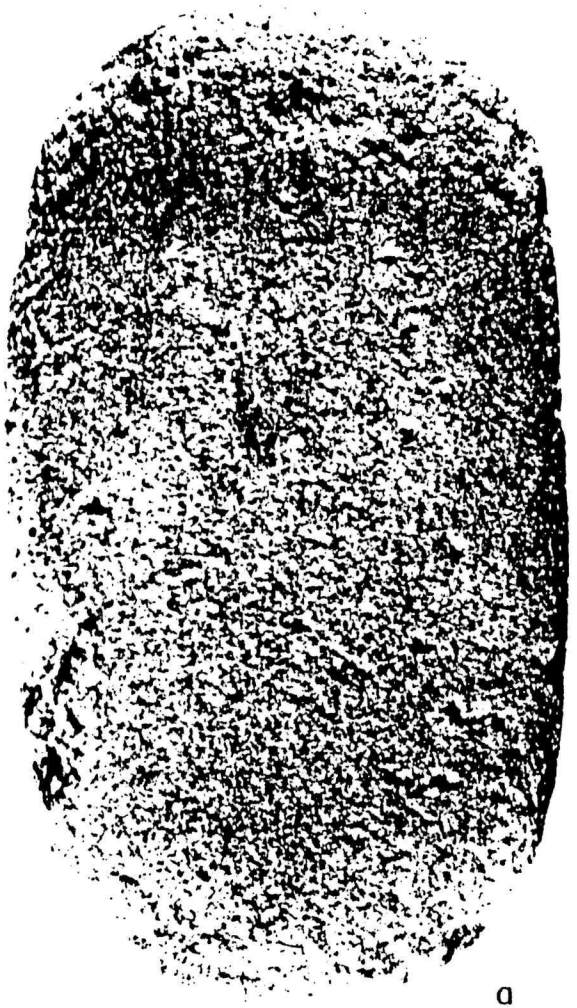
The 22 ground stone artifacts collected from Dangling Rope, Gypsum, and Moqui Canyons include 9 metates, 6 one-hand manos, 1 two-hand mano, and 4 unique and unidentifiable artifacts. All of the artifacts are made of locally available material, mostly sandstone. Of the artifacts, 11 come from Dangling Rope—5 metates, 4 manos, 2 fragments; 1 mano comes from Gypsum Canyon; and 10 come from Moqui Canyon--4 metates, 3 manos, and 3 unique artifacts of ground stone.

The manos are generally carefully shaped oval stones, whereas most of the metates are simply utilized slabs. Although the terms "metate" and "mano" connote stones used specifically for grinding maize, they also denote the preparation of other cereals and foodstuffs, including meat. With one exception the manos can all be classified as one-hand manos. The exception, a two-hand mano, is from Moqui Canyon; this mano plus the one from Gypsum Canyon are the only ones with single (unifacial) flat grinding surfaces. All of the other manos have two convex grinding surfaces (bifacial usage) resulting from direction of use (i.e., the leading edge is pushed and lifted slightly on the return stroke across the metate).

Dangling Rope Canyon

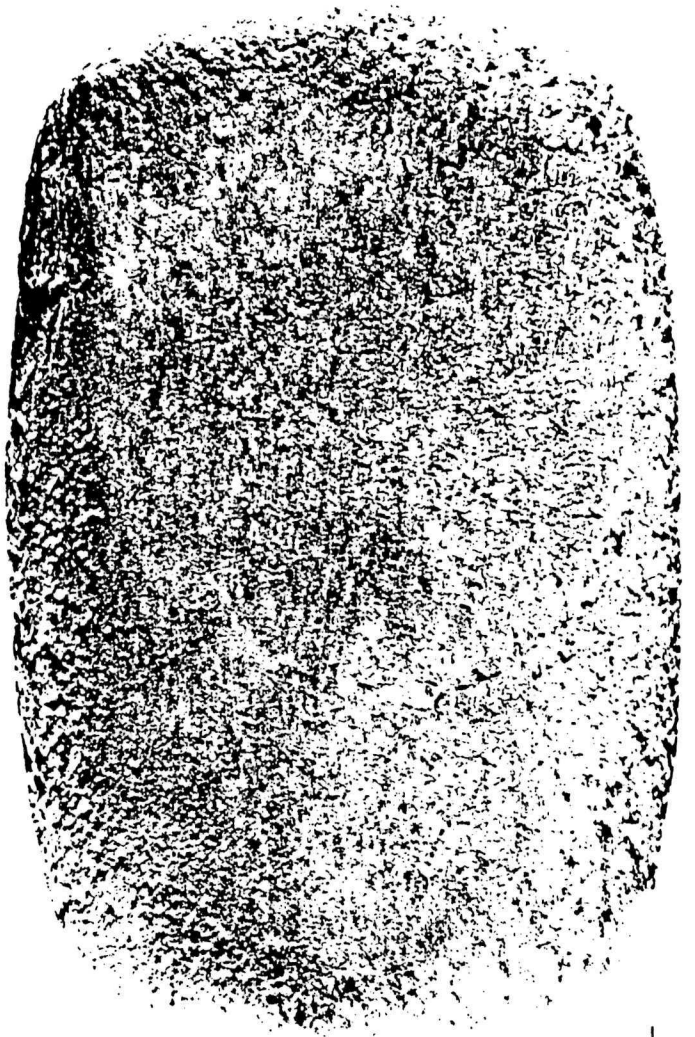
Four ground stone artifacts came from 42KA1709. One artifact is a complete one-hand mano, abraded on both sides to convex grinding surfaces (Fig. 109a). This oval mano measures 13.2 cm. in length, 7.4 cm. in width, and 4.2 cm. in thickness. The second artifact is a fragment of a smooth cobble, 4.2 by 3.0 cm. and 2.6 cm. thick, abraded along the edge in a thin line varying between

Figure 109. Handstones from Dangling Rope Canyon.



a

0 5 Cm.



l

0 5 Cm.

5 and 6 mm. No other wear is evident. A third artifact is a ground sandstone slab 8.2 by 5.2 cm. and 1.3 cm. thick. Of the recovered artifacts from Glen Canyon it is most similar to the tabular 2-hand mano recovered from 42SA5486, a site in North Gulch in Moqui Canyon. The fourth artifact is a mano. Although incomplete, the recovered end is oval with a convex grinding surface which has been polished.

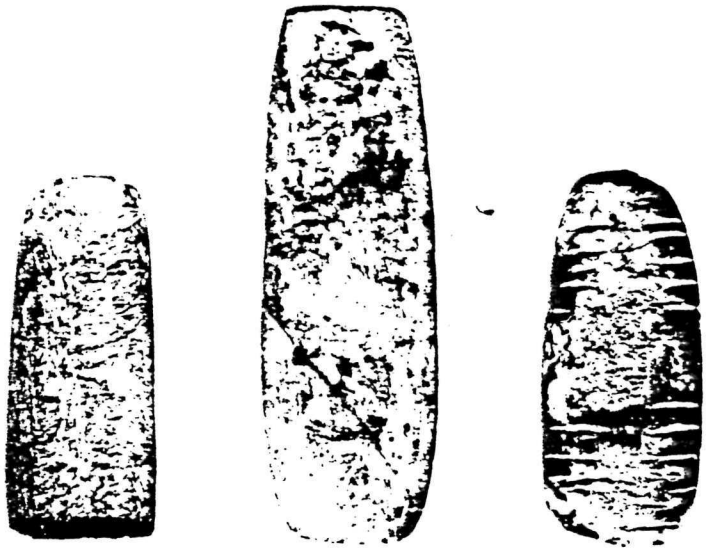
From 42KA1706 seven ground stone artifacts were recovered, including metates, manos, and artifact fragments. The one complete metate is a roughly shaped oval of tabular sandstone, 50 by 33 cm. and 7 cm. thick. The surface is pecked with an oval grinding depression. Two, fine-grained sandstone, metate pieces and two, coarse-grained, fragments were collected within a meter of the complete metate. Three of the metate fragments were pecked.

Two manos came from 42KA1706 (Fig. 109b). They are one-hand manos, abraded on both sides. In plan view one is a roughly shaped obovate cobble, 11.7 by 9.3 cm. and averages 4.5 cm. in thickness. Following Anderson's (1969:54) classification, both grinding surfaces are convex; however, one surface is only slightly convex having received greater abrasion. The other mano is pecked and is oblong in plan view and is 13.6 by 8.8 cm. and 4.9 cm. thick. Both grinding surfaces are convex with maximum abrasion on the shoulder.

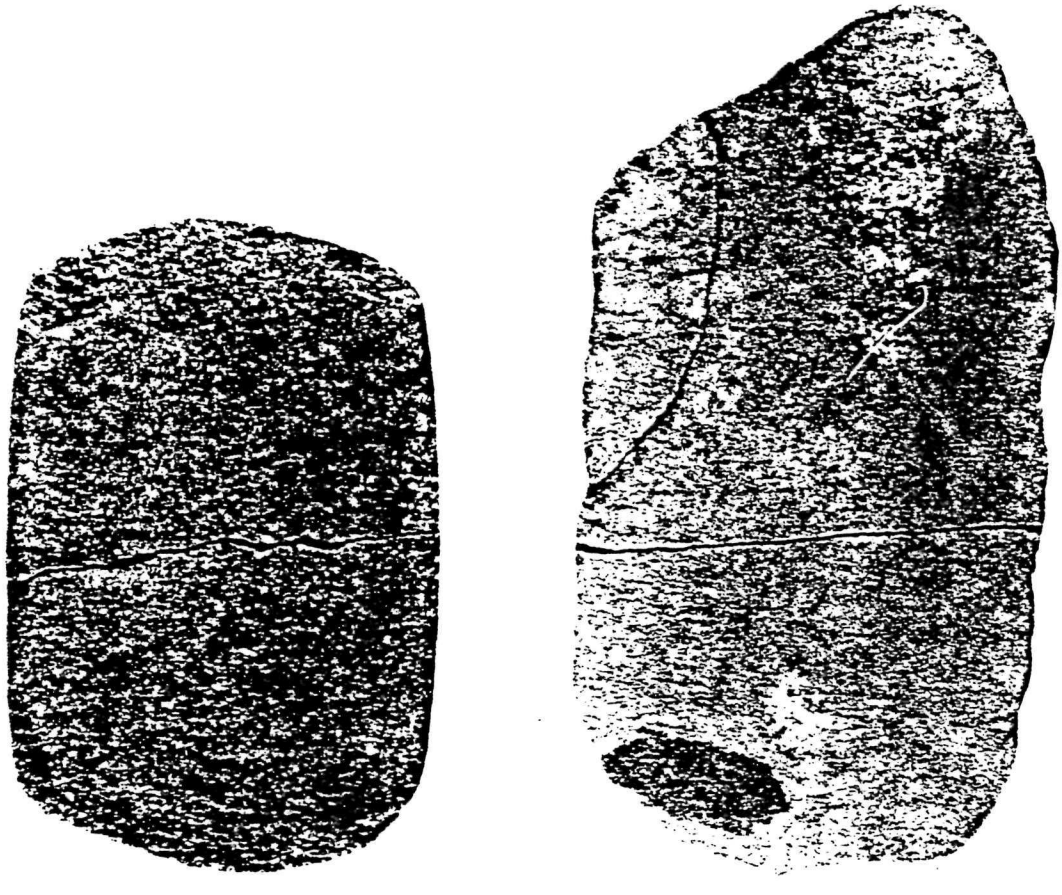
Also in the vicinity of 42KA1706, three ground stone objects (Fig. 110) were found that are tentatively identified as gaming pieces. The rectangular objects vary between 4.4 and 6.3 cm. and are ground on all sides. The obverse side of all of them is ground flat. All three are lenticular in cross-section on the medial axis. Only one (Fig. 110c) shows other marks besides abrasion; it has a set of parallel grooves down each side, which almost reach to the midline of the object. This particular object was recovered in 1976; it is red ochre and was probably used as a pigment applicator.

Figure 110. Ground stone gaming pieces from Dangling Rope Canyon (42KA1706).

Figure 111. Handstones from Moqui Canyon. Rappie Ruin (42SA683), a; 42SA5486, b.



0 5 Cm.



0 5 Cm.

0 Cm

Moqui Canyon

A single, ground stone, fragment from Steury Ledge (42SA533) is a portion of a rectangular metate. The edges and surface are pecked with only one surface ground smooth. Excavation at Rappel Ruin (42SA683) yielded a complete one-hand mano (Fig. 111a). In plan view it is oblong, 15.5 by 9.8 cm. and 3.1 cm. thick, with both grinding surfaces convex. From 42SA684 a fragment of a sandstone metate 5.5 by 9.5 cm. and 2.4 cm. thick with a flat grinding surface was recovered. A single fragment of a mano was recovered from 42SA740; both sides of it are abraded. From the mealing bin at 42SA5486 comes a two-hand mano (Fig. 111b) and a fragment of a metate. The tabular sandstone mano is shaped into a rough oval measuring 21 by 11 cm. and 1 cm. thick. The grinding surface is flat. Another ground stone artifact from this bin was a sandstone fragment of a metate averaging 6.2 cm. long, 4.8 cm. wide and 1.5 cm. thick.

Altogether, three ground stone artifacts were recovered from 42SA6214. Found in the rubble of Room 3 was one metate of white friable sandstone 35 by 25 cm. and 6 cm. thick. It has an oblong grinding depression. On the floor near the entrances of Rooms 1 and 2 were two sandstone slabs with a single, semicircular depression pecked into the center of the slabs. One slab is 37 by 30 cm. and 7 cm. thick with the depression diameter 4 cm., and from the nearest edge of the slab to the depression is 13 cm. The other slab is 37 by 28 cm. and 8 cm. thick with its depression diameter 5 cm., and from the closest edge of this slab to the depression is 11 cm. A similar slab with a pecked depression in the center was noted at 42SA6215. Since they were being associated with the entrance, it is possible that these slabs were used as door covers or deflectors.

Gypsum Canyon

A one-hand sandstone mano from Carol's House (42SA5379) has one abraded surface and is pecked flat, lightly ground, and fire blackened. The mano's dimensions are: 14.3 by 9.5 cm., 53. cm. at the thickest point, and 3.5 at the thinnest point.

CONCLUSIONS AND RECOMMENDATIONS

Dating and Cultural Affiliation

There are three major dating techniques used in Southwestern archaeology today, cross-dating of temporally significant traits, carbon-14 dating and dendrochronology. Dendrochronological dating is the most accurate method; unfortunately it is not generally applicable in the Glen Canyon region. During the UCRBASP numerous wood samples were collected for dendrochronological analysis, however, most of the samples represented complacent species, varieties that do not show sufficient variation in the annual growth rings to be useful in setting up a regional chronology. Dean (1964) summarizes the dateable tree-ring samples from southern Utah.

Two samples of charred roof beams from Carols House (42SA5379) in Gypsum Canyon were submitted to the Laboratory of Tree-Ring Research at the University of Arizona. Both samples were cottonwood (Populus sp.), a genus that is not generally dateable. Cottonwood was the most frequently utilized tree in Glen Canyon simply because it was the most easily obtainable species in the riverine environments in Glen Canyon.

Radiocarbon dating was not used extensively by the UCRBASP because the time span indicated by the date (within one or two standard deviations) is often larger than the time spans suggested on the basis of cross-dated artifacts. No radiocarbon samples from the 1977 excavations were submitted for assay. However, a charcoal sample from Carols House (42SA5379) in Gypsum Canyon was submitted by Carol Nieuwenhuis in 1976 in order to date one of the last episodes of alluviation in the canyon. The exact provenience of the sample is uncertain, but it probably represents a fragment of one of the roof beams. The sample dated 640 $\pm$ 200 radiocarbon years: A.D. 1310. At a minimum the

occupation of the site could range from A.D. 1100 to A.D. 1500. This date falls in the range of dates suggested by the limited amount of pottery at the site, i.e. a late Pueblo III occupation. But the radiocarbon date is too imprecise to permit any finer chronological interpretation at the site.

Cross-dating can be done either with diagnostic artifact types or with significant architectural features. Architectural features can not be used in Glen Canyon because no extensive analysis has ever been undertaken on the vast corpus of raw data generated by the UCRBASP. The 1977 crew noted structural differences between open sites and sites in alcoves. Lipe (1970:110, Fig. 10) implies this by noting there was a differential choice in site locations from the Kletha phase to the Horsefly Hollow phase.

The amount of architectural detail that could be analyzed in Glen Canyon is staggering. From 1957 to 1963 the University of Utah tested or excavated over 120 sites in Glen Canyon (Table 42). With the addition of about 50 sites excavated by the Museum of Northern Arizona during the same time period, the total number of sites excavated or tested and reported is about 200. Outside of Lipe's synthesis of data from the Red Rock Plateau (Lipe 1970), no other synthesis of the Glen Canyon material has appeared. Jennings' 1966 summary is not a detailed synthesis of the archeology nor a condensation of the descriptive reports but rather "an assessment of the overall project" (Jennings 1966:iii) which extolls the merits of an inter-disciplinary approach to such a research program. An archeological summary and synthesis of the basic data from UCRBASP has not yet been completed. Cross-dating based on architectural features in Glen Canyon is just not feasible at this stage.

For cross-dating purposes, then, we are limited to portable artifacts. Two two major classes of artifacts recovered during the 1977 work were pottery and lithics. Almost all of the lithic material was recovered from Dangling Rope

Table 42. List of Excavated or Tested Sites in Glen Canyon, Utah

Washington County, Utah

42WS50 (Three Mile Ruin)	X
172 (Goosenecks Overlook)	X
173 (The Reusch Site)	X
200 (Paraunuweap Knoll)	X
202 (Lamb's Knoll Cave #1)	X
203 (Lamb's Knoll Cave #2)	X

San Juan County, Utah

42SA313 (Sage Park)	X
314	T
315 (Coyote Ridge)	X
316 (The Fortress	X
323 (The Watchtower)	X
344	T
356	T
362	T
363 (Lone Tree Dune)	X
364 (Loper Ruin)	X
366 (Husteds Well)	X
368 (Backyard Site)	T
369 (Bar Point)	X
373 (Wasp House)	X
374 (Oakleaf Alcove)	X
375 (Hawk Hollow)	X
377 (Fence Ruin)	X
383 (The Billboard Site)	X
395 (Catfish Canyon Site)	X
413 (Forked Stick Alcove)	X
444 (Green Water Spring)	X
454 (Steer Palace)	X
463	T
531	T
540 (Pagahrit Dune)	X
543 (Toad Shelter)	X
544 (Horsefly Hollow)	X
545	T
550 (Surrey Terrace)	X
554 (Rogers House)	X
558	T
559	T
564 (Daves Site)	X
566 (Ledge Ruin Group)	X
567 (Ledge Ruin Group)	X
568 (Ledge Ruin Group)	X
576 (Shady Alcove)	X
583 (Echo Cave)	X
585 (Doll Ruin)	X
597 (Crumbling Kiva)	X
42SA598 (Defiance House)	X
615 (Mouse Alcove)	X
616 (Lost Ladder)	X
619 (Gourd House)	X
620 (Weirs Mural Site)	X
622 (Oven Alcove)	X
623 (Lyman Flat)	X
624 (The Penthouse)	X
627 (Dead Tree Flats)	X
632	T
633 (Widows Ledge)	X
635 (Mistake Alcove)	X
637 (Grimm Site)	X
643 (Mosquito Cave)	X
646 (Mat House)	X
651	T
655	T
659	T
662 (Grid Alcove)	X
675 (Red Ant Kiva)	X
678 (Copter Ledge)	X
679 (Hiboy House)	X
681 (Rehab Center)	X
693 (Ax Groove Alcove)	X
695 (Stevens Terrace)	X
729 (Flatrock House)	X
735	T
736 (Bernheimer Alcove, Big Cave #1)	X
738 (Ivy Shelter)	X
748	T
754 (Honeycomb Alcove)	X
755	T
757	T
760	T
762	T
776	T
781 (Tamarix Dune)	X
782	T
1010 (Scorup Pasture)	X
1011	T

X = Excavated; T = Tested

Table 42. (Cont.)

Kane County, Utah	
42KA172 (The Alvey Site)	X
173	T
174	T
178 (Gates Roost)	X
235 (Davis Pool Site)	T
241 (Davis Kiva Site)	X
254	T
272 (Horseshoe Alcove)	X
274 (Talus Ruin)	X
276 (Lizard Alcove)	X
331 (Three Forks Pueblo)	X
346 (The Bridgette Site)	X
354 (Mudhole Pueblo)	X
368 (The Observatory)	X
433 (Benchmark Cave)	C
443 (The Hermitage Site)	X
447 (The Kane Landing Site)	X
456 (Busted Jug Shelter)	X
457 (The Dune Site)	X
524 (Golden Stairs)	X
526 (Pocket Hollow Farms I)	X
528 (Pocket Hollow Farms II)	X
539 (Ava)	X
543 (Tewap Knoll)	X
544 (Sophia Cave)	X
601 (The Wright Site)	X
761 (Aspen Pueblo)	X
1060 (The Sand Hill Site)	X
1076 (Bonanza Dune)	X
Garfield County, Utah	
42GA43 (Rattlesnake Point)	X
49	T
51 (Spencer Site)	X
102 (Sheep Horn Alcove)	X
103 (Pantry Alcove)	X
286 (Circle Terrace)	X
288 (Triangle Cave)	X
290	T
367 (Buried Olla Site)	X

X = Excavated; T = Tested

Canyon. Analysis of the projectile points by Weder indicated that the benchland in this canyon could have been occupied any time from about 4000 B.C. to A.D. 400. This time span generally represents Archaic occupations on the Colorado Plateau (Schroedl 1976c). Tree-ring dates are the usual basis for cross-dating pottery types; Worthington uses these dates to determine the possible span of occupation at all of the sites from which pottery was collected in 1977. Unfortunately the dating of pottery collections that have less than one hundred sherds is highly suspect. Only two sites, the Over site (42SA6214) and 42SA740, had more than 100 sherds. On the basis of the pottery types present at these two sites, the probable span of prehistoric occuaption is A.D. 1250 to A.D. 1300. Thus they both fall into Lipe's (1970) Horsefly Hollow phase, A.D. 1210 to A.D. 1260.

In the Southwest, cultural affiliation is generally determined on the basis of significant cultural features or diagnostic artifact types, usually pottery, and in preceramic contexts on the basis of projectile points. The lack of pottery on the Dangling Rope benchland, coupled with the presence of large dart points and one-hand grinding stones suggests that this benchland was occupied by non-Pueblo populations. Weder's analysis of the wear patterns on the stone tools and the debitage from Dangling Rope seems to prove beyond reasonable doubt that Archaic peoples were using the benchland anytime between 4000 B.C. and A.D. 500.

All of the other sites taht were visited, tested, or excavated in 1977 fall into the later Pueblo time period after the time of Christ. As noted, dates for the Pueblo occupations at these sites can not be determined very precisely. The cultural affiliaton is uncertain as well, both Mesa Verde and Kayenta ceramics were recovered with the Kayenta ceramics dominating the collection. Worthington notes that simple dominance by percentage of a particular pottery type is

not sufficient evidence to assign a site to one particular cultural group or complex. In summary, most of these sites probably fall into the late Pueblo III period and show affinities to the Kayenta Anasazi.

Recommendations

Three sites were noted near the mouth of Gypsum Canyon in 1977, Carol's House (42SA5379), a rock ring (42SA6316), and a petroglyph panel (42SA6364). Of these, Carol's House, a late Pueblo III habitation site, and the petroglyph panel will be underwater when Lake Powell reaches its maximum flood pool elevation. Neither of these sites nor the rock ring which has numerous counterpart examples throughout Glen Canyon can be considered either distinctive enough or sufficiently significant to quality for a National Register nomination.

Although the finds on the Dangling Rope benchland loom important as an example of Archaic utilization of the intermediate benchlands in Glen Canyon, the sites can in no way be considered unique. Kay's work (1974) and 1978 National Park Service survey have indicated that Archaic utilization of the uplands and intermediate benchlands was quite extensive in the Lake Powell area. The reason this heavy Archaic utilization was not noted previously was that the UCRBASP concentrated on later highly visible Pueblo sites found in the canyon bottoms. Testing on the Dangling Rope bench produced no subsurface cultural evidence; intensive surface collection of the bench has cleared the area for the development of new marina facilities. The benchland does not qualify for National Register nomination.

After reviewing the archeological data generated in Lake Canyon and Moqui in 1976 (Schroedl 1976a) and the data recovered in 1977 and the previously published materials on these two canyon systems, we have concluded that each

of these canyons should be nominated for the National Register as district nominations. There are a number of reasons for suggesting that these canyons be nominated. First, and primarily, these two were among the most intensively utilized canyons in Glen Canyon in prehistoric times, even though neither of them have extremely large sites that are found in some of the other Glen Canyon tributaries. In Lake Canyon 89 historic and prehistoric sites have been recorded; in Moqui Canyon, 102 sites have been noted. Undoubtedly there are still several more sites in both of these canyons that have not yet been discovered. Not only were these canyons extensively occupied, but they show utilization over a long period of time. Moqui Canyon contains evidence of a sizeable Basketmaker occupation, while both canyons exhibit extensive late Pueblo II and Pueblo III occupations. Even some Pueblo IV occupations are noted in the canyons on the basis of pottery types; and in each canyon historic sites have been noted as well.

Archeologically these canyons are also significant since they fall into the contact zone between the Mesa Verde and the Kayenta Anasazi (Lipe 1970). Excavated sites in these canyons (21 in Lake Canyon, 15 in Moqui Canyon) have produced data that bear directly on the question of prehistoric cultural boundaries. These two canyon systems appear to be in the contact zone between the Mesa Verde and the Kayenta peoples.

Both canyons are also of historical significance in terms of the development of archeology in the area. At the end of the last century, the Wetherills made forays into Moqui Canyon and possibly Lake Canyon in search of Basketmaker sites. Later, the Bernheimer expeditions passed through Lake Canyon and Moqui Canyon where they excavated several sites.

Each canyon, however, has its own distinctive archeological resources. Not only does Moqui Canyon have several early Basketmaker sites, but it also has a significant amount of rock art that was not recognized prior to the 1977

compilation by Sebastian. Rock art occurs at more than 15 sites in the canyon and some rival the Davis Pool pictograph panel. Also, Moqui Canyon contains several sites, most notably 42SA720, that are "inaccessible" and have never been visited by archeologists.

Lake Canyon gained its name from a lake that existed in the upstream portions of the canyon in recent times prior to about 1910. This unique geological phenomena offered an unusual local setting for prehistoric groups to live and work as evidenced by the high density of archeological sites found around the edges of the old lake bed. Horsefly Hollow, is also found in Lake Canyon, the type site for the Horsefly Hollow phase designated by Lipe (1970).

Thus, there seem to be numerous reasons why both of these canyons should be nominated as prehistoric cultural districts to the National Register. The nominated areas should not be restricted to just the Glen Canyon Recreation Area (the boundary virtually bisects both of these canyons), but should also include the upstream portions of the canyons on Bureau of Land Management lands (Richard Fike, personal communication). Although parts of these canyons are administered by two different governmental agencies, the cultural unity and significance of each of the canyon systems is obvious, and both agencies should work together to preserve the cultural resources in these canyons. These two agencies should cooperatively nominate these two canyons, Lake and Moqui, to the National Register of Historic Places, thus serving notice of the significant role these canyons have played in the history and prehistory of the Glen Canyon area.

Summary

In summary, the 1977 work in Glen Canyon was successful in preserving archeological data that would be lost to natural as well as human agencies and

evaluating sites for the National Register. Carol's House (42SA5379), for example, will be lost when Lake Powell reaches the maximum flood pool elevation; fortunately we were able to excavated what little remained of this site. Two sites that were being destroyed by looters, the Over Site (42SA6214) and Angry Ridge (42SA5485), were also excavated. The excessive destruction of archeological sites by human activity has been noted previously (Schroedl 1976a) and again reaffirmed by the crew in 1977. Portable artifacts are virtually non-existent at archeological sites within a half-hours' walking distance of the lake. For this reason the 1977 crew surface collected 42SA740; the result was one of the largest collections of pottery from any site in Moqui Canyon.

The work in Dangling Rope canyon was significant for two reasons. First, from a methodological standpoint, it proved that not only is large scale surface collection of lithic scatters economically feasible, but that it is also productive in terms of the archeological data that can be recovered from such sites. Second, the Dangling Rope material is significant in that it demonstrates extensive use of the benchland by Archaic populations. This information is supported by numerous lithic scatters around Halls Crossing (Kay 1974) which suggest that the benchlands and uplands around Glen Canyon were extensively utilized by pre-Pueblo populations. This was apparently not recognized by the crews of the UCRBASP who concentrated on surveying and excavating later Pueblo sites in the canyons. This discovery of Archaic occupations in the area will certainly have an effect on future research in the area.

Finally, Sebastian's analysis of the rock art, Weder's analysis of the lithics, and Bye's analysis of the cultivated plant remains (Appendix), all limited by the data at hand, foreshadow the kinds of detailed analyses that need to be carried out on the archeological data from Glen Canyon. The archaeological data base for Glen Canyon has barely been tapped regarding scientific analysis of the

materials. The crews from the UCRBASP were too busy salvaging sites to undertake any detailed analyses. The time has come to synthesize this information in order to provide a clear understanding of the prehistory of the Glen Canyon area.

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APPENDIX I

DESCRIPTIONS OF ARCHEOLOGICAL SITES IN LAKE AND MOQUI CANYONS

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DESCRIPTIONS OF ARCHEOLOGICAL SITES IN LAKE AND MOQUI CANYONS

Introduction

Most of the archeological sites in Lake and Moqui Canyons were recorded by University of Utah survey crews between the summer of 1958 and 1962. The 1976 and 1977 crews recorded 14 additional sites in these canyons. The sites in both Lake and Moqui Canyons have been grouped into six categories or types (Table 1). For purposes of analysis the original site classifications used by the UCRBASP were redefined. It must be stated that the classification used here is totally arbitrary, based on the presence or absence of certain artifacts or features. The types of sites include lithic scatters, habitation sites, masonry sites, petroglyph/pictograph sites, isolated series of pecked hand and toeholds, and historic sites. The criteria upon which these distinctions are based are summarized in the discussions which follow. Two of the sites listed in this Appendix are isolated finds, while seven others have been dropped (See Schroedl [1976] for a discussion of these sites).

LITHIC SCATTERS

Lithic scatters are defined as those sites which exhibit lithic debitage and tools, but lack pottery, charcoal, other habitation debris or architectural remains. It may be postulated that these sites served merely as use areas involving no prolonged habitation.

HABITATION SITES

Sites exhibiting habitation debris and pottery as well as lithic artifacts, but lacking any architectural remains, are classified simply as habitation sites.

Table 1

Distribution of Types of Sites
in Lake and Moqui Canyons

Type	Canyon	
	Moqui	Lake
Masonry	53	38
Habitation	40	35
Pecked Hand and Toeholds	2	2
Petroglyph/Pictograph	2	1
Lithic Scatters	2	1
Isolated Finds	2	0
Historic	1	4
TOTAL	102	81

These are found along the canyon floors, atop the alluvial cutbanks, in overhangs in the sandstone cliff face, and on top of the canyon rims in sheltered blowouts and overhangs. The deposits of habitation debris and the presence of pottery as well as lithic artifacts indicate that these sites probably served as living areas.

MASONRY SITES

Masonry sites are separated from the habitation sites merely by the presence of architectural remains. The architecture consisted of either wet-laid or dry-laid sandstone structures. This classification includes such structures as retaining walls, granaries, and living quarters or rooms. These sites are generally located in overhangs and on ledges high above the canyon floor; however, they are also found on the canyon rim, and occasionally in the canyons on the alluvial remnants.

PETROGLYPH/PICTOGRAPH SITES

These sites are strictly rock art sites with no other associated archeological remains. When a petroglyph or pictograph panel was recorded in direct association with a habitation or masonry site it was not given separate status. There is a single isolated rock art site in Lake Canyon and two in Moqui Canyon. These isolated panels are located on open sandstone cliff faces.

PECKED HAND AND TOEHOLDS

Usually, pecked hand and toeholds were noted in direct association with masonry sites built in high alcoves or on ledges above the alluvium and served as the only means of access to these structures. In these instances, they were merely considered as a component of the site as a whole, and were not listed separately. However, in some cases, the series of pecked hand and toeholds were isolated from any other archeological feature, and they were given separate status. There are two of these isolated sites in Lake Canyon and two in Moqui Canyon. Three of these seemed to serve as means of exiting the canyons. However, in one instance in Lake Canyon (Site 42SA5509), the pecked hand and toeholds ascended approximately two meters up the cliff face and there stopped, evidently representing an aborted effort.

HISTORIC SITES

Historic sites are identified simply on the basis of the presence of historic artifacts or features (i.e., post-white contact). There are four historic sites in Lake Canyon and one in Moqui Canyon.

Lake Canyon

Site Designation	Site Type	Description
42SA316	masonry	Open masonry site on a small knoll bordering the streambed with partially collapsed limestone slab walls. Large rectangular plaza enclosed by wall, three small rooms along south end of rectangle. Trash area on slope below structure. The site was excavated by the University of Utah in 1960, as "The Fortress." (Sharrock et al. 1961:21-30). Area: 45 sq. m.
42SA373*	masonry	Located in small alcove 18 m. above streambed. Three coursed masonry, plastered structures, chinking of sherds and cobs. Fourth is collapsed unshaped slab structure. Intact roof of poles and adobe, roof entrance, and ventilator in one structure. Historic pictographs on alcove wall. Petroglyphs and abrading grooves on spalls at upstream end of alcove. The site was excavated by University of Utah in 1960, as "Wasp House." (Sharrock et al. 1961:161-173). Area: 5 x 60 m.
42SA374	masonry	Crude dry-laid walls defining eight rooms in large belled alcove. Trash areas near walls. Site has been pothunted. It was excavated by the University of Utah in 1960 as "Oakleaf Alcove." (Sharrock et al. 1961:192-193). Area: 15 x 200 m.

* = site now submerged, descriptions from previous surveys

Site Designation	Site Type	Description
42SA375	masonry	Nine circular dry-laid slab rooms located on talus slope in an alcove beneath the overhang. Site is partially covered by spalls and sand dune; it has been pothunted. The site was excavated by the University of Utah in 1960 as "Hawk Hollow." (Sharrock et al. 1961:173-178). Area: 34 x 90 m.
42SA537	habitation	Open campsite on dune near edge of old lake shore. Artifacts in eroded area of dune. Scattered historic artifacts on site. Deep runoff gully through site. Area: 30 sq. m.
42SA539	habitation	Campsite in shallow alcove near edge of old lake shore. Eroded alluvial fill inside alcove. Artifacts on slope below shelter. Area: 12 m. x 18 m.
42SA540	habitation	Open campsite on dunes and alluvial terrace on edge of old lake shore. Artifacts, burned rocks and ash visible in blowout areas of dunes. The site was excavated by the University of Utah in 1960 as "Pagahrit Dune." (Sharrock et al. 1961:180-183). Area: 185 x 400 m.
42SA541	masonry	Probable collapsed slab wall on low sandstone knoll. Artifacts on knoll and on dune at base of knoll. Area: 8 x 15 m.
42SA542	habitation	Open campsite on dune and talus slope at base of sandstone ledge. Scattered artifacts on ledges above site. Area: 15 x 30 m.
42SA543	habitation	Located on dunes at base of shallow overhang. Charcoal stains visible in eroded areas. The site was excavated by the University of Utah in 1960 as "Toad Shelter." (Sharrock et al. 1961: 59-66). Area: 27 x 69 m.
42SA544	habitation	Located on dunes in two adjacent alcoves at base of cliff. Artifacts on dunes and in eroded areas between dunes. The site was excavated by the University of Utah in 1960 as "Horsefly Hollow." (Sharrock et al. 1961:36-66). Area: 46 x 82 m.

Site Designation	Site Type	Description
42SA545	habitation	In large belled alcove. Remnants of small granary on low narrow ledge extending out from back wall of alcove. Abrading grooves and indistinct petroglyphs on alcove walls. Alcove use in historic times as cow camp and corral. Site was tested in 1960; test trenches revealed no deposition of archeological material, except in surface sand. Scattered artifacts on dune in front of alcove. Site has been pothunted: Area: 17 x 58 m.
42SA546	habitation	Open campsites and/or chipping sites on stabilized dunes in shallow basin formed by sandstone knolls. Possible collapsed dry-laid structure on crest on one knoll. Site is 50 m. east of shore line of old lake. Area: 275 x 275 m.
42SA547	habitation	Probably campsite on dune at base of cliff. Area: 2 x 6 m.
42SA548	masonry	Masonry structures in alcove. Two slab and adobe masonry rooms, one circular, one rectangular, built on large slump boulders in shallow alcove. Walls partially collapsed. Indistinct white pigment pictographs on alcove wall. Abrading grooves and pecked figures on large spall at front of alcove. Area: 15 x 30 m.
42SA549	masonry	Line of five rectangular contiguous rooms on ledge below crest of knoll. Walls partially collapsed. Two contiguous collapsed structures on slope of knoll below ledge. Masonry crude and unmortared. In resurveying the area, an associated site consisting of 5 structures was found on the north side of the knoll at approx. the same level (42SA5484). Area: 30 x 46 m.
42SA550*	historic	Collapsed pole and log structure on alluvial terrace remnant near base of cliff. Logs appear to have been cut with steel ax. Culinary utensils and refuse area near structure. The site was excavated by the University of Utah in 1960 as "Survey Terrace." (Sharrock et al. 1961:123-128. Area: 15 x 30 m.

Site Designation	Site Type	Description
42SA551	masonry	Rectangular dry-laid structure on sandstone knoll on rim of canyon about 90 m. above streambed. Masonry of unshaped slabs. Walls collapsed inward. Blowsand fill inside structure. It is recommended that the site be cleaned out and mapped. Area: 3 x 12 m.
42SA552	masonry	Circular (5 m. dia.) dry-laid wall on sandstone knoll on rim of canyon. Masonry of unshaped slabs, wall collapsed. Scattered artifacts on dune at base of knoll. Area: 5 x 12 m.
42SA553	habitation	Open campsite on alluvial terrace remnant. Most of area eroded away. Artifacts on slope below remnant. Area: 30 x 30 m.
42SA554	masonry	Two coursed masonry structures on narrow ledge above alluvial remnant. Wall of one structure partially collapsed. Weathered pecked steps and petroglyphs on face of ledge below structures. The site was excavated by the University of Utah in 1960 as "Rogers House." (Sharrock et al. 1961:66-75).
42SA555	habitation	Small collapsed jacal structure at one end of alcove. Smoke blackening on alcove ceiling. Area: 13 x 24 m.
42SA565	habitation	Open campsite at base of low sandstone hummock. Artifacts eroding into stream channel at base of dune. Area: 4 x 11 m.
42SA609*	masonry	Dry-laid masonry structure on ledge near streambed. Site has been pothunted. Area: 3 x 3 m.
42SA610	pecked hand toeholds	Series of badly weathered steps on and cliff face. Steps lead up to a high, now inaccessible alcove. Area: unknown.
42SA611*	habitation	Campsite or chipping site on rock ledge. Scattered sherds and flakes on narrow rock ledge at seep-line in cliff face. Area: 6 x 12 m.
42SA612*	habitation	Open campsite on alluvial bench 9 m. above streambed. Sherds and flakes eroding from dune on bench. Area: 9 x 15 m.

Site Designation	Site Type	Description
42SA613*	masonry	Two dry-laid rectangular structures on talus slope in long shallow alcove. Some trash deposits visible in potholes. Site has been pothunted. Area: 6 x 76 m.
42SA614*	masonry	Spall and adobe granary in small alcove near top of cliff. Square doorway, lintel and posts of willow. Area: 1 x 2 m.
42SA615*	masonry	Four visible structures in alcove of spall, adobe and jacal construction, about 10 m. above top of alluvial terrace. Artifacts on terrace below site. The site was excavated by the University of Utah in 1960 as "Mouse Alcove." (Sharrock et al. 1961: 157-160). Area: 5 x 15 m.
42SA616*	masonry	Remnants of two adjoining D-shaped rooms, spall and adobe masonry. Beam holes in wall. Three adjoining circular granaries. Dry-laid retaining wall at front of alcove. Pictographs on alcove wall. Site has been pothunted. It was excavated by the University of Utah in 1960 as "Lost Ladder." (Sharrock et al. 1961:141-148). Area: 6 x 18 m.
42SA617*	habitation	Slab-lined firepit and artifacts on eroding alluvial bench. Area: 9 x 12 m.
42SA618*	masonry	Spall and adobe wall remnant in shallow alcove. Access to alcove eroded away. Area: undetermined.
42SA619*	masonry	Four contiguous spall and adobe structures in low, belled alcove. Rooms built up behind retaining walls. Single wall along entire front of alcove. Numerous whole gourds on floor. Room smoke-blackened. The site was excavated by the University of Utah in 1960 as "Gourd House." (Sharrock et al. 1961: 128-141). Area: 12 x 15 m.
42SA620*	habitation	Artifacts eroding from dunes at base of cliff. Scattered petroglyphs on cliff face. The site was excavated by the University of Utah in 1960 as "Weirs Mural." (Sharrock et al. 1961:183-192). Area: 46 x 46 m.

Site Designation	Site Type	Description
42SA621*	habitation	Unlined hearths visible in blowout areas on alluvial bench above streambed. Area: 15 x 15 m.
42SA622	masonry	Rectangular spall and adobe room in small alcove. D-shaped granary adjacent to room. Dry-laid retaining wall at front of alcove. The site was excavated by the University of Utah in 1960 as "Oven Alcove." (Sharrock et al.42SA622 (Continued 1961:108-114). Stabilization is recommended, since destruction by tourist traffic would seem imminent. Area: 9 x 9 m.
42SA623	habitation	Artifacts and charcoal eroding from dunes on alluvial bench. Site cut by runoff gullies. Navajo sweat house on site. It was excavated by the University of Utah in 1960 as "Lyman Flat." (Sharrock et al. 1961:96-107) Area: 150 x 30 m.
42SA624	masonry	Two rectangular spall and adobe rooms on rock ledge in high alcove. Adobe rimmed doorway in wall of one structure. Wall of second structure partially collapsed. Bedrock metates and abrading grooves on sandstone bench below alcove. Scattered petroglyphs on cliff wall. The site was excavated by the University of Utah in 1960 as "The Penthouse." (Sharrock et al. 1961:92-95). Area: 8 x 90 m.
42SA625	habitation	Located on sandstone bench at base of cliff. Sherds scattered on loose talus slope. Area: 12 x 12 m.
42SA626	masonry	Wall fragment on high inaccessible ledge above alluvial bench. Masonry appears to be spall and adobe. Area: unknown.
42SA627	habitation	Heavy concentration of artifacts and charcoal eroding from runoff gullies across bench located near base of cliff. The site was excavated by the University of Utah in 1960 as "Deadtree Flats." (Sharrock et al. 1961:75-91). The site is presently highly dissected by erosional channels. Area: 15 x 30 m.

Site Designation	Site Type	Description
42SA628	habitation	Open campsite on alluvial remnant at base of sandstone bench. Deep runoff gully bisects dune. Ash lenses visible in cutbank. Area: 15 x 15 m.
42SA651	habitation	Artifacts, burned rocks, and charcoal in blowout areas of dunes at base of sandstone knolls. Site tested in 1960 by University of Utah. No depth noted. Area: 8 x 38 m.
42SA652	masonry	Collapsed semicircular dry-laid room on ledge on rim of canyon. Artifacts on dunes and benches below structure. Area: 9 x 9 m.
42SA653	masonry	Collapsed, dry-laid slab circular structure on dune at base of ledge. Artifacts on dune and bench below structure. Area: 9 x 18 m.
42SA654	habitation	Open campsite on dune at base of sandstone knoll. Artifacts in blowout areas. Area: 6 x 6 m.
42SA655	masonry	Rectangular (16 x 3 m.) partially collapsed slab masonry structure on crest of sandstone dome on rim of canyon. L-shaped single course boulder wall adjacent to structure. Area: 9 x 18 m.
42SA657	habitation	Open campsite on stabilized dune on wide ledge just below rim of canyon. Area: 9 x 46 m.
42SA658	masonry	Three contiguous slab and adobe masonry rooms in shallow alcove just below rim of canyon. One room, semicircular, contained collapsed roof. Other rooms square, low walls, no roof. Sherd area on dune in small saddle on rim above alcove. Area: alcove - 3 x 9 m. sherd area - 9 x 9 m.
42SA659	masonry	Three-room slab and adobe structure on knoll on rim of canyon. Walls partially collapsed. North wall of structure 1.5 m. high. Artifacts on slope below rooms. Rooms were cleared of fill in 1960 by University of Utah survey. The clearing revealed level puddled clay floors in two rooms and an unlined firepit in one room. Area: 5 x 11 m.

Site Designation	Site Type	Description
42SA660	masonry	Low slab and adobe wall on narrow ledge at back of high arching alcove. Artifacts on benches below ledge. Area: 9 x 122 m.
42SA661	masonry	Low, coursed masonry wall on narrow ledge 9 m. above stream bed. Weathered pecked steps from stream level to ledge at its north end. Area: 2 x 5 m.
42SA662	habitation	Three contiguous alcoves at base of cliff. Trash areas on talus slopes in alcoves. Charcoal and ash visible in eroded areas. Abrading grooves and petroglyphs on spalls. The site was excavated by the University of Utah in 1960 as "Grid Alcove." (Sharrock et al. 1961:178-180). At the time of the 1976 survey, sand had covered over the excavated areas, largely obscuring the site. Area: 29 x 114 m.
42SA663	habitation	Outline of low collapsed wall on dune in alcove. Charcoal and artifacts visible in eroded areas: Area: 3 x 6 m.
42SA664	masonry	Semicircular dry-laid masonry room in dune in alcove. Wall partially collapsed. Circular slab and adobe granary on ledge above room. Second granary in crevice above ledge. Area: 15 x 30 m.
42SA665	masonry	Rectangular, roofed structure built against wall of cave. Doorway in one wall. Sandstone door slab inside structure. Low slab and adobe retaining wall across mouth of cave. Site has been pothunted. Area: 6 x 8 m.
42SA666	masonry	Dry-laid structure on dune. Circle of vertically placed sandstone slabs on crest of dune at base of low sandstone knoll. Area: 3 x 3 m.
42SA667	masonry	Campsite on dune covered ledge. Small slab and adobe granary in shallow alcove adjacent to ledge. Series of pecked steps below alcove. Area: 9 x 30 m.
42SA668	habitation	Campsite on sandstone ledge and adjacent talus slope. Scattered artifacts on flat area at top of talus slope and ledge. Site has been pothunted. Area: 5 x 9 m.

Site Designation	Site Type	Description
42SA669	masonry	Three adjacent alcoves containing slab and adobe structures. Six contiguous granaries with adobe rimmed doorways at north end of largest alcove. Two semicircular rooms at south end of alcove. Two adjacent small alcoves contained semicircular slab and adobe granaries. Access to large alcove by series of pecked steps. Site has been pothunted. Area: 9 x 60 m.
42SA670	masonry	Low slab and adobe retaining wall across front of shallow alcove above jump-up in canyon. Slabe and adobe masonry, pole roofed semicircular granary in small alcove on opposite side of canyon. Area: wall - 2 x 3 m., granary - 1 x 1.5 m.
42SA671	masonry	Low semicircular dry-laid slab wall on sandstone knoll on rim of canyon. Area: 2 x 3 m.
42SA672	masonry	Partially collapsed semicircular dry-laid wall on dune at base of sandstone knoll on rim of canyon. Artifacts on benches below structure. Area: 9 x 15 m.
42SA673	habitation	Campsite on dune at base of low sandstone spur. Charcoal visible in eroded areas of dune. Artifacts on beach below dune. Area: 9 x 9 m.
42SA674	habitation	Open campsite on dune in basin between sandstone knolls near rim of canyon. Artifacts on dune and in runoff gully between knolls. Area: 30 x 60 m.
42SA687	habitation	Open campsite on dune in basin on rim of canyon. Low dry-laid semicircular wall at center of dune. Charcoal stains visible in eroded areas: Area: 15 x 37 m.
42SA689*	habitation	Scattered artifacts on bedrock floor of shallow alcove and on sloping dune in front of alcove: Area: 15 x 15 m.
42SA690	habitation	Open campsite or chipping area in sandy basin on rim of canyon. Area: 27 x 37 m.

Site Designation	Site Type	Description
42SA691	lithic scatter	Open chipping site on dunes near rim of canyon. Cobble deposits on benches nearby. Area: 137 x 183 m.
42SA692	masonry	Rectangular dry-laid masonry structure on sandstone spur near rim of canyon. Walls collapsed. Dry-laid slab wall along crest of spur near structure. Artifacts on dunes below spur. Area: 15 x 15 m.
42SA693*	habitation	Located in large crescentic alcove. Probable bell-shaped cists in alluvium floor. Extensive organic trash deposits. Numerous abrading grooves on spalls. Indistinct petroglyphs on back wall of alcove. The site was excavated by the University of Utah in 1960 as "Ax Groove Alcove." (Sharrock et al. 1961:149-167). Area: 30 x 76 m.
42SA694*	historic	Collapsed log and pole structure on alluvial remnant. Stock trail on ledges on opposite side of canyon. Area: unknown.
42SA695*	habitation	Artifacts, charcoal, and burned rocks in blowout areas of dune on alluvial remnant. The site was excavated by the University of Utah in 1960 as "Stevens Terrace." (Sharrock et al. 1961:114-122). Area: 15 x 21 m.
42SA696*	historic	Collapsed pole lean-to on alluvial remnant near cliff. Area: 3 x 4.5 m.
42SA697	historic	Collapsed log and pole structure on alluvial terrace. Conical pole sweat hosue 180 m. downstream from structure. Area: structure - 6 x 7 m., sweat house - 1 x 1 m.
42SA698	habitation	Open campsite on dune near shore of old lake. Area: 90 m. sq.
42SA5483	petroglyph	Single anthropomorph petroglyph, pecked into the sandstone cliff face. Approx. 25 cm. in height.
42SA5484	masonry	Four to five probable structures of dry-laid slabs. Recommend cleaning out room. Area: 20 x 20 m.

Site Designation	Site Type	Description
42SA5485	masonry	Two unmortared slab structures. One is circular, approx. 3 m. dia., the other rectangular, 2 m. x 3 m. Excavated in 1977 as "Angry Ridge," this report. Area: 15 x 20 m.
42SA5509	pecked hand and toeholds	A series of toeholds or steps extending up an alcove face approx. 2 m.

Moqui Canyon

Site Designation	Site Type	Description
42SA370*	masonry	Three probable rooms on top of a talus slope composed of large spall. No wall alignments are left standing. Several metates were found. Area: undetermined.
42SA371*	masonry	Several rooms located on a high ledge above the streambed. Area: undetermined.
42SA533*	masonry	Four structures on a high ledge approx. 76 m. above the floor of the canyon. Includes two rooms and two granaries, all of mortared tabular sandstone. This site at one time also included site 42SA5487, a petroglyph panel. Excavated in 1977 as "Steury Ledge," this report. Area: 10 m. x 15 m.
42SA535*	habitation	Occupation area on a small sand and talus slope. Red sand, ash, charcoal, and fire-blackened rocks were observed. Area: 15 m. x 2 m.
42SA576*	habitation	Occupation area within a large, belled alcove above a steep talus slope, approx. 18 m. above the canyon floor. Exhibited extensive midden debris. The site was excavated by the University of Utah in 1959 as "Shady Alcove." (Lipe et al. 1960:44-48). Area: 60 m. x 15 m.
42SA577*	masonry	Six structures located along the top of a high talus slope. Area: 2 m. x 12 m.
42SA578*	habitation	Two possible room outlines and large quantities of debitage, sherds, and organic material. Area: 45 m. x 18 m.
42SA583*	masonry	Four rooms of dry-laid sandstone wall construction and two slab-lined cists in a deep semicircular alcove above an old alluvial terrace. Extensive midden deposits present. The site was excavated by the University of Utah in 1959 as "Echo Cave." (Lipe et. al. 1960:60-69). Area: 30 m. x 20 m.

Site Designation	Site Type	Description
42SA584*	habitation	Charcoal, sherds, and bone on floor of a deep, bell-shaped alcove in cliff face approx. 15 m. above the floor of the canyon. Area: 60 x 30 m.
42SA585*	masonry	Four slab and adobe rooms on a talus slope with a pictograph panel on the cliff face. The site was excavated by the University of Utah in 1959 as "Doll Ruin." (Lipe et al. 1960: 49-60).
42SA586*	pecked hand and toeholds	A series of 31 steps pecked up a cliff face to gain entrance to a talus covered alcove. The alcove itself is inaccessible.
42SA587*	pecked hand and toeholds	A series of steps pecked into a cliff face, leading up to a high alcove. The alcove itself is inaccessible.
42SA588*	masonry	Six contiguous rooms on a talus slope beneath a low overhanging alcove. Rooms are semicircular in outline. Area: 45 x 45 m.
42SA589*	masonry	Three contiguous semicircular, semi-subterranean rooms of mortared sandstone slabs. Area: 30 x 15 m.
42SA590*	masonry	One small room of dry-laid sandstone slabs within a small alcove. Sherds and debitage present. Area: 6 x 9 m.
42SA604	habitation	Charcoal and ash, debitage, and organic debris visible on floor of high crescentic alcove. Same site as 42SA785. Area: 6 x 60 m.
42SA605	—	Site redefined into three separate sites, see 42SA733, 42SA734, and 42SA5486.
42SA606	masonry	Two D-shaped dry-laid rooms in high crescentic alcove. Extensive trash deposits outside rooms. Area: 10 x 50 m.
42SA629*	masonry	Two dry-laid semicircular rooms on a steep talus slope within a large alcove. Area: 3 x 15 m.
42SA675	masonry	Deeply buried structure. Portion of columnar slab masonry exposed in cutbank.

Site Designation	Site Type	Description
42SA675	(continued)	Top of masonry 2 m. below top of alluvium. Scattered artifacts on alluvial terrace surface. The site was excavated by the University of Utah in 1961 as "Red Ant Kiva." (Sharrock et al. 1963: 97-108). Area: 15 x 15 m.
42SA676	pictograph	Panel of 12 figures in shallow over-hang in Kayenta sandstone ledges 18 m. above streambed. White pigment zoomorphic and geometric motifs. Area: 11 m. along face of ledge.
42SA677	masonry	Wet-laid slab masonry structure on ledge. Semicircular horizontally laid slab and adobe masonry room on ledge beneath slight overhang. Front section of wall collapsed. Wall 0.5 - 1 m. high. Area: 3 x 4.5 m., 20 m. above streambed.
42SA678	masonry	Six structures in shallow alcove in Navajo sandstone bedding plane 90 m. above streambed. Two D-shaped granaries, one with roof, at extreme ends of alcove. Two storage cists at edge of steep talus. The site was excavated by the University of Utah in 1961 as "Copter Ledge" (Sharrock et al. 1963:127-136). Area: 4.5 x 60 m.
42SA679	masonry	Five contiguous rooms occupy tip of Kayenta sandstone spur. Two largest rooms have walls standing 1 - 2 m. Three slab and adobe granaries built in small alcoves below main structures. Semicircular dry-laid slab room in shallow alcove adjacent to granaries. The site was excavated by the University of Utah in 1961 as "Hiboy House." (Sharrock et al. 1963:109-114).
42SA680	habitation	Small campsite on low dune at base of Navajo sandstone cliff 20 m. above streambed. Artifacts on ledge in front of dune. Site corresponds to 42SA730.
42SA681	masonry	Structures in deep, high-arched alcove in Navajo sandstone cliff 100 m. above streambed. Spring source and pool within alcove. Site has been extensively pothunted. Clay-rimmed firepit and organic trash deposits visible in disturbed areas. One

Site Designation	Site Type	Description
42SA681	(continued)	low rectangular wet-laid masonry structure on talus slope outside alcove. The site was excavated by the University of Utah in 1961 as "Rehab Center." (Sharrock et al. 1963:69-90). Area: 18 x 30 m.
42SA682	masonry	Two low dry-laid walls on narrow ledge in Navajo sandstone cliff face. Scattered artifacts and charcoal on ledge behind walls. Area: 2 x 12 m.
42SA683	masonry	Six masonry structures in high arching alcove near rim of canyon about 90 m. above streambed. Access afforded by steps carved in cliff face below site. Site excavated in 1977, "Rappel Ruin," this report. Area: 45 m. long, 4 m. wide.
42SA684	masonry	Wet-laid masonry structures on ledge of Navajo sandstone. Three contiguous small rooms, probably storage structures, on narrow ledge. Masonry of unshaped slabs and blocks set in copious quantities of mud mortar. Access to ledge by series of pecked steps. Scattered geometric motif petroglyphs on face of ledge below structures. Site excavated in 1977, this report. Area: 3 x 9 m.
42SA685	habitation	Located on a ledge at top of talus slope of Navajo sandstone about 70 m. above streambed. Small pole-roofed granary at center of occupation area. Extensive panel of anthropomorphic pictographs on cliff face at north end of site. Artifacts on talus slope and bench below site. Area: 1 - 2 m. x 36 m.
42SA686*	masonry	Structure in alcove. Walls buried by alluvium, and subsequently exposed by erosion. One meter wall protrudes from alluvium. Area: 1 x 15 m.
42SA702*	habitation	Site consists of a large, deep alcove, with the surface exhibiting corncobs. Area: 30 x 30 m.
42SA720	masonry	Structures in inaccessible alcove 90 m. above streambed. Continuous slab wall along entire alcove edge. Access originally by way of two huge spalls at downstream

Site Designation	Site Type	Description
42SA720	(continued)	end of site. Cottonwood log wedged horizontally behind the larger spall. Area: est. 3 x 9 m.
42SA721	masonry	Three dry-laid masonry structures in alcove 75 m. above streambed. Access via rock spall and pecked hand and toeholds. Structure walls 0.3 m. to 1 m. high. Fill of one structure tested to depth of 0.5. No artifact yield; no floor features. Few artifacts scattered on surface: Area: 6 x 15 m.
42SA722	masonry	D-shaped wet-laid structure built into ledge of Kayenta sandstone. Structure roofed by ledge ceiling. Walls 1 m. high; entry partially collapsed. Area: Ledge 2 x 7 m.
42SA723	masonry	Slab wall at edge of high arched alcove 90 m. above streambed. Small portion of wall at east end of alcove still standing. Site is presently inaccessible. Area: est. 3 x 36 m.
42SA724*	habitation	Alcove in Navajo sandstone above streambed. Access by hand and toeholds pecked into cliff for 6 m. Three-fourths of floor area covered by rock fall, remaining floor area sand.42SA724*(continued)Chipping area located on low dune at base of cliff west of alcove. Area: 2 x 90 m.
42SA725*	masonry	Four ill-defined dry-laid masonry structures on ledge of alcove in Navajo sandstone. Area: 9 x 120 m.
42SA726	Isolated find	Conical sand dune within high arched alcove in Navajo sandstone cliff face. Steep sand slope from mouth of alcove to top of alluvial terrace 60 m. below. Only evidence of occupation was whole vessel on surface of interior dune. Area: alcove 9 x 16 m.; dune 3 m. high.
42SA727	masonry	Shallow alcove in Navajo sandstone cliff 20 m. above streambed. Low two-course dry-laid slab outline of structure on alcove floor. Concentration of chipped stone found on sandy surface adjacent to mouth of alcove. Area: 1 x 15 m.

Site Designation	Site Type	Description
42SA728	masonry	Dry-laid slab wall beneath overhang of Navajo sandstone 45 m. above streambed. Wall remnant 1 m. long, .5 m. high at right angle to cliff face. Area: level area 1 x 2 m.
42SA729	masonry	Four rectangular, slab masonry structures and a D-shaped granary built beneath an overhang of Kayenta sandstone. Greatest height of walls is 1 m. Structures built parallel to face of overhang. The site was excavated by the University of Utah in 1961 as "Flatrock House." (Sharrock et al. 1963:91-96). Area: 3 x 18 m.
42SA730	—	This site is the same as site 42SA680.
42SA731	masonry	Rectangular wet-laid horizontal slab masonry structure in small alcove in Navajo sandstone. Structure inaccessible. Remnants of pole and brush roof visible through collapsed entryway of structure. Site about 15 m. above cliff base and 90 m. above streambed. It is recommended that an attempt be made to gain access. Area: est. length of alcove - 7 m.; structure - est. 1 x 2 m.
42SA732	habitation	Alcove in bedding plane of Navajo sandstone. Floor area of alcove covered with rockfall and blowsand. Area: alcove 0-8 x 76 m.
42SA733	masonry	Single D-shaped structure of dry-laid horizontal slabs in shallow alcove in Navajo sandstone 20 m. below alcove, on ledge of Kayenta.
42SA734	masonry	Four structures built on stepped ledges of alcove in Navajo sandstone. Two lower level structures consist of D-shaped 3 m. dia. dry-laid masonry room and a well preserved wet-laid masonry granary with door slab and part of pole roof intact. Two upper level (4.5 m. higher) structures are nearly identical in floor plan to lower structures. Access to alcove by hand and toeholds pecked into cliff face. Area: both levels - 18 x 24 m.

Site Designation	Site Type	Description
42SA735	habitation	Deep bell-shaped alcove in Navajo sandstone 45 m. above streambed. Alcove floored by sand and rockfall. Front of alcove partially obscured by high sand dune. Two circular 2 m. dia. depressions and two bark-lined pits 1 m. in dia. in sandy floor of alcove. Human bone scattered on surface, and burial in a rockfall crevice at east end of alcove. Area: 0-45 x 60 m.
42SA736	masonry	Four masonry structures located on bench of talus slope 15 m. above streambed. A rockfall-choked alcove in the Wingate sandstone located on same level as talus ledge just downstream from the alcove is an extensive discontinuous panel of red pictographs of anthropomorphic and zoomorphic figures. Recent signatures on alcove walls and talus boulders indicate this is Cave 1 of the Bernheimer-Morris expedition of June, 1929. The site was excavated by the University of Utah in 1961 as "Bernheimer Alcove." (Sharrock et al. 1963:34-60). Area: 6 x 90 m.
42SA737	lithic scatter	Chipping site. Concentration of lithic materials on low dunes and bedrock on south rim of Moqui Canyon. Area: 30 x 30 m.
42SA738	habitation	High arched alcove in Navajo sandstone 60 m. above streambed. Narrow ledge follows curve of alcove wall. Surface exposure of human burial on narrow ledge. Faint petroglyphs on rear wall of alcove above exposed burial. The site was excavated by the University of Utah in 1961 as "Ivy Shelter." (Sharrock et al. 1963:115-125).
42SA739	Isolated find	Shallow alcove at base of Navajo sandstone cliff. Ledge of alcove slopes steeply downward to Kayenta sandstone ledges below. Most of alcove interior covered by blocks of rockfall. Sherds of one vessel found on sandy portion of alcove ledge. Area: 1 x 8 m.
42SA740	masonry	Seven low dry-laid horizontal slab structures on bare ledges of Kayenta sandstone.

Site Designation	Site Type	Description
42SA740	(continued)	Ledges form 3-step spur jutting from right bank cliffs into canyon. Four circular dry-laid masonry rooms on highest ledge; 1 D-shaped dry-laid slab masonry structure butts against a boulder on the middle ledge and two rectangular dry-laid slab masonry structure lie on lowest ledge. Artifacts associated with structures on all three levels. Area: 30 x 30 m. horizontal, approx. 12 m. vertical.
42SA741	habitation	A sandy talus slope at base of Navajo sandstone cliff 60 m. above streambed. Artifact concentration on small flat area protected by a huge boulder at top of talus slope. Area of ledge is 3 m. x 3 m. Artifacts scattered on surface of talus. Area: 15 x 30 m. on talus.
42SA742	masonry	Collapsed wet-laid horizontal slab masonry structure vaguely D-shaped in outline. Outline measures 1 m. at widest point. Structure built on crumbling ledge of Navajo sandstone 90 m. above the streambed. Area: structure 1 x 1 m.
42SA743	habitation	Site on crest of 76 m. high brush-covered sand dune that projects from left bank into the canyon. Crest near level of base of Navajo sandstone. Dune is about 45 m. long and 18 m. wide. Rectangular, vertical slab-outlined pit exposed on surface. Site immediately below structure in alcove 42SA731. Artifacts adjacent to slab-lined pit. Area: 30 x 30 m.
42SA744	masonry	Boulder strewn remnant of a ledge in wide alcove in Navajo sandstone. Major portion of alcove ledge eroded by action of seep line within alcove. A low circular (2 m. dia.) dry-laid masonry structure located on ledge. Structure outline of unshaped, uncoursed vertical and horizontal laid blocks and slabs exfoliated from alcove wall. Scattered charcoal in blowsand fill of structure. Area: ledge 4.5 x 12 m.
42SA745	historic	Five ax-hewn cottonwood poles braced against stones that form a 3 m. ramp from lower to higher ledge. Ramp is about

Site Designation	Site Type	Description
42SA745	(continued)	1 m. wide and may be part of a cattle trail along the rim of the canyon. Trail could be traced about 15 m. on either side of ramp. Area: about 6 m. sq.
42SA746	masonry	Rectangular heavily mortared structure filling major part of a small alcove in Kayenta sandstone ledge. Structure inaccessible. Alcove forms floor and ceiling of structure. Thick collar of mortar rims entryway. Area: alcove est. 4.5 m. wide x 1.5 m. high by 2 m. deep.
42SA747	masonry	Partial wall of 2 m. dia. circular structure of unshaped boulders and slabs built on ledge of Kayenta sand-stone. Max. height of wall remnant 1 m. Area: ledge 4.5 m. x 9 m.
42SA748	habitation	Shallow alcove in Navajo sandstone. Extensive petroglyph panels at extreme ends of alcove wall. Major evidence of occupation on sand terrace in front of alcove. Sandy terrace separated from alcove by dry arroyo. Lithic materials fround on 1 m. ledge in alcove and on surface of sand terrace. Tested. Area: alcove 4.5 m. deep, 45.7 m. wide; sand terrace 13 sq. m.
42SA749	habitation	High shallow alcove in Navajo sandstone. From both sides of alcove active dunes fall 20 m. toward center of alcove floor. A draw between the two dunes leads to the center of the alcove. Heavy concentration of lithic materials on surfaces of both dunes. Extensive surface collection of lithic materials. Area: 15 x 16 m.
42SA750	habitation	Artifacts on sandy slope at base of Kayenta sandstone ledge 4.5 m. above tributary stream bed. Area: 3 x 8 m.
42SA751	habitation	Gently sloping sandy terrace at base of falling dunes near head of tributary. Site is at edge of spring source. Area: 15 x 30 m.
42SA752	habitation	High shallow alcove at base of Navajo sandstone. Narrow 3 m. ledge follows the curve of the alcove wall and slopes steeply downward to sandy terrace 15 m.

Site Designation	Site Type	Description
42SA752	(continued)	above streambed. Ledge had abundant cover of scrub oak, some of which has been burned off. Two vague 2 m. dia. circles of unshaped stones at east end of alcove. Artifacts found near stone circles. Area: ledge 0-3 m. x 70 m.
42SA753	masonry	High recessed alcove that forms box end of 180 m. long draw eroded into Wingate sandstone. A narrow ledge follows bedding plane within alcove 20 m. above bedrock floor of draw. Outlines of one rectangular (1.2 x 2.4 m.) and one circular (3 m. dia.) boulder structure built on alcove ledge. Panel of zoomorphic and anthropomorphic petroglyphs on cliff face at mouth of draw. The site is now inaccessible from the floor of Moqui Canyon, due to the steeply eroded alluvial cut banks. Area: alcove ledge 4 m. x 20 m.; cliff face ledge 6 m. x 15 m.
42SA754	habitation	Sandy ledge in shallow alcove 20 m. above streambed. Nineteen circular depressions in consolidated sand of alcove floor. The site was excavated by University of Utah in 1961 as "Honeycombe Alcove." (Sharrock et al. 1963:26-33). Area: 4.5 x 18 m.
42SA755	habitation	Largest alcove found. Interior floor of alcove primarily sand. Talus mound piled at center of mouth of alcove. Leakage through the thin roof and interior drainage from the talus mound has washed out south end of alcove fill. Sherds collected on surface at north end of alcove near pothole in sandy fill. Tested. Area: 45 x 106 m.
42SA756	masonry	Low deep alcove in sheer cliff face about 40 m. above streambed. Alcove ceiling and walls very jagged and broken. 15 m. below and 90 m. ENE of alcove is terrace of alluvial remnant. Heavily mortared D-shaped slab structure and slab-outlined bin on surface of alluvial remnant. Area: alcove 0-4.5 x 15 m.; terrace 8 x 12 m.
42SA757	habitation	Bell-shaped alcove in Navajo sandstone near head of tributary. Heavy matting of reeds over much of alcove floor, some

Site Designation	Site Type	Description
42SA757	(continued)	areas of mat appear to have been burned. Petroglyph panel of horned animals and a geometric figure on back wall of alcove. Tested. Area: 4.5 x 23 m.
42SA758	not a site	This site was described as a lense of stained sand, observed in a cut-bank. It proved to be just that, with no cultural remains.
42SA759	masonry	Shallow alcove in bedding plane of Wingate sandstone. Two low D-shaped dry-laid masonry structures at west end of alcove. Smaller structure 1.5 x 2 m.; larger 2 x 4.5 m. Petroglyph panel of horned animal figures 60 m. upstream from structures. Area: alcove 3 x 23 m.
42SA760	habitation	Shallow rockfall-filled alcove 6 m. above present streambed. Two huge wedge-shaped spalls stand upright on talus that forms floor of alcove. One meter wide ledge of compacted sand located at upstream end of alcove. Surface artifact collection made from terrace ledge and from among rock spall. Petroglyph panel of six zoomorphic figures (identical to figures at 42SA759) on cliff face at downstream end of site. Tested. Area: 0-3 x 30 m.
42SA761	habitation	Low sand dune and traces of alluvium in wide meander about 1.5 m. above streambed. Artifacts and fire hearths exposed in laminae of eroded alluvium and dune. Area: 20 x 45 m.
42SA762	habitation	Shallow low alcove in Wingate sandstone. Two circular depressions approx. 0.75 m. in dia. in consolidated sand of alcove floor. Much charred and uncharred wood scattered on surface of ledge. Very extensive petroglyph panels of zoomorphic and anthropomorphic figures pecked into surface of talus boulders and cliff face. Tested. Area: 0-4.5 x 22 m.
42SA763	masonry	A 0.6 m. wall of unshaped stone following curve of ledge protected by half-dome alcove about 60 m. above the streambed. Deep narrow cleft breaks cliff behind the ledge. A 0.3 m. layer of sand and rockspall cover area enclosed by wall. Area: 2 x 4 m.

Site Designation	Site Type	Description
42SA764	masonry	Semicircle of dry-laid unshaped slabs built against flat side of boulder on level terrace about 6 m. above streambed. Floor area enclosed by wall and boulder 0.3 m. lower than surrounding surface. Area: (enclosed by wall and boulder) 2 x 3.6 m.
42SA765	habitation	Three fire hearths exposed on eroded surface of sandy terrace about 9 m. above streambed. Ash, charcoal and a few artifacts on slope adjacent to hearths. Area: 9 m. sq.
42SA766	lithic scatter	A sandy knoll near center of canyon floor at convergence of tributary streambed and Moqui streambed. Few scattered artifacts on slope of knoll. Area: 3 x 3 m.
42SA767	masonry	Alcove at box end of short draw eroded into Wingate sandstone. Three low incomplete structures of unshaped slabs on ledge halfway from draw floor to alcove lip. One structure outline associated with pieces of rotted timbers. Area: ledge 0-4.5 m. x 15 m.
42SA768	masonry	Curved wall of dry-laid, horizontal slab masonry enclosing one end and side of alcove ledge. One end of wall abuts alcove wall and touches alcove ceiling. Remainder of wall free-standing. Wall is 3.6 m. long, avg. ht. 1 m. Area: ledge 2.5 x 9 m.
42SA769	masonry	Long shallow alcove on west side of boxed draw. Surfce of ledge within alcove slopes downward and is very eroded. 2.4 m. dia. structure of42SA769(continued)unshaped stone at upstream end of alcove. Artifacts associated with structure. Area: ledge 6 x 60 m.
42SA770	habitation	Small alcove in Wingate sandstone 1 m. high remnant of alluvium in center of alcove. One m. below alluvial remnant surface is thick layer of charcoal and ash. Some fire-stained and cracked stones protrude from face of alluvium. Heavy growth of poison ivy and scrub oak in alcove. Area: alluvial remnant 1.2 m. high, 3 m. long, 1.5 m. wide.

Site Designation	Site Type	Description
42SA771	not a site	Inacessible alcove 65 m. high in cliff face. A continuous line of slabs of a fallen wall(?) across mouth of alcove. When viewed from above, on the left or opposite bank of the Moqui tributary canyon, this site proved to be nothing more than spall accumulation within a deep alcove. Area: est. 9 m. high, 15 m. wide.
42SA772	habitation	High arched alcove 60 m. above tributary streambed. Rockfall fills major portion of floor of alcove. A 1.5 m. wide band of disturbed sandy fill between alcove wall and rockfall floor. Petroglyphs of zoomorphic, anthropomorphic and geometric figures pecked and abraded into surfaces of boulders on floor of alcove. Zoomorphic and geometric pictographs of white, red and deep brown pigment painted on alcove walls. Pencil and white chalk inscriptions on alcove wall read "Bernheimer Expd 6/12/29." Cobble has green pencil inscription "Moki III." Area: 9 x 22 m.
42SA773	habitation	Shallow bell-shaped alcove in Navajo sandstone cliff face. Sandy floor of alcove has extensive areas of scattered charcoal and concentrated gray ash. Many straight grooves of varying length abraded into cliff face at downstream end of site. Area: floor 9 x 22 m.
42SA774	habitation	Shallow alcove at base of Navajo sandstone cliff adjacent to 42SA773. Sandy floor fill, low hummocks of dead grass and reeds. Extensive areas of charred material on surface. Alcove mouth obscured by heavy growth of oak brush. Area: floor 7 x 30 m.
42SA775	habitation	Deep bell-shaped alcove in Navajo sandstone 90 m. above streambed. Narrow ledge follows curve of alcove wall. Steep boulder talus falls from alcove interior. Small amount of cultural debris among boulders. Area: 9 x 15 m.
42SA776	habitation	On narrow promontory of alluvium. Heavy concentration of worked lithic materials on deflated surface at base of falling dune. Tested. Area: 6 x 12 m.

Site Designation	Site Type	Description
42SA777	not a site	Four lenses of decayed organic debris exposed in face of cutbank 20 m. above streambed. No artifact yield from the lens tested. These lenses only contain natural organic debris, and do not exhibit cultural materials. One lens face tested. Area: horizontal extent 30 m.
42SA778	habitation	Surface concentration of sherds and lithic materials on sloping bedrock at base of Wingate sandstone cliff. Site is directly above 42SA777, but no direct association could be made. One exposed fire hearth associated with artifact concentration. Area: 18 x 60 m.
42SA779	habitation	Blowout on edge of dune capping alluvial terrace 30 m. above streambed. Artifacts probably originate on surface of alluvium covered by dune. Area: dune height max. 1 m.; artifacts on slope for 45 m.
42SA780	habitation	Narrow noncontinuous ledge protected on three sides by slight overhang of Wingate cliff face. Artifacts scattered on bedrock surface. Area: 15 x 30 m.
42SA781	habitation	Remnant of alluvium standing at confluence of short tributary to main canyon. Sherds exposed in face of alluvium approx. 5 m. below surface of upper terrace. Indications of at least two occupations buried in upper terrace; both layers showed chunks of charcoal; in only one, the lower, were artifacts exposed. The site was excavated by the University of Utah in 1961 as "Tamarix Dune." (Sharrock et al. 1963:61-69). Area: ca. 5 m. deep; 15 m. along alluvial cliff face.
42SA782	habitation	Broad terrace about 4.5 m. above streambed. Cut made by bulldozer blade into surface of terrace exposed artifacts, burned materials and ash. Max. depth of cut .3 m. Tested. Area: blade cut exposure 2.5 x 15 m.
42SA783	habitation	Truncated cone-shaped alluvial remnant. Lenses of charcoal and ash buried beneath 2.5 m. of alluvium. Three superimposed

Site Designation	Site Type	Description
42SA783	(continued)	lenses of charred material distinguished; only in two lower lenses were artifacts exposed. Area: alluvial remnant, dimensions at level of artifact yield, 4 x 4.5 m.
42Sa784	habitation	Shallow overhang of Navajo sandstone sheltering a narrow rockfall-covered ledge. Steep talus of sand and rockfall from ledge to dry streambed. Few scattered artifacts found on ledge and for a short distance down talus slope. Area: ledge 3 x 45 m.
42SA785	—	Proved to be the same site as 42SA604.
42SA786	—	Two dry-laid sandstone structures. One rectangular about 5 x 8 m., and one circular, about 6 m. in dia. Area: 15 x 20 m.
42SA5487	petroglyph	A panel approx. 20 m. in length, pecked into the Navajo sandstone cliff face about 1 to 2 m. above a steep talus slope. This is approx. 20 m. above the present lake level. Originally associated with 42SA533. Area: 20 m. in length.
42SA5488	masonry	Three dry-laid sandstone slab walls with a max. height of 1.25 m. The site may or may not be of aboriginal construction. No artifacts were found in association with the structure, which may be a result of its easy accessibility to boaters.
42SA5489	masonry	A small granary, approx. 1 m. in dia., made of unmortared sandstone slabs. Two adze polishing grooves are in association with the structure. Area: 1 x 5 m.
42SA5490	masonry	The site is composed of a rectangular structure, about 2 m. on a side, and an associated petroglyph panel. The structure is located on an inaccessible ledge, with a petroglyph panel on the cliff face below the ledge.
42SA5491	masonry	A wall foundation, built amongst spall, in a small alcove. The structure itself is approximately 2 x 4 m. No artifacts were found in association with the structure. Area: 10 x 50 m. (alcove)

Site Designation	Site Type	Description
42SA5510	masonry	Two small rectangular dry-laid masonry structures in rear of alcove. Only two courses of the wall remain. A 5 m. long retaining wall is found in front of one structure. Area: 15 x 25 m.
42SA6214	masonry	Three contiguous dry-laid masonry rooms on a Kayenta Sandstone bench overlooking the alluvial terrace. Excavated in 1977 as the "Over Site," this report. Area: 20 x 25 m.
42SA6215	masonry	A single circular dry-laid masonry structure overlooking the stream on a sandstone bench. Area: 2 x 5 m.
42SA6317	masonry	A single masonry granary at the top of a talus slope. Area: 3 x 3 m.

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APPENDIX II

QUATERNARY STRATIGRAPHY OF GYPSUM CANYON, SOUTHEASTERN UTAH:

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INTRODUCTION

Unconsolidated sediments occupying canyon floors in dissected portions of the Colorado Plateau are primarily alluvial silts, sands, and gravels which preserve evidence of episolic alluviation and dissection. In Gypsum Canyon, a tributary of the Colorado River in southeastern Utah, deposits of an extremely coarse nature suggests that mass-wasting and debris flows predominated as depositional agents during the aggradation of three major alluvial fills.

SETTING

Gypsum Canyon is a tributary of the Colorado River whose drainage basin lies entirely within San Juan County, southeastern Utah (Figure 1). Beef Basin Wash, a small intermittent stream, flows through Gypsum Canyon. The canyon is the lower portion of the valley of Beef Basin Wash. Perennial springs maintain the stream in its flowing reaches, which occur in the middle portion of the basin.

The portion of Gypsum Canyon studied extends 6.9 kilometers upstream from the mouth, where a steep headwall occurs. Beef Basin Wash cascades some 50 meters to the base of the headwall which serves to separate Gypsum Canyon into upper and lower reaches.

1 Stratigraphic descriptions given in this report are derived from a larger report by the author entitled, "Alluvial History of Gypsum Canyon, Southeastern Utah;" unpublished masters' thesis, University of California, Berkeley, 1978. Permission to conduct field work in the canyon was given by the Glen Canyon National Recreation Area. The project was guided from its inception by Dr. Luna B. Leopold of the University of California, Berkeley.

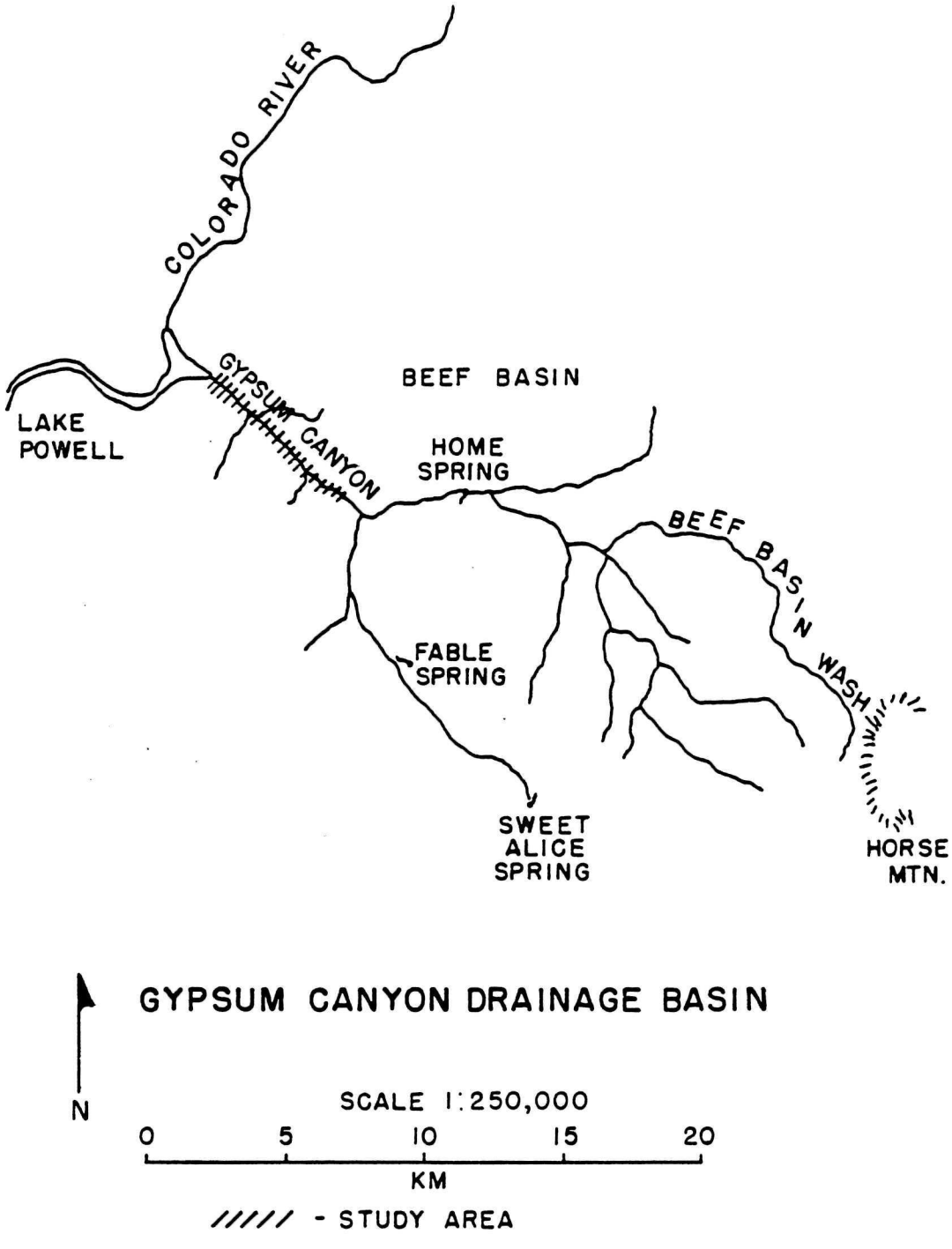


Figure 1. Map of southeastern Utah showing the location of Gypsum Canyon.

Sparse vegetation and dry reaches along watercourses attest to the arid conditions which prevail. The average rainfall for the region is 18 centimeters. Extreme temperatures of 42°C in the summer and in -8°C the winter months yield an annual average of 17°C for the canyons in the vicinity of Hite, Utah. The types of vetegation observed in the canyon (Table 1) are indicative of the dry climate.

Bedrock Geology and Structure

The pre-Quaternary stratigraphy of Gypsum Canyon includes approximately 810 meters of Middle Pennsylvanian to Lower Permian strata (Baars, 1971). Interbedded gypsum, limestone, halite, and slate of the Paradox Formation crop out at the mouth of Gypsum Canyon, forming the basal 90 meters of the bedrock section. Dark gray, fossiliferous limestone containing elongated chert nodules, interbedded with marine sandstone and shale, characterize the Honaker Trail Formation. The Honaker Trail Formation is 305 meters thick, extending from the Paradox Formation to the Halgaito Shale, a unit comprised of 110 meters of reddish-brown shale, siltstone and sandstone. The rimrock of the canyon in tan, cross-bedded Cedar Mesa Sandstone, which forms the upper 305 meters of the section.

Quaternary Stratigraphy

From precipitous rim to canyon floor, the sheer, confining walls of Gypsum Canyon expose some 800 meters of Pennsylvanian and Permian strata. A conspicuous lack of bedrock outcrops in stream channels near the mouth distinguishes Gypsum Canyon from adjoining tributaries of the Colorado River. As stream incision progressed through bedrock, recession of the massive cliffs through mass-wasting and slumping contributed debris which mantles the canyon floor and obscures its bedrock basement.

TABLE 1

Vegetation Observed in Lower Gypsum Canyon

In order of relative abundance

	%
Sage (Artemisia filifolia Torr.)	25
Mormon Tea (Ephedra trifurca)	25
Snakeweed (Gutierrezia microcephala Gray)	10
Juniper	10
Yellow Beeplant (Cleome lutea Hook)	5
Tamarisk (Tamarix ramosissima Ledeb.)	5
Yucca (Yucca elata?)	5
Prickly Pear (Opuntia polyacantha Haw)	5
Douglas Groundsel (Senecio Douglasii)	3
Roundleaf Buffaloberry (Shepherdia rotundifolia Parry)	2
Common Reed (Phragmites communis)	1
Beavertail Cactus (Opuntia basilaris)	1
Arizona Rainbow Cactus (Echinocereus pectinatus var. rigidissimus)	1
Fremont Poplar	1

The following types comprise less than one percent of the total vegetation:

Bearded Beardtongue (Penstamon barbatus (Cov. Roth)
Desert Marigold (Baileya multiradiata Haw and Gray)
Eaton Beardtongue (Penstamon eatonii Gray)
Hairy Evening Primrose (Oenethera trichocalyx Nutt ex. T and G)
Kaibab Bitterweed (Hymenoxys subintegra Cockerell)
Low Crypthantha (Crypthantha humilis (Gray) Payson)
Newberry Twinpod (Physaria newberri Gray)
Pinyon Pine
Prince's Plume (Stanleya pinnata)
Thompson's Wooly Locoweed (Astragalus mollissimus Torr.)
Yellow Crypthantha (Crypthantha flava (A. Nels) Payson)

Massive bedrock slump blocks derived from the Paradox and Honaker Trail Formations comprise the oldest Quaternary features observed in Gypsom Canyon. Two ages of slump blocks may be discerned adjacent to canyon walls. Older slump blocks may be distinguished from the canyon walls by a difference in dip of the bedding, which deviates from the surrounding horizontal stratigraphy. The more prominent younger slump blocks are derived from the older slump blocks and stand away from the cliffs (Figure 2). Strata exposed in the slump blocks are largely intact although intense shattering is evident in cliffward portions.

Unconsolidated sediments overlie and abut against bedrock and bedrock slump blocks to a depth of at least 200 feet. Three distinct fills are recognized in the canyon as shown in Figure 3. Each fill is associated with a terrace. Successively younger terraces are inset within the oldest of these, the Gypsum Canyon Terrace, which stands approximately 24 meters above the present streambed.

Gypsum Canyon Terrace

Exposures of the fill underlying Gypsum Canyon Terrace occur in scarps along the streambed and reveal a stratigraphy in which coarse, poorly-sorted lithologically heterogeneous deposits predominate (Figure 4). Variability within the unit is appreciable, with downstream changes in alluvial and debris flow components augmented by the sideslope production of talus, colluvium and landslide deposits.

Lithologies exposed in section include limestone, calcareous sandstone, siltstone, and chert. A light reddish-brown, calcareous, sandy matrix occurs with the coarser debris. The matrix, which is cemented by calcium carbonate in portions of the fill, is silty, very fine-to-fine quartzose sand with a median grain diameter of 0.1 millimeters. Individual sand grains have a coating of finer particles as well as iron oxide.

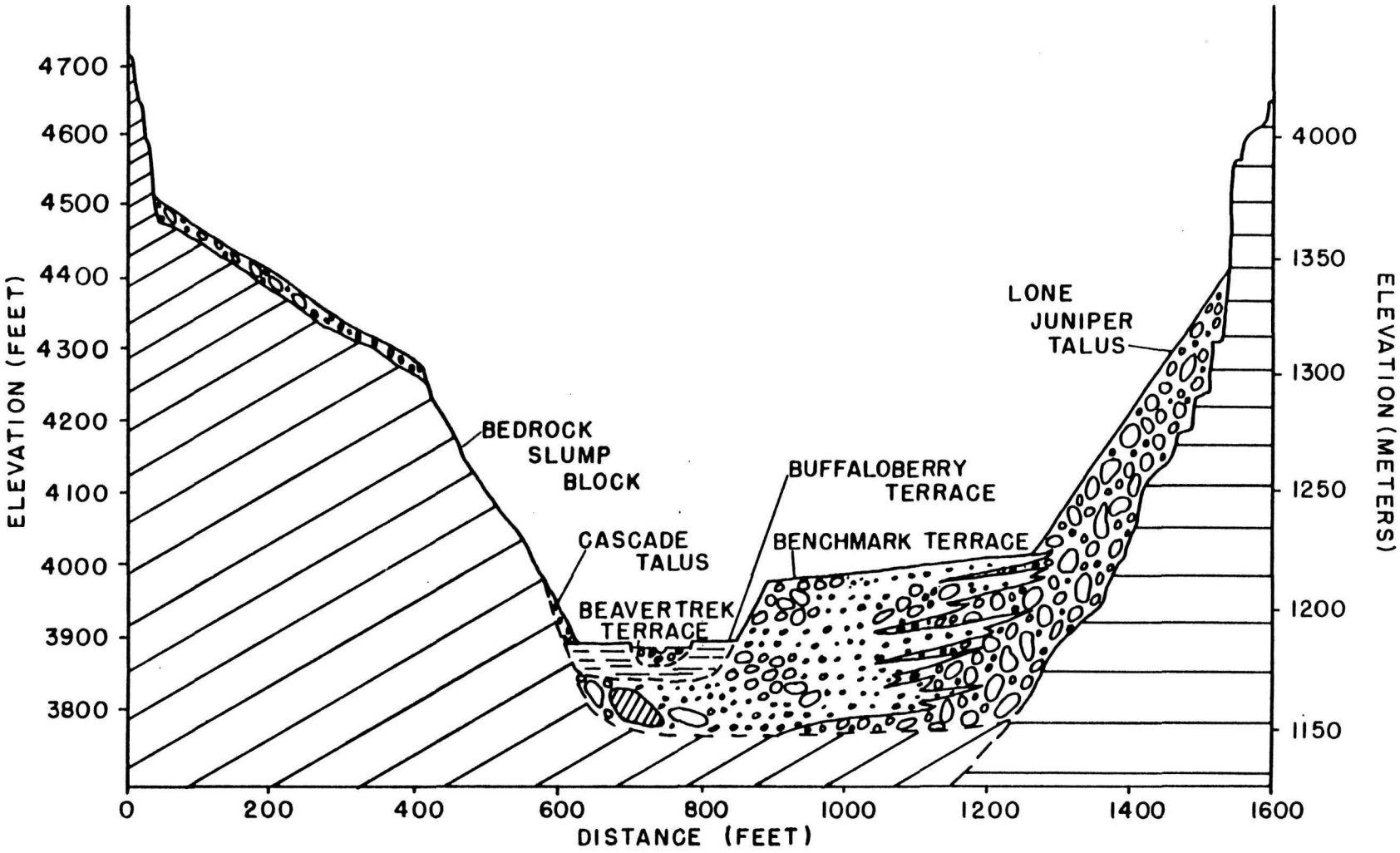


Figure 2. Slump block overlain by talus in lower Gypsum Canyon.

Beavertrek Terrace fill-debris flow deposits in a matrix of fine sand and silt; boulders on surface preserve lobate pattern of flows	
Spirifer Fan Unit-crudely-bedded pebbles and cobbles; unweathered; reddish-brown matrix	
Cascade Talus-angular, 1-3 ft. boulders with no matrix; 25-ft. diam. near headwall	
Bighorn Fan Unit-debris flow deposits overlying Buffaloberry Terrace	
Buffaloberry Terrace fill-gray stream deposits composed of moderately well-bedded pebbles, cobbles, and boulders in a tan matrix of fine-grained sand with pebbly lenses; sandy soil at surface, 1-3 feet thick	
Bobcat Fan Unit-side-canyon debris flow deposits which overlie Benchmark Terrace; surficial boulders are well-weathered and include limestone, sandstone, siltstone; rillenstein present on limestones	
Lone Juniper Talus-tan, sub-angular, dolomitic sandstone boulders in a reddish-brown silty matrix; surficial boulders have desert varnish; boulders typically 3-5 ft., some 25 ft.	
Benchmark Terrace fill-degraded and dissected fill composed of interbedded alluvium, talus, debris flows, colluvium, and slide debris; deposit exhibits crude bedding and is poorly-sorted; surficial boulders are typically limestone with well-developed rillenstein and 1-2 inches of solution around chert nodules; lithologies exposed in section include limestone, calcareous sandstone, siltstone, and chert in a reddish-brown silty matrix; portions cemented by calcium carbonate	
Slump blocks-large, rotated blocks of bedrock; strata dip towards parent cliffs; bedding intact with some deformation in cliffward portions; convex-upwards profile; talus or colluvium may overlie slump blocks	BASE NOT EXPOSED

Figure 3. Generalized cross section of Gypsum Canyon.

Figure 4. Scarp in Gypsum Canyon Terrace.



Hillslope processes contributed debris to the fill which is exposed in gullies and canyons tributary to Beef Basin Wash. Poorly-sorted, sub-angular boulders of tan dolomitic sandstone characterize talus deposits within the fill. The boulders are typically 1-1.5 meters in diameter. Slide debris present consists of chaotic blocks of talus, some of which have acquired a coating of desert varnish in exposed sections. Platy rock fragments of predominantly limestone and siltstone in sandy, calcareous matrix material comprise colluvial deposits within the unit. In contrast to the rest of the fill, the colluvial matrix is pale brown silty sand with gravel-sized slate fragments. Rock fragments in the colluvium are generally 27 centimeters in diameter, with the largest fragment measuring 18 centimeters.

Soil Profile Development

A light reddish-brown, calcareous soil with abundant angular pebbles and cobbles occurs at the terrace surface to a maximum depth of one meter. A pH of 8 was obtained for the soil by the field saturation technique. The soil is composed of silty, very fine-to-fine sand with a median grain diameter of 0.09 millimeters. Quartz grains coated with iron oxide comprise more than 90% of the sand. Sparse organic material occurs with silty sand at the surface to a depth of about 5 centimeters. Induration of the soil increases with depth due to the deposition of calcium carbonate in the lower portion of the soil profile. Degradation of the terrace surface has truncated soil profiles on many terrace remnants.

Weathering Features

Well-developed rillenstein, a solution feature of calcareous rock types, is ubiquitous on limestone boulders exposed on Gypsum Canyon Terrace. Rillenstein has the appearance of sharp-rimmed craters on dense, finely crystalline limestone (Figure 5). Rillenstein is less pronounced on coarse-grained and highly

Figure 5. Crater-like aspect of rillenstein on limestone boulder exposed on Gypsum Canyon Terrace.



fossiliferous limestones. Solution has proceeded to the extent that more resistant chert veins and nodules stand exposed in marked relief (Figure 6). Measurements of chert relief ranged from 1-7 centimeters on limestone boulders of Gypsum Canyon Terrace, giving an indication of the minimum amount of solution that has occurred. Solution exposes the smooth, original surface of veins and nodules. Where unbroken by transport of weathering, the nodules are pitted and covered with manganese oxide. Fracturing of the chert reveals a fresh reddish-brown or gray color.

Sandstone boulders exposed in sections of the fill are extremely weathered. Outlines of relic sandstone boulders may be discerned in section (Figure 7), but weathering has reduced the rock to a fine powder. Presumably sandstone boulders once constituted a larger fraction of surficial boulders but have almost completely weathered away.

Relation to Alluvial Fans

Accumulations of large, well-rounded boulders, 1-3 meters in diameter, form alluvial fans on Gypsum Canyon Terrace where tributary canyons debouch upon the oldest fill. Blue limestone, tan limestone, purple-red sandstone, and tan sandstone boulders were deposited by debris flows issuing from side canyons. No intervening matrix is preserved among the boulders. Limestone boulders have rillenstein. Desert varnish is present on many sandstone boulders, which are friable and have disintegrated in place.

Relation to Talus

Prominent talus cones, containing large blocks of tan, dolomitic sandstone, are deposited upon Gypsum Canyon Terrace and referred to as older talus in Figure 3. Talus boulders are distinguished from boulders exposed on the surface of the fill by their composition and size. The talus boulders are generally 3-7 meters in diameter. One talus block measured 9 meters. A reddish-brown

Figure 6. Chert nodule covered with manganese oxide.

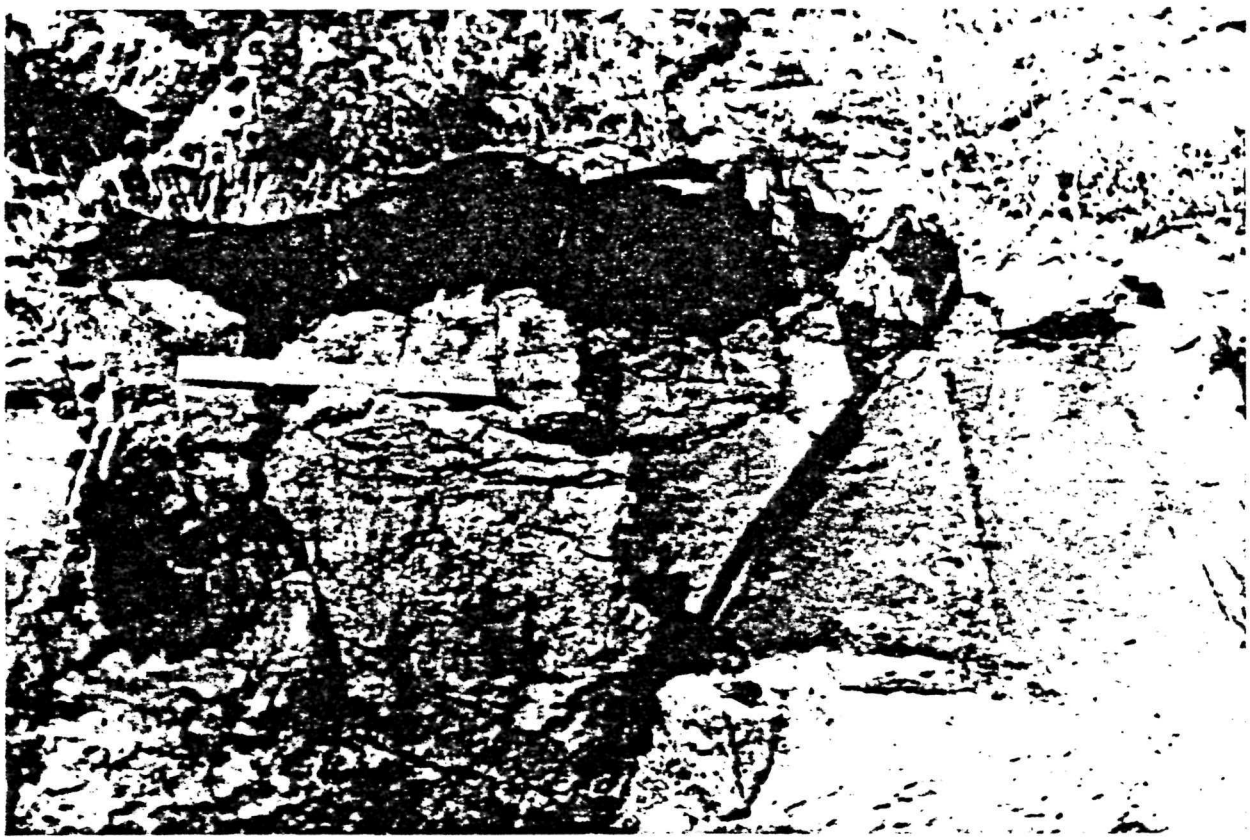


Figure 7. Relic sandstone boulders.



matrix of silty sand occurs with the talus blocks. In some portions of the canyon, the talus consists of individual blocks on the surface of the fill. The talus may also overlie older slump blocks and bedrock where the fill has been removed by erosion.

Buffaloberry Terrace Fill

Remnants of Buffaloberry Terrace, which stands on the average of 4 meters above the channel, are underlain gray stream alluvium which is similar in appearance to the load on the present streambed. The terrace has an exceptionally smooth surface due to a layer of light brown sandy soil.

Moderately well-bedded boulders, cobbles, and pebbles in a light brown matrix of fine-grained quartzose sand underlie the soil as shown in Figure 8. The matrix material accounts for about 30% of the deposit. Well-rounded clasts within the alluvium predominate, but are interbedded with lenses of angular gravels. Cobble-sized clasts are most prevalent within the alluvium. Average boulder size is less than one meter with a maximum observed size of two meters. Lithologies present include 65% dense, blue limestone with no rillenstein, 20% tan, calcareous sandstone, 5% purple-red sandstone, and less than 5% each of chert and gypsum.

Soil Profile Development

The soil on the terrace surface has a pH of 7.5-8 and is composed of 95% quartz grains, some of which are frosted. Particle size analysis indicates that the soil is a uniformly-graded, very fine-to-fine sand with a median grain size of 0.11 millimeters. The soil has a larger silt component than the underlying matrix material.

A layer of organic matter, which has accumulated to a depth of 5-25 centimeters, occurs at the top of the soil profile. The epipedon is formed by the humic layer and an underlying layer of light brown sand, approximately 25

Figure 8. Characteristic section of Buffaloberry Terrace Fill.



centimeters thick, which retains relic cross-bedding. Lenses of slightly darker sand occur in the B horizon, where no evidence of bedding is preserved. Although the soil is calcareous, no horizons of accumulation of either calcium carbonate or gypsum were observed. The maximum thickness of the soil is one meter. A few colluvial rock fragments of blue limestone, tan sandstone, chert, and gypsum overlie the soil.

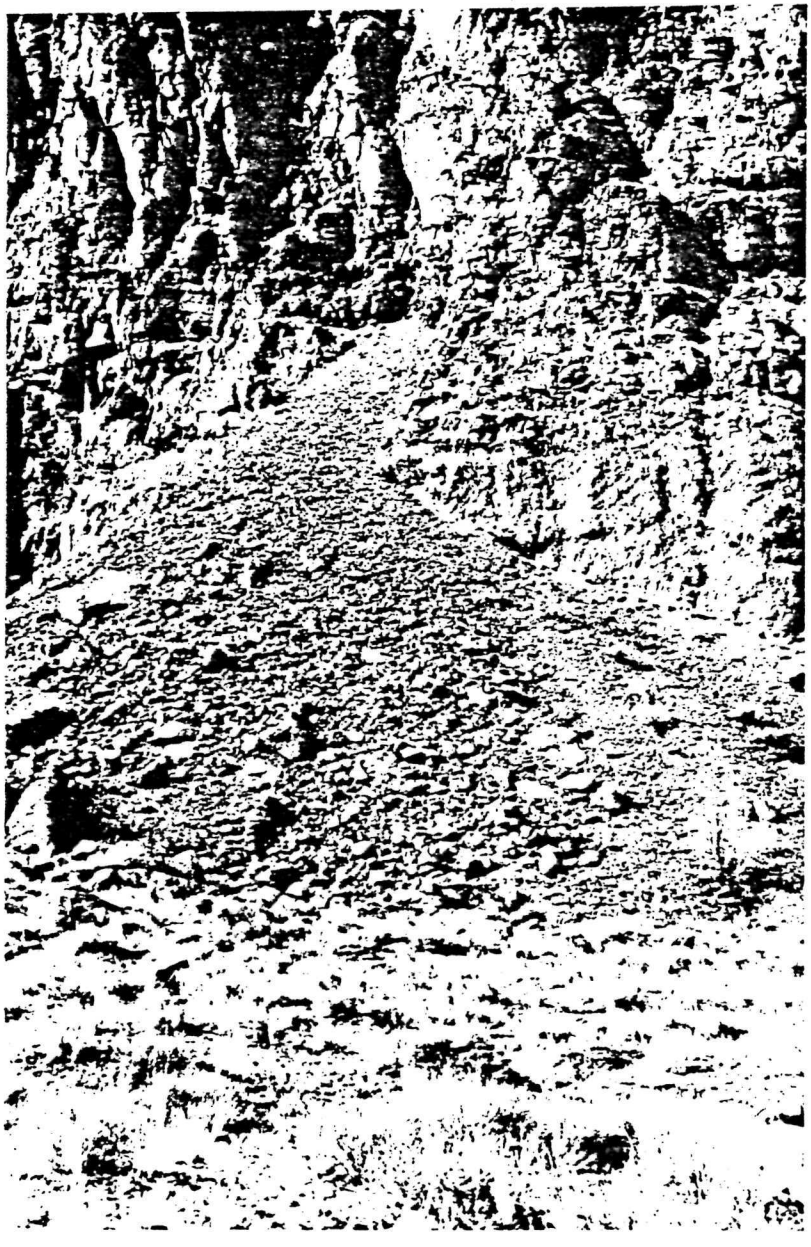
Younger Surficial Deposits on Buffaloberry Terrace

Portions of the upper part of the Buffaloberry Terrace Fill consist of younger alluvial fan deposits largely derived from fans on the surface of Gypsum Canyon Terrace Fill. Sub-rounded, lithologically heterogeneous boulders in debris flow lobes may be discerned on the younger fans. Boulders blanket 80-95% of the fan surfaces to a depth of 1-3 meters. The largest boulder measured on a fan is 4.6 meters in diameter. Average boulder size is 1-1.5 meters. Lithologies observed on the fans include 40% dark gray limestone, 50% tan, dolomitic sandstone, 5% purple-red sandstone, and less than 5% gypsum.

Rillenstein occurs on limestone boulders but is not as well-developed as that present on Gypsum Canyon Terrace limestones. Solution adjacent to chert veins ranges from 0.7-1.5 millimeters on limestone boulders. Rillenstein observed on boulders derived from older fan deposits may have begun forming prior to the aggradation of Buffaloberry Terrace. Desert varnish occurs at streaks and blotches on sandstone boulders. Purple-red sandstone boulders have exfoliation rinds and are disintegrating in place. Less than 5% of the fan surfaces sustain vegetation due to the density of boulders.

Talus consisting of coarse rock fragments with no intervening matrix material overlies Buffaloberry Terrace (Figure 9). The talus is abundant in a narrow rock gorge below the steep headwall separating upper and lower Gypsum Canyon. Angular blocks of dark gray limestone with bluish-black chert nodules

Figure 9. Limestone rubble forming talus cone of Buffaloberry Terrace in lower Gypsum Canyon.



are accumulating in the gorge. The blocks are 1-9 meters in diameter. In the middle portion of lower Gypsum Canyon, talus cones composed of angular rock fragments, less than one meter in diameter, continue to form on Buffaloberry Terrace. No rillenstein or solution around chert nodules is evident on the talus blocks.

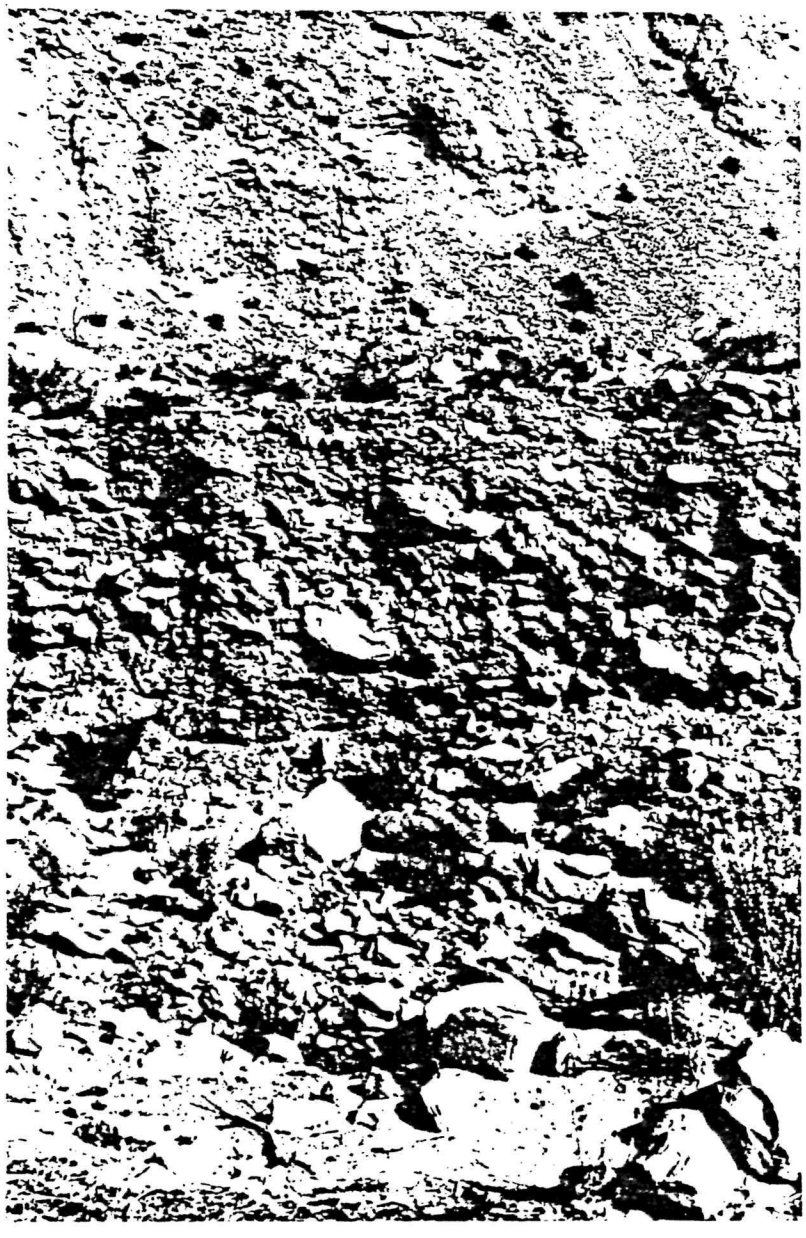
Beavertrek Terrace Fill

Debris flow deposits constitute the youngest fill in Gypsum Canyon. The debris flows, usually inset within Buffaloberry Terrace as shown in Figure 3, occasionally overlap the older surface. Remnants of Beavertrek Terrace stand approximately 3 meters above the present stream channel. Beavertrek Terrace is distinguished from Buffaloberry Terrace by its lack of a thick, sandy soil and by the presence of large boulders in lobate patterns (Figure 10). A thin mantle of unstabilized aeolian sand is deposited among the boulders.

The largest boulder on the terrace is 2.6 meters in diameter. Lithologies are represented in the surficial deposits include 55% tan, calcareous sandstone, 35% dense, blue limestone, 5% gypsum, and 5% purple-red calcareous sandstone. Rillenstein is not present on limestone boulders and weathering of other rock types is not evident. Driftwood of juniper and pine is abundant on Beavertrek Terrace in the mid-portion of lower Gypsum Canyon.

Boulder size decreases downwards in section. Subangular cobbles and pebbles exhibit crude bedding. A light brown matrix of sand and silt accounts for less than 10% of the deposits.

Figure 10. Debris flow deposits of angular, unsorted boulders exposed in scarp of Beavertrek Terrace Fill.



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APPENDIX III

DIETARY ANALYSIS OF HUMAN COPROLITES FROM RAPPEL RUIN (42SA683), GLEN CANYON NATIONAL RECREATION AREA

by

Mark A. Stiger

Introduction

In the study of prehistoric populations a major concern is the reconstruction of past economic and resource exploitation. An important aspect of this concern is the plants and animals utilized for food. The most direct means of discovering the flora and fauna deemed edible and staple by a prehistoric group is by examining ancient feces or coprolites.

Method

Several methods have been used in the past for study of dessicated fecal specimens. Early researchers broke open the dried stools and examined seeds in the interior (Young 1910). However, most recent investigators use the wet or rehydration technique (Fry 1970a, Fry and Hall 1975, Stiger 1977) as was developed by E. O. Callen (Callen and Cameron 1955). The advantage of the rehydration method of coprolite analysis is that the dried feces is reconstituted to a fresh consistency by immersion in a salt-water solution. This allows the fecal pellet to be disaggregated without damaging soft and delicate tissues, fibers and other remains. Approximately half the coprolite is soaked in the solution and rehydrated.

Once the fecal constituents have been separated (seeds in vials, tissues and hairs mounted on slides), the different components are identified with the aid of comparative collections.

Results

The results of this study are given in Fig. 1. The number of coprolites with cultivated plant remains is lower than coprolites from other areas in the Anasazi southwest at a comparable date (Stiger 1977). When the coprolites that contain some cultivated food are considered separate from coprolites containing no corn, beans, or squash, two discrete types of coprolites are apparent. Almost every component category is found in exclusively only one coprolite type (Table 1). The results of a coprolite pollen study similarly indicates this dichotomy (Scott and Stiger 1978).

The two different diets represented can be explained by two alternative hypotheses. The first hypothesis regards all coprolites as of Anasazi origin and the differences in components are due to seasonality in the diet. The second hypothesis explains the two diets by reason of two different cultural populations. These two populations would be the farming Anasazi and a later hunting and gathering group.

Distribution of coprolites in the site indicates that the eaters of corn, beans, or squash were more concerned that the location of deposition of feces be outside of habitation or storage rooms (Table 2). The coprolites not containing domesticates were found in every excavated room and seemingly represent different defecatory habits.

Comparison with other coprolites found in Hogup Cave, Utah (Fry 1970b), shows similarities between "Shoshoni" coprolites and this paper's "hunting-gatherer" coprolites. These similarities are high grass use, absence of domesticates, and high percentage of coprolites containing artiodactyl hair or bone. No bulrush was found in the Hogup "Shoshoni" coprolites.

For the above reasons the hypothesis of two diets reflecting two different cultures is accepted for this paper. In the future, radiocarbon dates on the coprolites could be used to further support or reject this explanation.

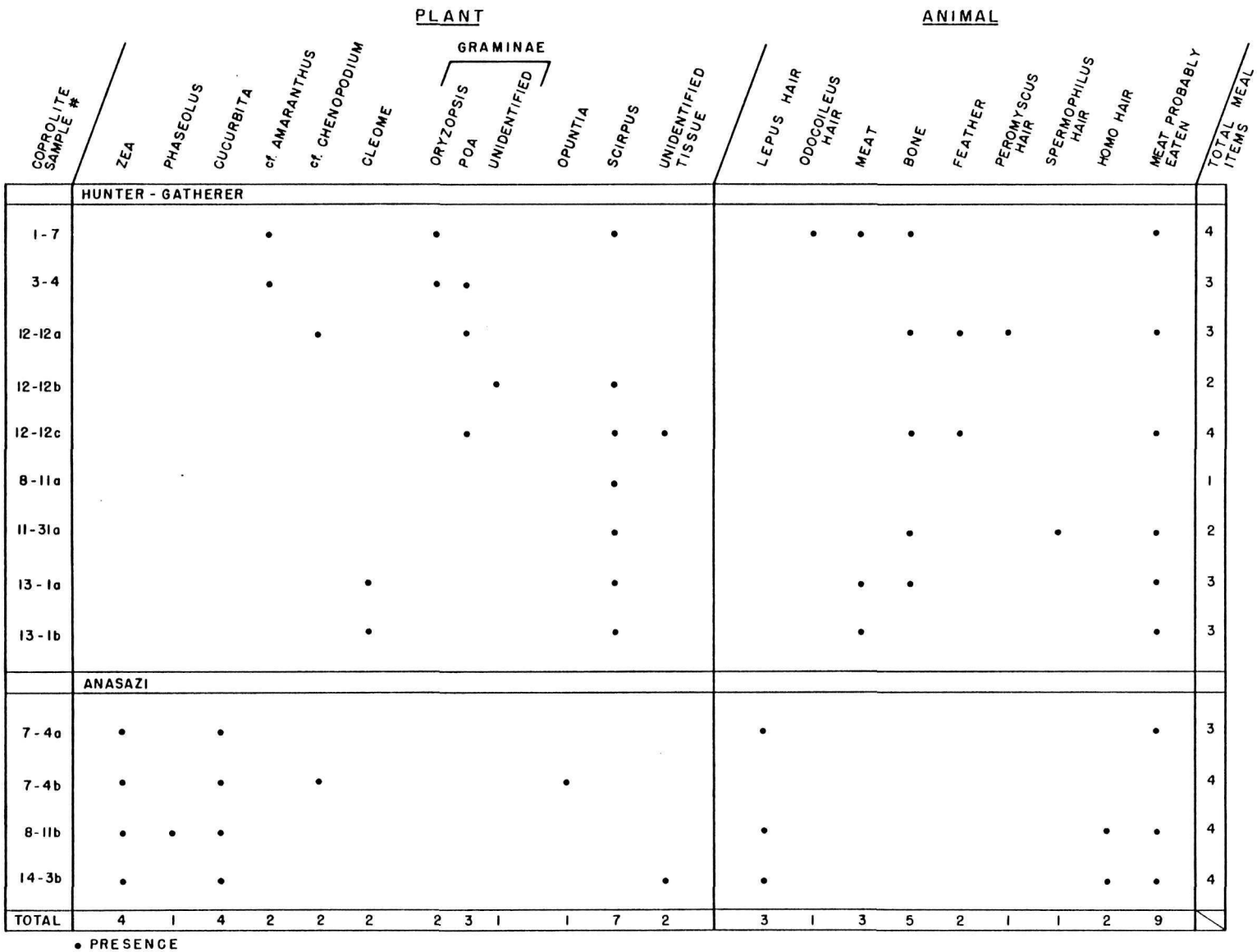


Figure 1. Macroscopic contents of human feces from Rappel Ruin (42SA683)

Table 1. Component Occurrence in Coprolite Types

	Hunting/Gathering Diet		Anasazi Diet		Total
	N=9	%	N=4	%	N=13
Plant					
Corn	-	-	4	100	4
Beans	-	-	1	25	1
Squash	-	-	4	100	4
Beeweed (Cleome)	2	22	-	-	2
Bulrush (Scirpus sp.)	7	78	-	-	7
Goosefoot (cf. Chenopodium)	1	11	1	25	2
Grass					
Poa type	3	33	-	-	3
Orizopsis hymenoides	2	22	-	-	2
Unidentified	1	11	-	-	1
Pigweed (cf. Amaranthus)	2	22	-	-	2
Prickly pear (Opuntia)	-	-	1	25	1
Unidentified leaf or tissue	1	11	2	25	2
Number of Identified Plants	7		5		11
Animal					
Jackrabbit Hair	-	-	3	75	3
Deer Hair	1	11	-	-	1
Meat	3	33	-	-	3
Bone	5	56	-	-	5

Table 1. Component Occurrence in Coprolite Types

	Hunting/Gathering Diet		Anasazi Diet		Total
	N=9	%	N=4	%	N=13
Feather	2	22	-	-	2
Deer Mouse Hair	1	11	-	-	1
Ground Squirrel Hair	1	11	-	-	1
Human Hair	-	-	2	50	2
Probable Number of Animal Species Eater	4		1		5

Table 2. Coprolite Proveniences, Rappel Ruin (42SA683)

Coprolite #	Provenience	Cultural Assignment
1-7	Room 4	Hunting/Gatherer
3-4	Room 5	Hunting/Gatherer
8-11a	Rat Midden East of Rooms 3 and 4	Hunting/Gatherer
11-31a	Room 2	Hunting/Gatherer
12-12a	Room 4	Hunting/Gatherer
12-12b	Room 4	Hunting/Gatherer
12-12c	Room 4	Hunting/Gatherer
13-1a	Room 1	Hunting/Gatherer
13-1b	Room 1	Hunting/Gatherer
7-4a	Rat Midden East of Room 5	Anasazi
7-4b	Rat Midden East of Room 5	Anasazi
8-11b	Rat Midden East of Rooms 3 and 4	Anasazi
14-3b	Room 5	Anasazi

PREVIOUS WORK WITH GLEN CANYON COPROLITES

Only three studies of Glen Canyon coprolites have been published previously, Martin and Sharrock (1964), Callen and Martin (1969), and Fry (1970a). Martin and Sharrock (1964) were concerned only with the pollen content of the feces. Therefore, their work is not comparable with this study. Callen and Martin (1969) compared coprolitic pollen and macro-remains. Their work showed little correspondence between the two types of information in a single coprolite. Because of poor depositional proveniences, and confusing data presentation their paper will not be used for comparison with the present study. Fry (1970a) analyzed 24 coprolites from Pueblo II-III deposits in Glen Canyon. His results are summarized by Stiger (1977) and used in part for the reconstruction of Anasazi diet. For the purposes of this study the synthetic work of Stiger (1977) will be used.

Conclusions

The human feces from Rappel Ruin, 42SA683, represent two populations with different subsistence strategies. The earlier population, represented by the Anasazi, were highly dependent on cultivated plant species, and consumed a few field weeds and jack rabbits. The later population was probably a hunter-gatherer group eating grasses, bulrush seed, and several types of large and small game.

The data from the Anasazi coprolites fits well in the model for prehistoric Pueblo dietary patterns as given by Stiger (1977). This model sees increasing reliance on domesticates through time until abandonment. Dependence on domesticated food is in part attributed to population pressure. This same process has been argued for in several other essays (Binford 1968, Cohen 1977, Boserup 1964).

Similarly, the hunting-gatherer's coprolites in this study fit into the pattern for late Archaic diet as established by Fry (1970a, 1970b) and explained by Cohen (1977). This pattern is one of intense use of low priority food items (i.e. grasses, rodents) necessitated by population pressure.

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APPENDIX IV

POLLEN ANALYSIS OF CULTURAL FEATURES AND COPROLITES FROM GLEN CANYON NATIONAL RECREATION AREA

by

Linda Scott and Mark A. Stiger

March 17, 1978

Introduction

Thirteen human coprolites, one stratagraphic column, and four samples from feature fill were analyzed for pollen content. The coprolites were analyzed in hopes of discovering some botanical remains not found during macro-investigations (Stiger 1977). At the beginning of the project, it was felt that pollen in the coprolites would possibly indicate flowers ingested or seasonality of deposition. The stratigraphic column was analyzed to demonstrate past botanical environmental dynamics. The feature fill was examined to discern ethnobotanical residue.

Preparation of Archeological Samples for Pollen Analysis

SOILS

1. The sample size should vary between 50 and 100 cc. or ml., depending on the nature of the sediment. Sand generally contains less pollen than silts and clays. Surface samples usually have sufficient pollen so that a 50 cc. sample is plenty. Add 7% HC1 to the sediment in the beaker and mix thoroughly to dissolve calcium carbonates. Stir the sample and/or add more HC1 until there is no further reaction.

2. Screen the sample through 150 micron mesh (#100 U.S.A. Standard Testing Sieve, Stainless Steel) to remove large particles of sand, charcoal, organic debris, and small pebbles. Add water and swirl the sediment in the beaker, sieving the

supernatant and some sediment. Clean the screens thoroughly between the samples. Pour the sieved sample before decanting into beakers. Most of the sediment should be in the last beaker to facilitate swirling of the sample as you fill the centrifuge tubes.

3. Centrifuge liquid and sediment from sieving. Concentrate the sediment into one 50 ml. tube for each sample to prepare it for zinc bromide, except when the sediment fills one-half or more of the tube, then split the sediment into two tubes. Add ½" zinc bromide to the sediment (or more if necessary) and stir it thoroughly or mix on vortex mixer. Centrifuge it or mixtures at approximately 2500 rpm for 20-25 minutes. Decant it and save the supernatant. Repeat the zinc bromide separation as needed, generally 2 to 3 times. Dilute zinc bromide with approximately 1-2 ml. 7% HCl and add water forcefully to fill the tube. Centrifuge and discard supernatant. Sediment should remain in the bottom of the tube. Change to conical 15 ml. tubes at this point for further washing. Wash three times.

4. Optional Treatment for Charcoal. Mix 1:1 mixture of potassium chlorate and nitric acid in beaker (May use dry potassium chlorate and add nitric acid--stir and let sit or boil in water bath for a few minutes to dissolve charcoal. If reaction occurs between sample and acids (fizzing or bubbling) add water immediately to dilute--proceed with caution. Do not allow to sit too long as this mixture will destroy pollen. Samples prepared with this process will have very light pollen grains which may be enlarged to double their normal size. Wash four to six times. Add some 7% HCl to the last washes to clear the supernatant.

5. Add small amount of HF to sample (the amount depends on how much inorganic sediment remains in the sample) and boil for three minutes in a water bath. Wash three times and centrifuge.

6. Wash with small amount of glacial acetic acid, then acetolate (9 parts acetic anhydrite plus one part sulphuric acid) for three minutes in boiling water bath. Wash with small amount of glacial acetic acid.

COPROLITES: Use 1 cc. of coprolite, begin with a 5% KOH (100 ml. water and 5 grams of dry KOH)--then sieve thoroughly. May need treatment for charcoal or HF. Will probably need a swirl in a watch glass to remove sand. Acetolate all samples.

Results

The samples analyzed and their proveniences are shown in Tables 1 and 2. Fig. 1 and 2 show the results of this study.

Table 1. Sample Proveniences

Coprolites

Site Number	Sample Number	Provenience
42SA683	1-7	Room 4
42SA683	3-4	Room 5
42SA683	7-4a	Rat Midden East of Room 5
42SA683	7-4b	Rat Midden East of Room 5
42SA683	8-11a	Rat Midden East of Rooms 3 and 4
42SA683	8-11b	Rat Midden East of Rooms 3 and 4
42SA683	11-31a	Room 2
42SA683	12-12a	Room 4
42SA683	12-12b	Room 4
42SA683	12-12c	Room 4
42SA683	13-1a	Room 1
42SA683	13-1b	Room 1
42SA683	14-3b	Room 5

Feature Fill

Site Number	Sample Number	Provenience
42SA683	10-2	Rat Midden
42SA683	15-2	General Fill of Room 2
42SA683	16-2	General Fill of Room 2
42SA5379	3-2	Hearth

Stratigraphic Column

42SA5379	Column Number 1	See Table 2

Table 2. Carols House
Stratigraphic Column 2 Proveniences

Surface	———	Analyzed
10 cm	Sterile	Not Analyzed
20 cm	Sterile	Analyzed
30 cm	Sterile	Not Analyzed
40 cm	Sterile	Analyzed
50 cm	Cultural Fill	Analyzed
60 cm	Cultural Fill	Analyzed
70 cm	Cultural Fill	Analyzed
80 cm	Floor Contact	Analyzed

Interpretations

CULTURAL FEATURES

The pollen preservation is very poor in all samples. Only two samples produced any pollen at all. The sample from the rat midden at 42SA683 yielded a few grains of Cleome pollen. This is interesting with respect to the coprolite pollen. Only the Anasazi coprolites contained high percentages of Cleome pollen and most of them were found in rat middens. No solid conclusions can be drawn on this scanty evidence, but one might speculate that the fill pollen is derived from deteriorated coprolites.

The firepit fill at Carols House (42SA5379) contained 58% pine pollen. This pollen is probably "fallout" from roofing material. A sample from 10 cm. above the floor in the same room (Strat. column 2, 70 cm) contained 62% pine pollen. The sample from above the floor was in the midst of roof fall (A. Schroedl, personal communication). The remainder of the pollen from the firepit does not lend itself to interpretation further than establishing its presence in the past pollen rain.

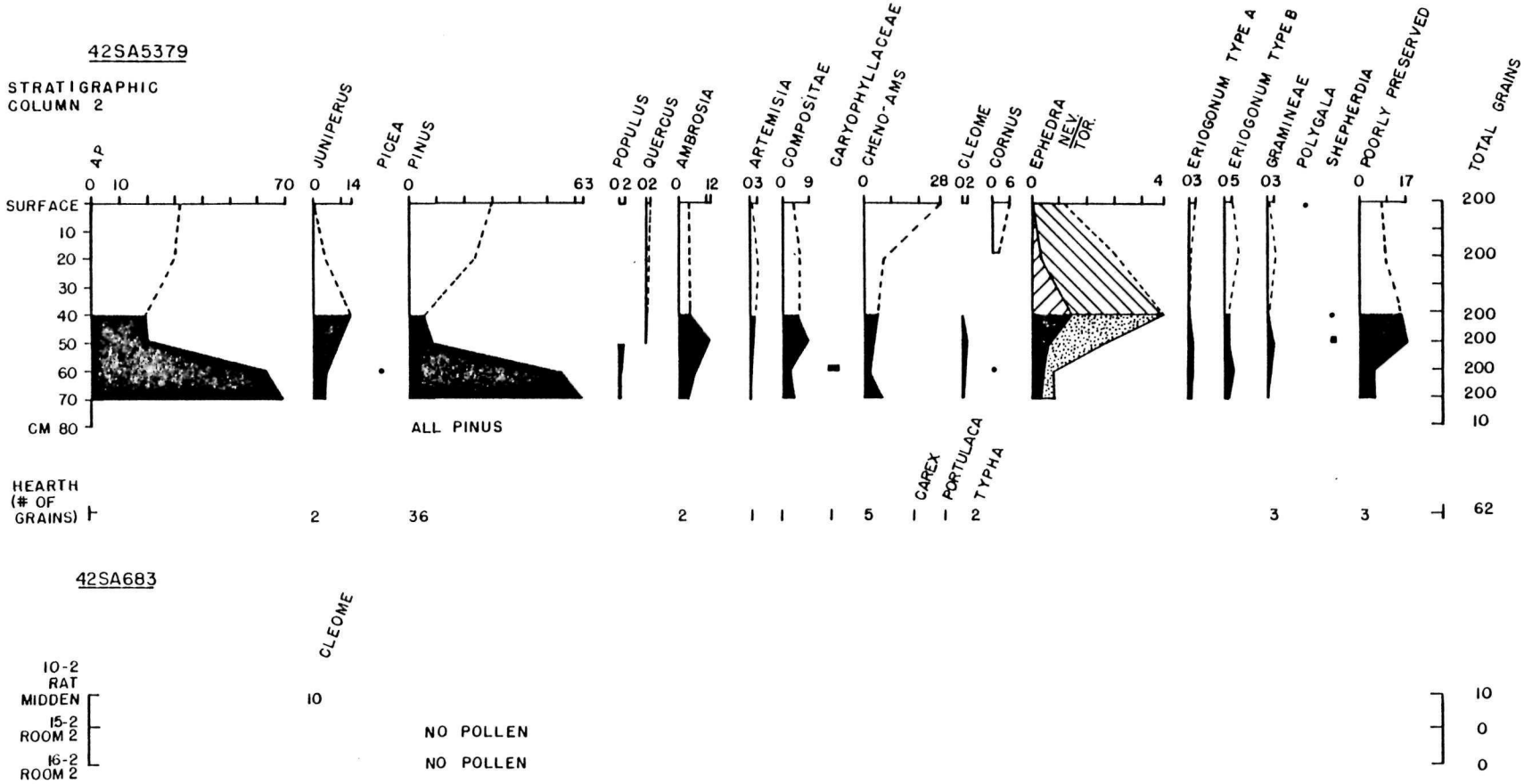


Figure 1. Pollen from stratigraphic columns at sites 42SA5379 and 42SA683

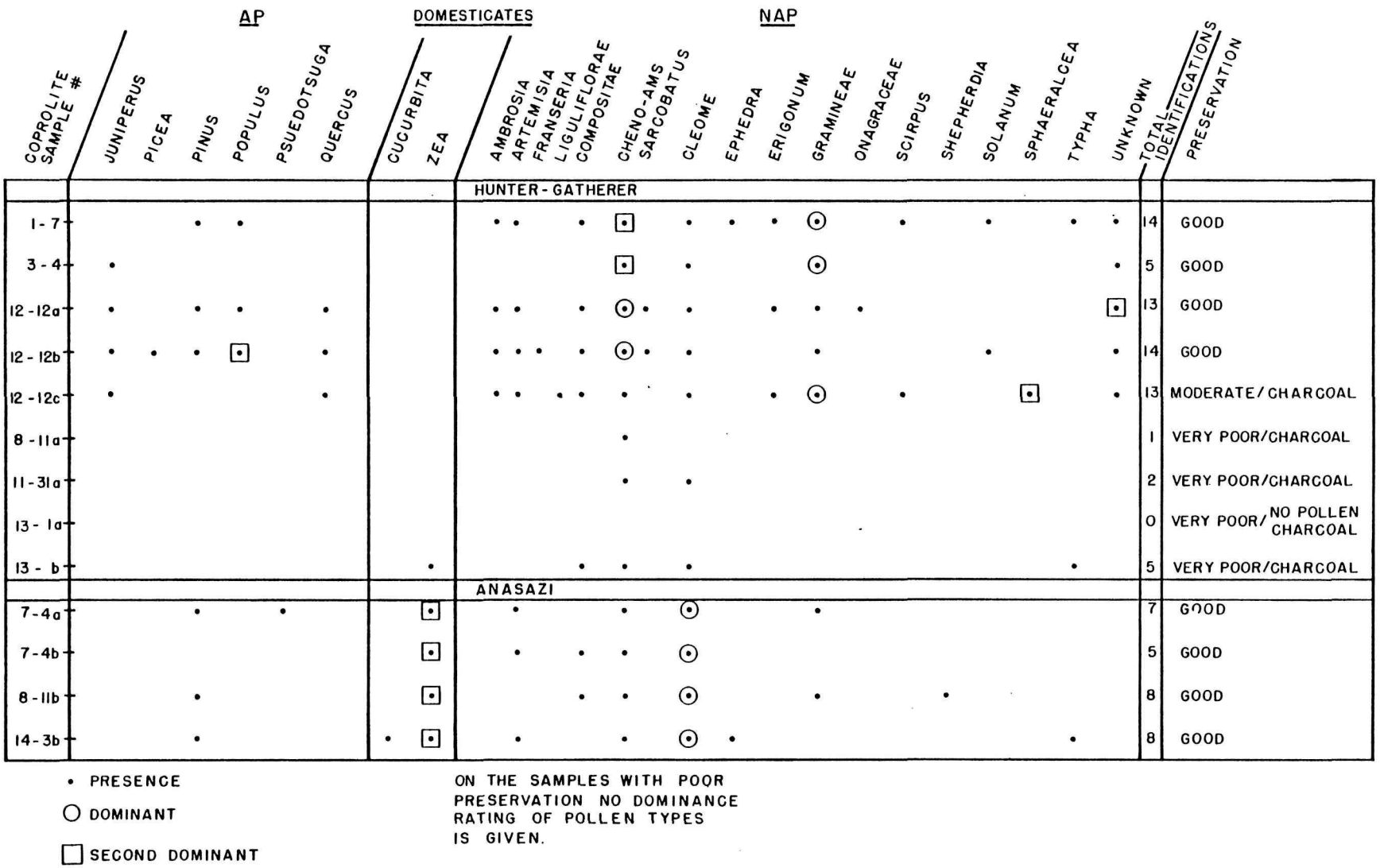


Figure 2. Pollen from coprolites

STRATIGRAPHIC COLUMN

The pollen record from this column can be divided into two units. The first unit is represented by the four samples from 50 to 80 cm. in depth. These samples were taken from "cultural fill" consisting mainly of roof fall materials (A. Schroedl, personal communication). The pollen in this unit probably represents roofing debris (Pinus, Juniperus, Populus) and weeds growing on a collapsed roof (Ambrosia, Compositae, Cleome, Graminae).

The second depositional unit is represented in the pollen record by samples taken at 40 and 20 cm. depth and the modern surface. The major vegetational changes represented are the early increase in arboreal pollen (especially Pinus) and late decline in Ephedra with increasing Cheno-Ams.

The arboreal pollen rise in Pueblo post-abandonment times has been noted elsewhere in the southwest (Martin and Byers, 1965; Scott, 1974). This fluctuation has traditionally been attributed to climatic change (Schoenwetter 1970). More recently, however, the possibility of culturally influenced vegetational change has been argued for (Stiger 1977), as suggested by Martin and Byers (1965). Stiger accounts for initially low arboreal values by Anasazi deforestation of mesa tops with a temperate latitude swidden farming system. After abandonment, natural succession returned the old fields to their earlier ecological status as climax forests. This succession would be represented as rising relative values for arboreal pollen. Further weight for this argument is gained from the observed decline of juniper pollen in the Glen Canyon record. Since juniper is a pioneer tree species (Erdman 1970:20), the replacement of juniper by pinon in an aging forest should be expected to show in this manner in the pollen record.

The changes in Cheno-Ams and Ephedra are more difficult to explain. Both plant groups are wind pollenated. While Ephedra is a genus of shrubs, Cheno-Ams are manifested by both forbs and shrubs.

Ephedra is commonly found on talus slopes and in more open sections of the pinon-juniper forest in the southwest. If the forest near Glen Canyon were gradually growing back, as mentioned above, the closing forest canopy could eventually eliminate many potential locations for Ephedra. This is a possible explanation, but no ecological data on Ephedra is available at this time.

The Cheno-Ams group includes the weedy annuals, such as goosefoot and pigweed, and shrubs of open flats such as greasewood and saltbush. The pollen of these two types was not distinguished during the stratigraphic column counts. The late (surface) high in Cheno-Am pollen is probably attributable to the recent ecosystem disturbances. These disturbances, such as fluctuating reservoir levels and overgrazing, would aid the distribution of weedy annuals and hence their pollen.

COPROLITES

Pollen analysis of coprolites has occasionally been used to make inferences of seasonality for nomadic groups (Bryant, 1974). The first such study for a sedentary group was that of Williams-Dean and Bryant (1975) at Antelope House, an Anasazi habitation. Their pollen analysis of human coprolites indicated that most fecal specimens represented a spring/summer season. This conclusion was based on a relative abundance of pollen and macro-remains. However, more recently, the role of pollen analysis in coprolite studies has been examined with modern experimental samples (Kelso and Solomon, 1976). This new evidence indicates that "differences in coprolite relative pollen frequency values previously used to describe changes in diet, season, and environment are meaningless" (Kelso and Solomon 1976:142). Kelso and Solomon conclude that coprolitic pollen is only an indicator for dietary reconstruction. For the purposes of this study presence-absence and the two dominant pollen types are dietary indicators while the other pollen in an indicator of the surrounding vegetation.

On the basis of pollen content two coprolite types are seen (Table 4). The distinguishing characteristic of one group is the dominence of Cleome and Zea pollen. These two coprolite types are comprised of the same samples ascribed to the two different populations on the basis of macro-scopic contents (Appendix III). Only one sample not included contained Zea pollen (13-1b). This sample's pollen was poorly preserved and Zea may be a contaminant from the soil.

Pollen from the Anasazi coprolites is remarkably homogeneous. The presence of Cleome pollen is interesting as this plant was not macro-scopically observed in the Anasazi coprolites (Appendix III). This same phenomenon is reported by Callen and Martin (1969). Evidently Cleome was valued more for its greens or flowers than seed.

The hunting-gatherer coprolites show much more diversity in kinds of pollen identified and in dominant pollen types. Important dietary plants are Graminae, Cheno-Ams, Populus, Sphaealacea, and an unidentified type.

Conclusions

Pollen analysis of a stratigraphic column from Glen Canyon has enabled a partial reconstruction of past vegetational change. The major pollen fluctuations are probably due to environmental succession following abandonment of the area by prehistoric farmers.

Thirteen coprolites examined yielded dietary information not available by other analytical methods. The results further support a classification of coprolites into two types, representing two cultures and subsistence strategies. The first culture, the Anasazi, depended on domesticates, Cleome and weeds. The second culture, a hunting-gathering one, subsisted on a more varied diet. Perhaps a different environment is also represented.

Pollen samples from archeological features were poorly preserved and yielded few grains, no interpretations are possible.

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APPENDIX V

A REPORT ON THE CULTIVATED PLANT REMAINS (MAIZE, BEAN AND CUCURBIT) FROM THE 1977 GLEN CANYON EXCAVATIONS

by

Robert A. Bye, Jr.

Introduction

Remains of cultivated food plants were uncovered from sites in the Glen Canyon region of the Upper Colorado River in Utah during the 1977 excavation season. Three major food plants are represented: maize (Zea mays), cucurbits (Cucurbita), and beans (Phaseolus). For the most part, these specimens were excavated from the general fill of various rooms although some samples (especially the larger maize samples) were found in association with rat middens (Table 1).

Basically, the cultivated remains examined indicate that the maize-bean-cucurbit food complex was important in the subsistence diet of the former inhabitants of the caves. The possible races of maize present in the collections examined in this report are referable to those races described in an earlier report on Glen Canyon maize (Cutler 1966). Cucurbita pepo appears to be the common cucurbit or squash associated with these sites. It was reported from the earlier Glen Canyon excavations (Cutler 1966). One species of bean, Phaseolus vulgaris (the common bean), is represented by one of the common Southwestern types.

Description of Material

The botanical specimens were examined and studied in accordance with standard procedures for archeoethnobotanical material. The data derived from the studies are used to identify and interpret the plant remains. Because of the

Table 1. Provenience data for cultivated plant remains frrom 1977 Glen Canyon excavations (42SA6317, Rappel Ruin (42SA683), and 42SA684).

Maize (Zea mays)	
FS 1-4*	Room 4, General fill
FS 2-5	Room 1, General fill
FS 3-3	Room 5, General fill
FS 6-13	Room 2, General fill
FS 7-6	Rat Midden
FS 8-10	Rat Midden
FS 11-27	Room 2, General fill
FS 12-11	Room 4, General fill
FS 13-2	Room 1, General fill
FS 14-4	Room 5, General fill
42SA648	
FS 2-5	no provenience
42SA684	no provenience
Cucurbit	
(Cucurbita pepo)	
42SA683	
FS 1-1	Room 4, General fill
FS 2-7	Room 1, General fill
FS 3-9	Room 5, General fill
FS 6-11	Room 2, General fill
FS 7-5	Rat Midden
FS 8-12	Rat Midden
FS 11-29	Room 2, General fill
FS 13-5	Room 1, General fill
FS 14-6	Room 5, General fill
Bean (Phaseolus spp.)	
42SA683	
FS 3-7	Room 5, General fill
FS 6-12	Room 2, General fill
FS 14-5	Room 5, General fill

*These are the field designated sample numbers e.g. "FS 1-4" is Field Specimen Lot Number 1, sublot 4.

large number of cobs and cob fragments and the delicacy of the cobs, the examination of the maize was the most time consuming. Although several characters were considered in the preliminary analysis of the maize, only five characters were found to be sufficiently reliable. Some of the characters and overall description of the maize remains are summarized in Tables 2 and 3. Because of the poor representation of the whole cobs, only the following characters were used throughout the study of the samples: 1) cob diameter, 2) rachis diameter, 3) cupules per 2 cm length, 4) average cupule width, and 5) row numbers. The data from these five characters were subject to statistical analysis by a computer program designed for these samples (Program ZEA 1, see Addendum 1).

Although a large number of characters have been used in the analysis of maize, only a few are reliably observable in archaeological remains (Cutler and Blake 1973; Nickerson 1954). These characters are: 1) cupule width, 2) rachis diameter, and 3) row numbers. No kernel data were obtained due to the lack of kernels on the cobs or in the matrix. The cupule width actually represents the average cupule width for each cob. Three to six cupules per cob were measured at the point nearest the mid-length of the cob (as could be best determined). The rachis diameter, the inner lignified core of the cob, is more reliable than the measurement of the cob diameter. The diameter was taken at the point nearest the mid-length of the cob (as could be best determined). In some cases where the rachis resembled an elipse more than a circle (due to mechanical damage after harvest), the eliptical diameters were mathematically converted into circular diameters. The row number was counted directly on whole cob or extrapolated from the fragments. The basal (largest) row numbers were used; in many cases the row numbers were reduced upwards on the cobs.

Table 2

Characters of Zea Mays

CHARACTERS	Rappel Ruin (42SA683)FS										42SA6317		42SA684
	1-4	2-5	3-3	6-13	7-6*	8-10*	11-27	12-11	13-2	14-4	ttl.	FS 1-1	FS 2-5
whole cobs	7	2	1	4	9	7		1	1		32	2	
fragmented cobs	20	10	29	10	25	59	2	35	1	5	196	6	10
cob diameter (largest)													
1/3 distance from base	15	4	1	2	7	7		4		1	41	1	
near base	8		4	2		2					16		
1/2 distance from base		1	5	6	9	19		7	2		49	6	2
row number, uniform	17	6	8	4	10	9		11	1		66		1
row number, reduced upward	7	4	17	9	19	55	1	20	1	4	137	8	9
cob deformed			2		7						9		
rows spiralled											3		
charred	10	1	15	2	10	20	2	19	1	2	91		3
decomposed	7	1	20	7	7	46	1	30	1	2	122	1	3
damaged (structural)	5		2	1	6	3		6		2	22		1
hole at base (cob on stick)	3	1	1		4	1		3			13	1	
SAMPLE SIZE	27	12	30	14	35	66	2	36	2	5	229	8	10

*Rat Midden

Table 3

Row Numbers of Zea Mays

CHARACTERS 1-4		Rappel Ruin (42SA683)FS 2-5	3-3	6-13	7-6*	8-10*	11-27	12-11	13-2	14-4	42SA6317 FS 1-1	FS 2-5	42SA684
4	(number)			1	1		2						1
	(%)			3.5%	8.3%		3%						12.5%
6	(number)			1			1						
	(%)			3.5%			1.5%						
8	(number)	5	4	7	3	7	11	1	10	1	3		1
	(%)	19%	37%	25%	25%	20%	17%	100%	28%	50%	60%		12.5%
10	(number)	9	3	6	1	20	15		8		1	1	2
	(%)	35%	27%	22%	8.3%	59%	23%		23%		20%	14%	25%
12	(number)	10	3	11	6	6	27		14	1	1	5	1
	(%)	38%	27%	39%	50%	18%	42%		40%	50%	20%	72%	12.5%
14	(number)	2	1	2	1	1	8		3			1	3
	(%)	8%	9%	7%	8.3%	3%	12%		9%			14%	37.5%
16	(number)						1						
	(%)						1.5%						
SAMPLE SIZE		26	11	28	12	34	65	1	35	2	5	7	8

*Rat Midden

Two other characters were measured and recorded for analysis. They were cob diameter and number of cupules per 2 cm. length of cob. The cob diameter varied in the position with reference to the base of the cob (Table 2). Also, cob diameter may be misleading if the glumes had been unevenly eroded or destroyed. The number of cupules per unit length is sometimes a good measure of the compaction of the kernels along the ear. Measurements of the number of cupules per given measurement (depending on length of the cob or cob fragment) were standardized to a unit of length of 2 cm.

The measurement of the bean seeds included the height, length, and thickness in accordance to Kaplan's (1956) techniques. Morphological characters also follow Kaplan's terminology for description of archeological Phaseolus.

Characters examined in the cucurbit remains are basically derived from Cutler and Whitaker's (1961) approach. Of particular importance are the cellular and surface features of the rind, the morphology of the seed, and characteristics of the peduncle.

All measurements obtained from the plant remains were taken with a caliper and the units were in the metric system. Because the maize remains varied in degree of preservation and completeness, individual cobs were labelled, measured, and placed in numbered plastic bags with seals. In this way the parts of individual items would not be lost and the cobs can be readily identified and retrieved for futher investigation.

Previous Studies

The significance of archaeological cultivated plants has increased tremendously in recent years. Mangelsdorf (1974) has summarized the major points in maize evolution in which archaeological remains played a critical role. Similar situations are found with Phaseolus (Kaplan 1956, 1965, ms.) and Cucurbita (Whitaker and Bemis 1975; Whitaker and Cutler 1965, 1968).

Zea mays L.

Maize evolution in the southwest has been examined and reviewed by many workers (e.g., Anderson and Cutler 1942; Carter and Anderson 1945; Galinat et al. 1970; Mangelsdorf 1974). Cob and kernels of maize from Glen Canyon region have been analyzed by Cutler (1966). Four races were identified: 1) Reventador, based on a few cobs and kernels; 2) Onaveno (a flinty section of Pima-Papago race), the most common race; 3) Maiz Blando, the second most common corn; and 4) Maiz de Ocho, an eight row maize.

The modern era of maize classification began with garden and field studies of many varieties of corn (e.g., Anderson and Cutler 1942; "Races of Maize" groups (e.g., Wellhausen et al. 1952)). Based on these works, races were identified and characterized. Basic genetic and evolutionary studies of Casas, et al. (1968), De Wet and Harlan (1976), Galinat (1973), and Mangelsdorf (1974) have increased our understanding of the origins and diversity of this cultivated plant. With a larger data base derived from field and experimental samples, refined and modified concepts of maize classification are emerging (Goodman 1967, 1968; Goodman and Bird 1977; Goodman and Panterniani (1968). The reliability of certain characters used in interpreting maize classification and evolution is being questioned and reevaluated. More questions are being raised about the variability of many characters and about their genetic, physiological, environmental, and cultural bases. The features of the cupules and spikelets are considered of increasingly greater importance (Galinat 1970).

Archeological maize has received special attention as evidenced in the study of the origin and evolution of maize -- especially with reference to tripsacoid characters. Recent discussions concerning the origin of maize has dropped Tripsacum from consideration as a principal component. Mangelsdorf, himself an author of the concept based on Tripsacum hybridization, has

significantly modified this opinion (Mangelsdorf 1974). Tripsacoid characteristics are said to reflect the influence of teosinte introgression into maize. These characteristics include induration of the glume along with shortening of the rachillae, upward inclination of the spikelets, narrowing of the cupules, and relaxed condensation of the spikelets. However, some of these characteristics, such as induration of the glumes, may be due to other genetic and physiological factors such as the increased efficiency of the ear to act as an energy sink (Galinat 1975).

When studying archeological maize, one must be careful in selecting characters for analysis and interpreting the data. As more experimental and field data accumulate, some traditional concepts used as criteria for interpretations are not as well accepted as in the past. Modern studies point to the need for evaluation of these criteria (e.g., Goodman and Bird 1977; Bye unpubl. data). Further data are needed to interpret quantitative characters and their variability (range and origin). Discrepancies may exist due to preselection of prized ears in modern maize studies (and may not reflect the total range that exists in a particular race from a given population) and due to the mixing and separating of pure lines of corn under native cultivation practices. These problems are further amplified in the archeological context, where sample size and the origin and condition of given samples may be beyond the control of the investigator. Caution must be exercised in assigning archeological specimens to given races and deriving specific interpretations and conclusions from them.

Phaseolus

Beans have served as a critical complement in diets of maize agriculturists. The evolutionary history and supporting evidence are not as strong for beans as they are for maize. Although opinions exist to the contrary (Berglund-Brucher and Brucher 1974), it is generally accepted that Phaseolus vulgaris L.,

the common bean, originated in middle America (Gentry 1969; Kaplan 1965). The tepary, P. acutifolius Gray var. latifolius Freeman, has been considered a domesticate from northern Mexico with subsequent diffusion into the American Southwest where the best archeological remains exist. However, tepary has been recovered from Tehuacan in central Mexico where it antedates the Southwestern material by nearly 4000 years. Although modern nutritional, genetic, and ethnobotanical data are being examined in reconstructing the evolutionary history of beans (Evans 1976; Kaplan 1973), the descriptive and interpretive concepts of the North American beans are still based on Kaplan's classical treatment (Kaplan 1956). Various seed characters are important such as the hilum, the shape of the ends of the seeds, the ground color, and the distinctive markings.

Although these two beans have been reported from sites around Glen Canyon, they have not been recovered in archeological excavations of Glen Canyon sites (Carter 1966). The scarlet runner bean, P. coccineus L., and the sieva bean, P. lunatus L., have not been reported from the area.

Cucurbita

Cucurbits in the American Southwest are represented by four cultivated species (Cucurbita pepo L., C. mixta Pang., C. moschata Duch., and Lagenaria siceraria (Mol. Standley) and one wild species (C. foetidissima HBK.). The evolutionary history and characteristics of cucurbits have been studied by Cutler and Whitaker (1961), Whitaker and Bohn (1950), Whitaker and Cutler (1965, 1968), and Whitaker and Bemis (1975). Cucurbita pepo is the oldest of the three cultivated cucurbits in the American Southwest. Both C. pepo and C. mixta were recovered from the Glen Canyon area (Cutler 1966). Two cultivars of C. pepo were found in the Glen Canyon material: one type is similar to the common modern squash grown for food and the other type is a cultivar restricted to the

Glen Canyon - lower Green River region and was grown for use as a container (Cutler 1966). The bottle gourd (L. siceraria) is represented by a few archeological specimens (Cutler 1966).

Rinds of cucurbits can be distinguished to genera by the type of cells and layering in the rind (epidermis, subepidermal layer, and inner layer) (Cutler and Whitaker 1961). Other characters that are useful in determining the species of Cucurbita are the peduncle and the seed (Whitaker and Bohn 1950; Cutler and Whitaker 1961). The characteristics of the peduncle and seed are the most reliable in making determinations.

Specimens from the 1977 Glen Canyon Excavations

Zea mays

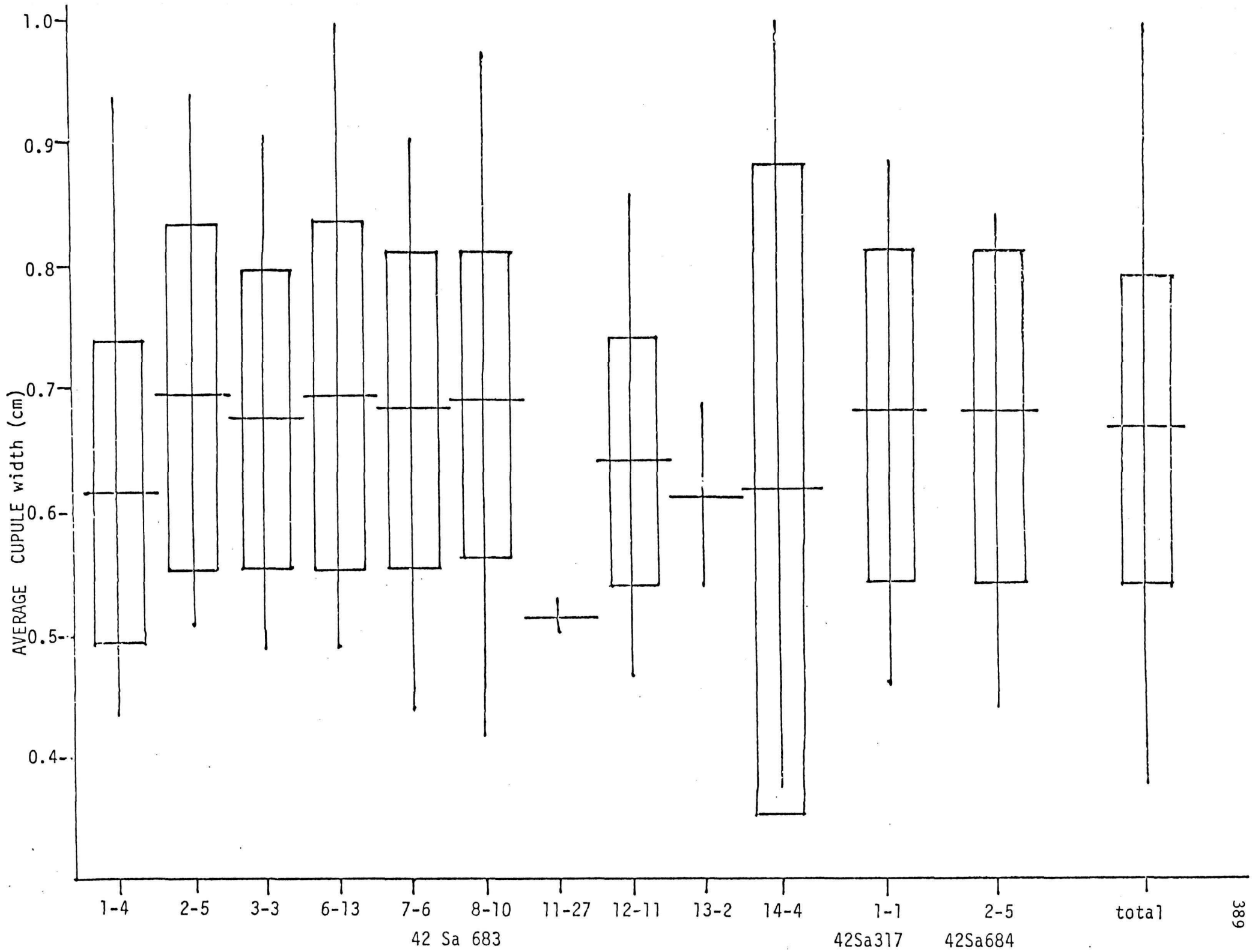
In order to conduct an adequate analysis of archeological maize, the sample must meet the following conditions: whole cobs, intact kernels, and large sample size. Unfortunately, these conditions are not met with the collections under discussion. Only 14% of the cobs were intact, no kernels were present, and the sample size of whole cobs is relatively small. Nonetheless, certain patterns do emerge from the analysis of the materials.

Most of the maize remains appear to belong to two, or possibly three, races of corn. The most common race is the Pima-Papago type. Maiz Blando may also be represented in the sample, but it is difficult to distinguish the two races based on cobs alone (Cutler 1966). Maiz de Ocho may also be present based on the analysis of the cobs for row numbers.

Evidence for recent teosinte introgression (through hybridization with Reventador) is questionable. In all the samples, a few cobs had small rachis diameters and spacing between the spikelets, while a number of the cobs displayed induration of the glumes. These features are often considered

Explanation of Figures 1 - 3.

The mean, range, and standard deviation of measurements for three characters (Figure 1 - average cupule width, Figure 2 - rachis diameter, and Figure 3 - number of cupules per 2 cm length) are diagramed for samples from each feature for the three sites and for the total samples examined in this report. The short, horizontal line indicates the mean; the long, vertical line represents the range of values; and the box covers the standard deviation (one standard deviation on either side of the mean).


1.0
0.9
0.8
0.7
0.6
0.5
0.4
AVERAGE CUPULE width (cm)
1-4
2-5
3-3
6-13
7-6
8-10
11-27
12-11
13-2
14-4
1-1
2-5
total
42 Sa 683
42Sa317
42Sa684

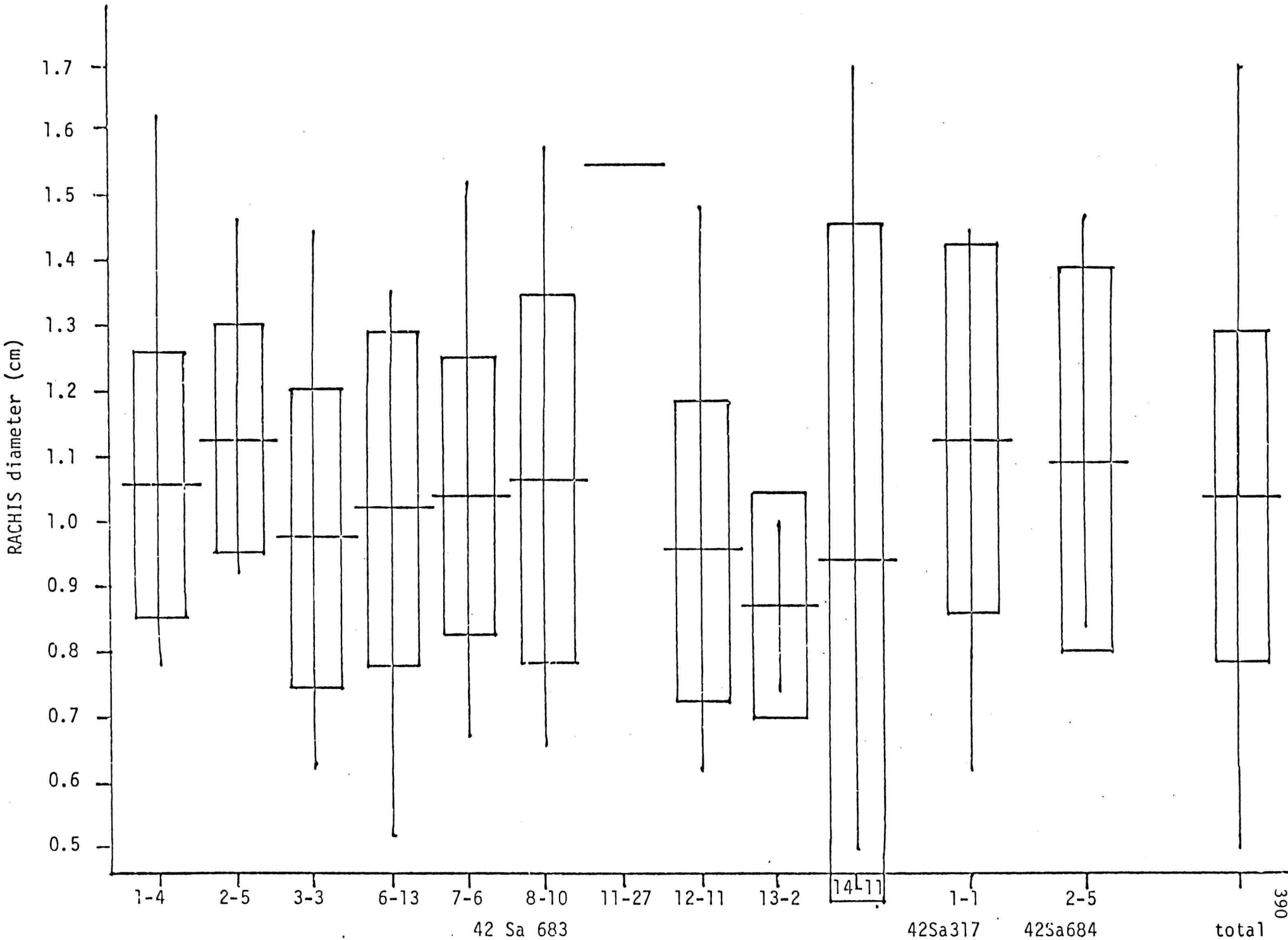


Figure 2. Rachis diameter

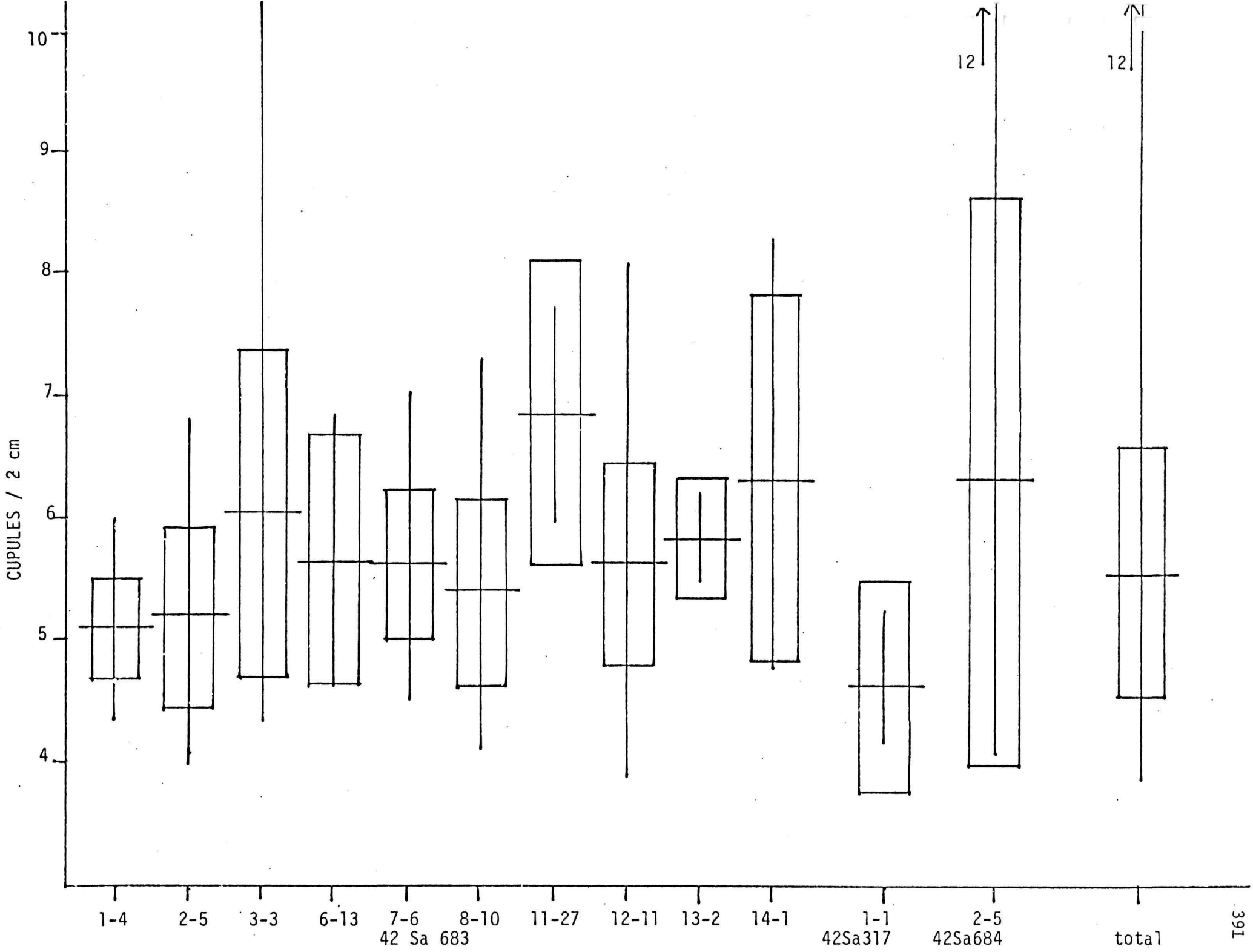


Figure 3. Cupules per 2 cm length

tripsacoid characters in traditional interpretations (Galinat et al. 1956; Galinat and Ruppe 1961). However, these characteristics in the Glen Canyon specimens may represent no more than the effects of stressed growing conditions (especially release of control of compaction on the cob). A few cobs were deformed and suggested an early physio-morphological state of fasciation, possibly caused by a fungus, the remains of which may still be present inside the rachis.

Maize data on row number and average cupule width are plotted in Figures 4 - 9. A line indicating the rachis diameter of 1.2 cm is also marked for reference. The larger diameters are above the line and the smaller diameters are below. The rachis diameters tend to increase with decrease of row number and increase of cupule width. These graphs are comparable to those constructed by Cutler (1966) for maize from earlier Glen Canyon excavations. Most of the points for the cobs with 10 or more rows fall into the range of Pima-Papago race and the points for the cobs with 8 rows fall into the range for Maiz do Ocho race, both of which are plotted in Cutler and Meyer (1966, Figure 7).

Pima-Papago Race

The Pima-Papago race is usually a 12 to 14 row maize with a rachis diameter of 1.2 to 1.7 cm. The rachis diameter may actually be less for specimens which have undergone shrinkage. Shrinkage under preservation as well as a restricted growing environment are more plausible explanations for the specimens with small rachis diameters than that of teosinte introgression. Consequently, the Pima-Papago race was probably the most commonly cultivated maize from this area at that time (based on recovered material). Other races which are similar and related to this type of maize include Onaveno and Maiz Blando. The Pima-Papago race is grown by contemporary Indians in the drainages in the desert regions of the greater Southwest.

Figure 4. Graphs of Zea mays samples for row number, cupule width, and rachis diameter for 42SA683, FS 1-4 and 42SA683, FS 2-5.

Figure 4 a.

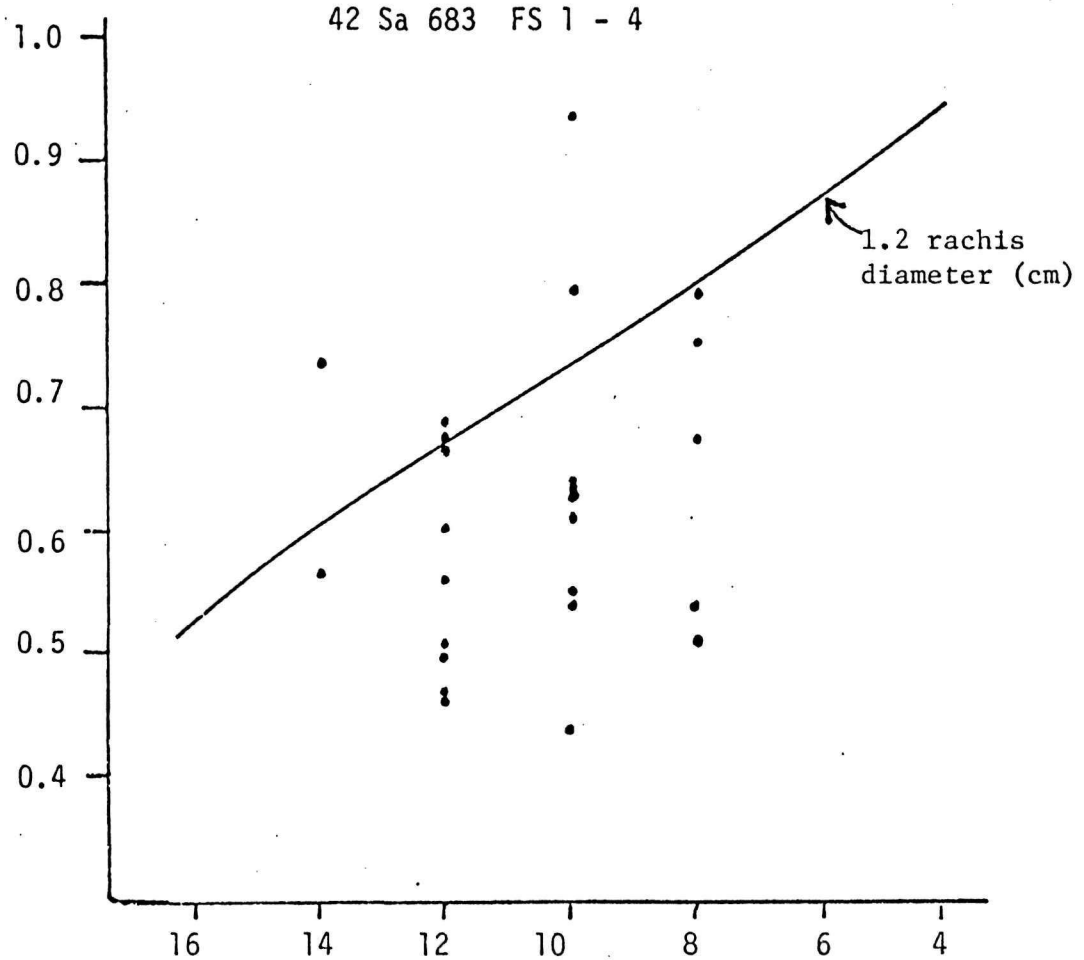


Figure 4 b.

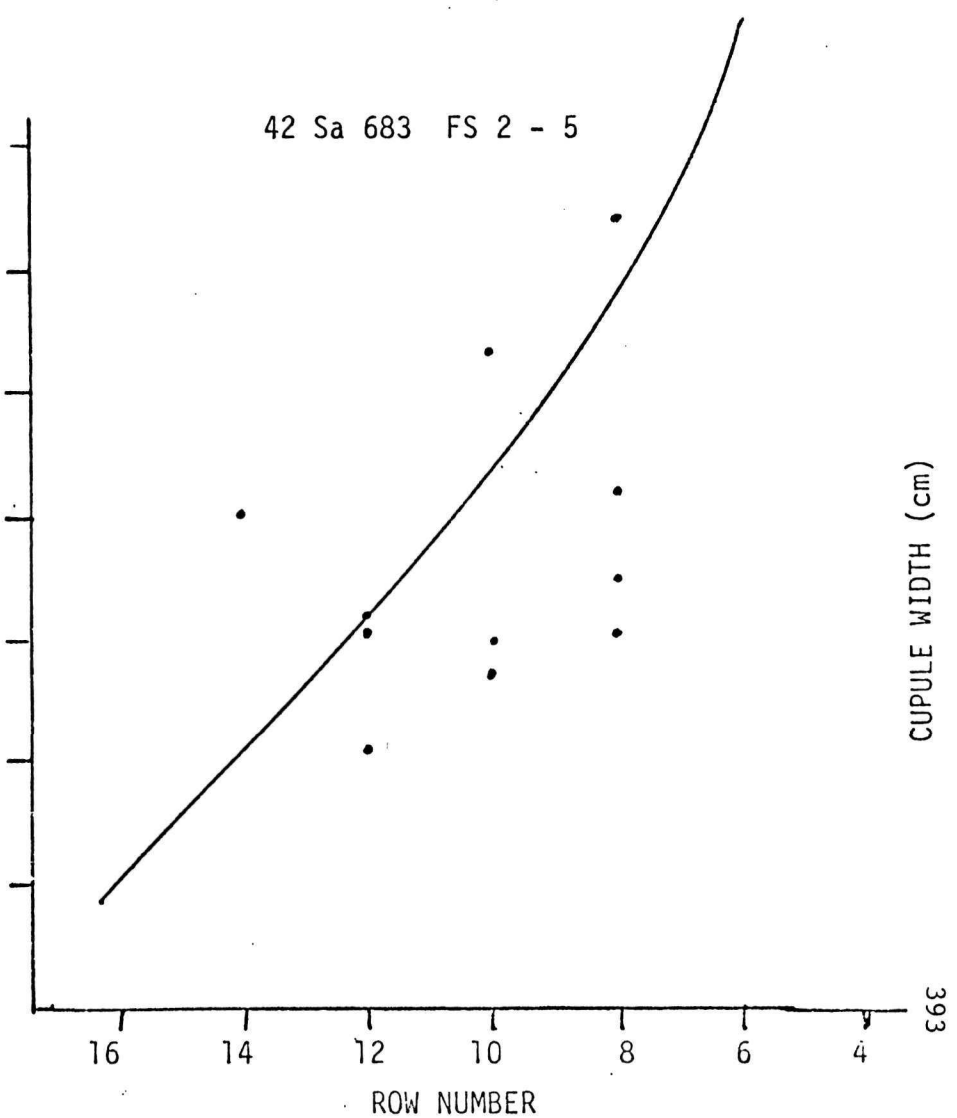


Figure 5. Graphs of Zea mays samples for row number, cupule width, and rachis diameter for 42SA683, FS 3-3 and 42SA683, FS 6-3.

Figure 5 a.

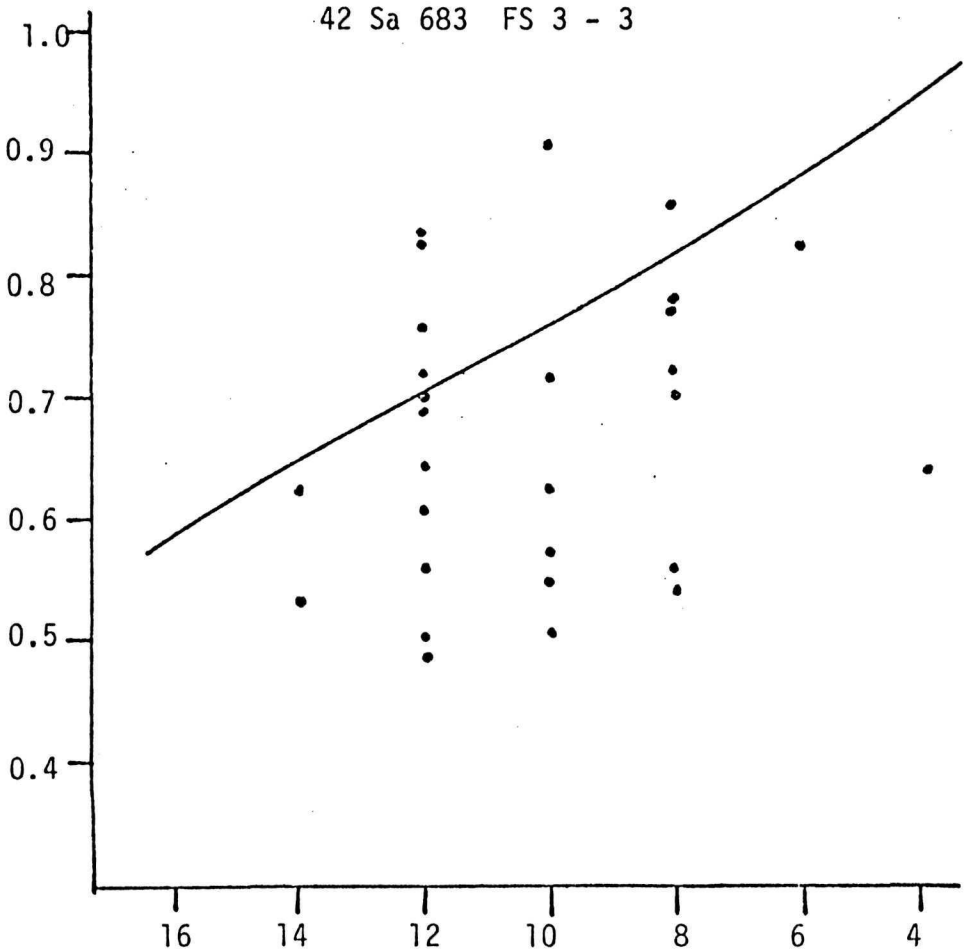


Figure 5 b.

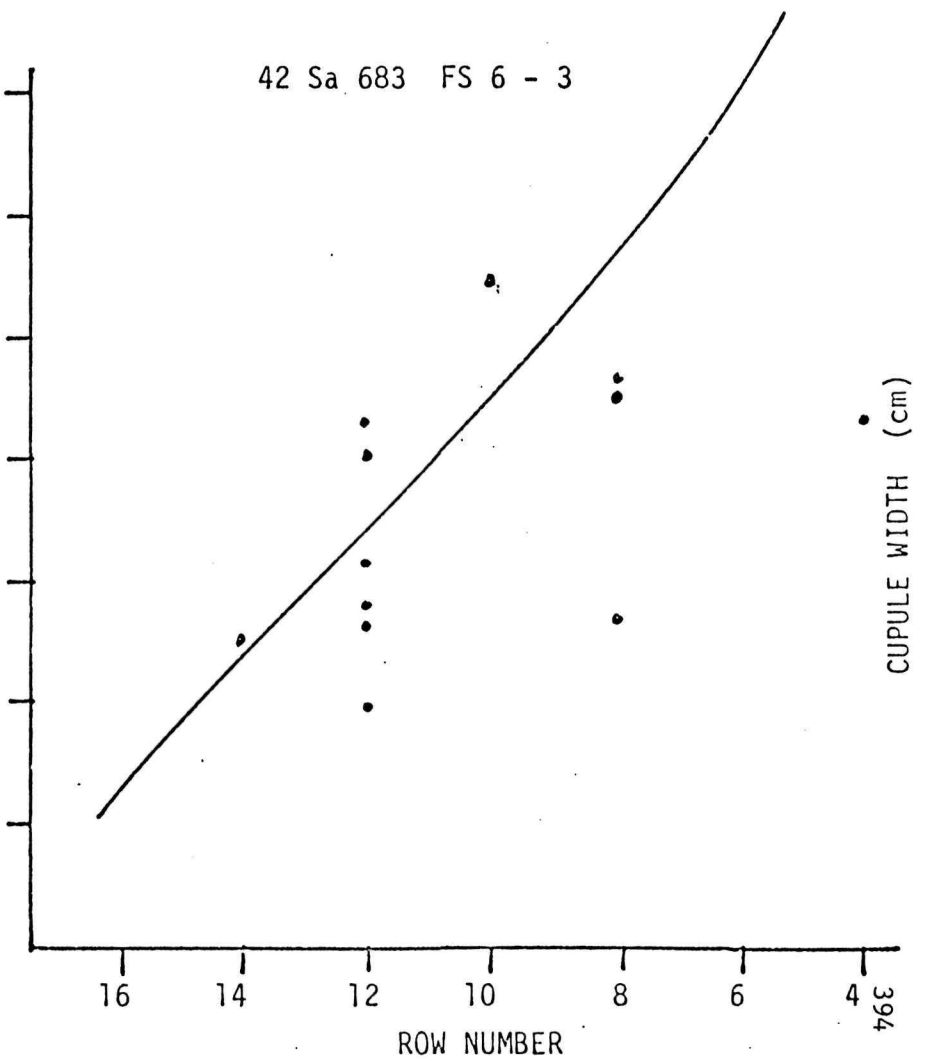


Figure 6. Graphs of Zea mays samples for row number, cupule width, and rachis diameter for 42SA683, FS 7-6 and 42SA683, FS 8-10.

Figure 6 a.

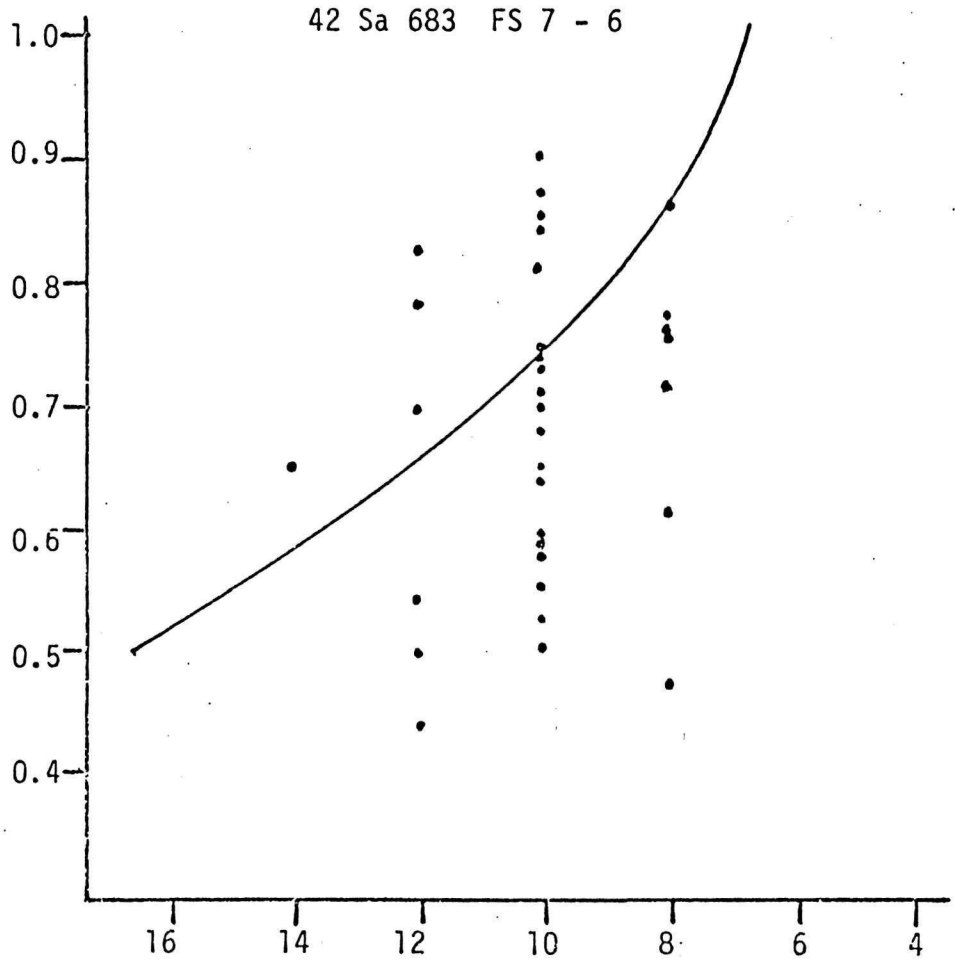


Figure 6 b.

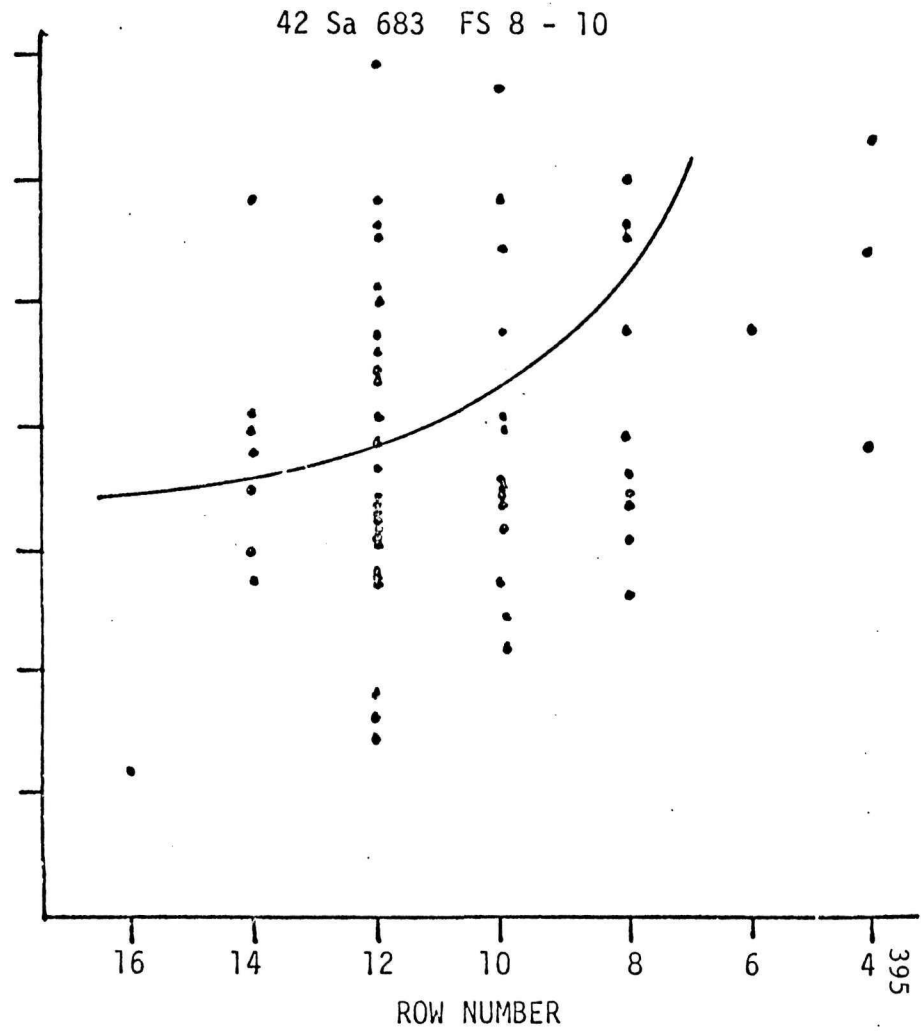


Figure 7. Graphs of Zea mays samples for row number, cupule width, and rachis diameter for 42SA683, FS 11-27 and 42SA683, FS 12-11.

Figure 7 a.

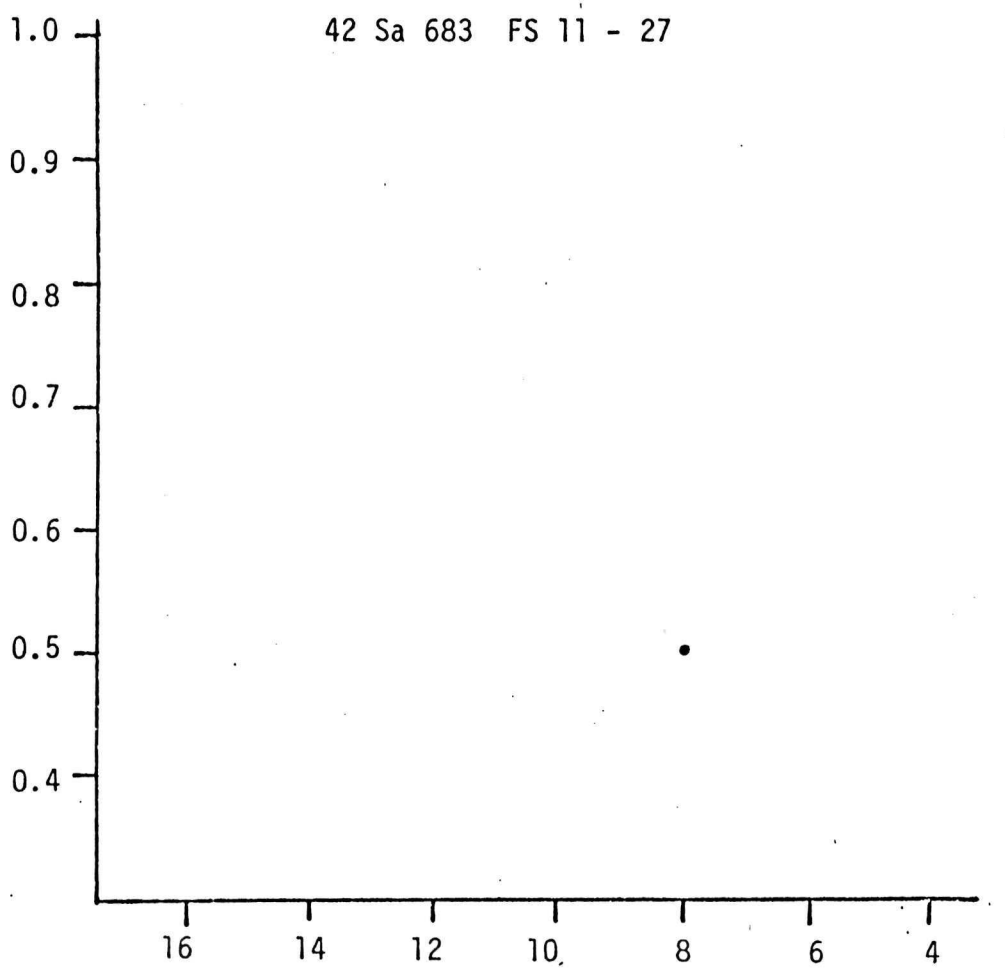


Figure 7 b.

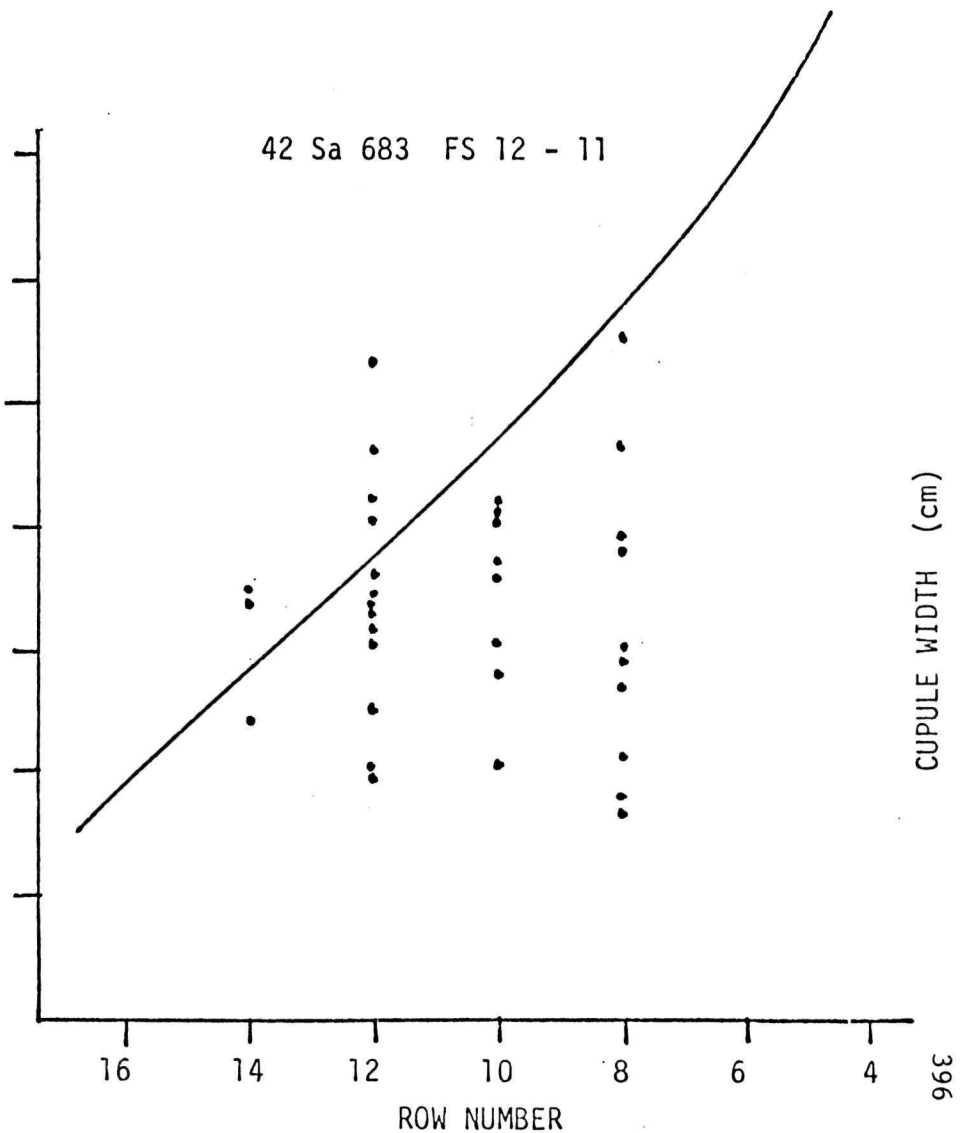


Figure 8. Graphs of Zea mays samples for row number, cupule width, and rachis diameter for 42SA683, FS 13-2 and 42SA683, FS 14-4.

Figure 8 a.

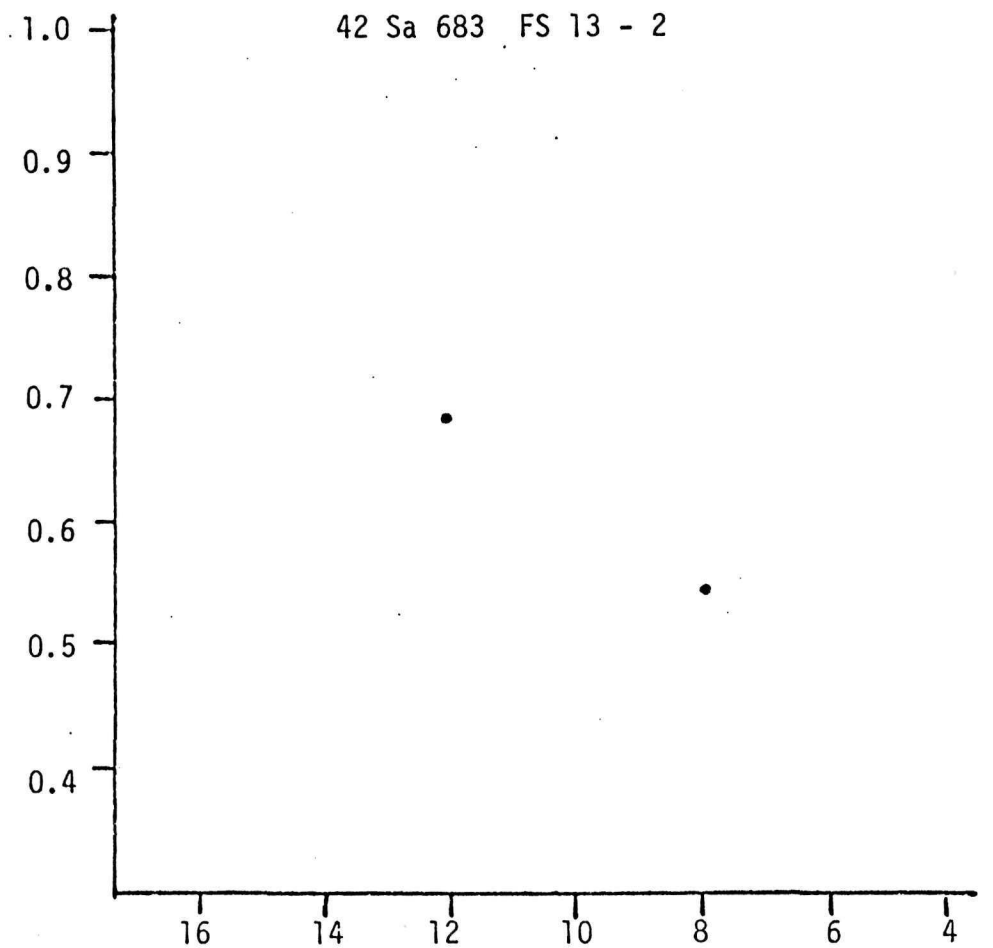


Figure 8 b.

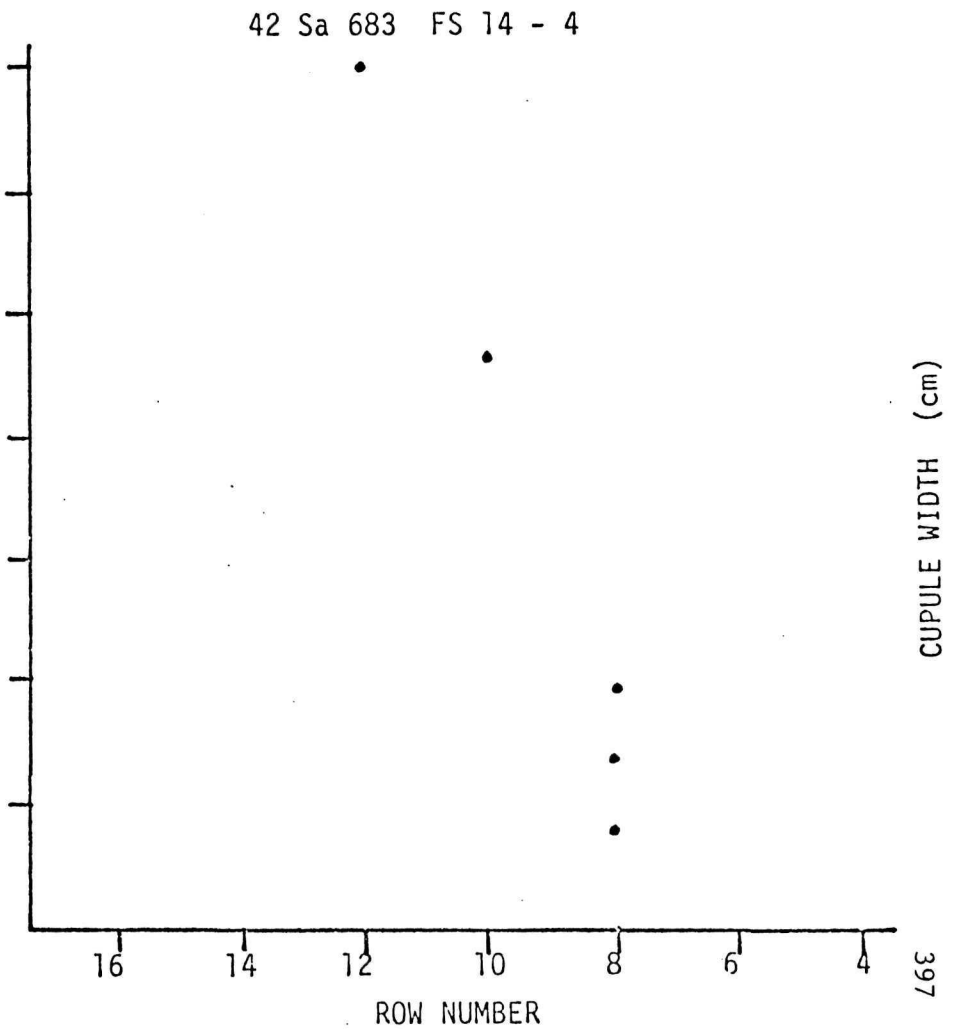


Figure 9. Graphs of Zea mays samples for row number, cup8le width, and rachis diameter for 42SA317, FS 1-1 and 42SA684, FS 2-5.

Figure 9 a.

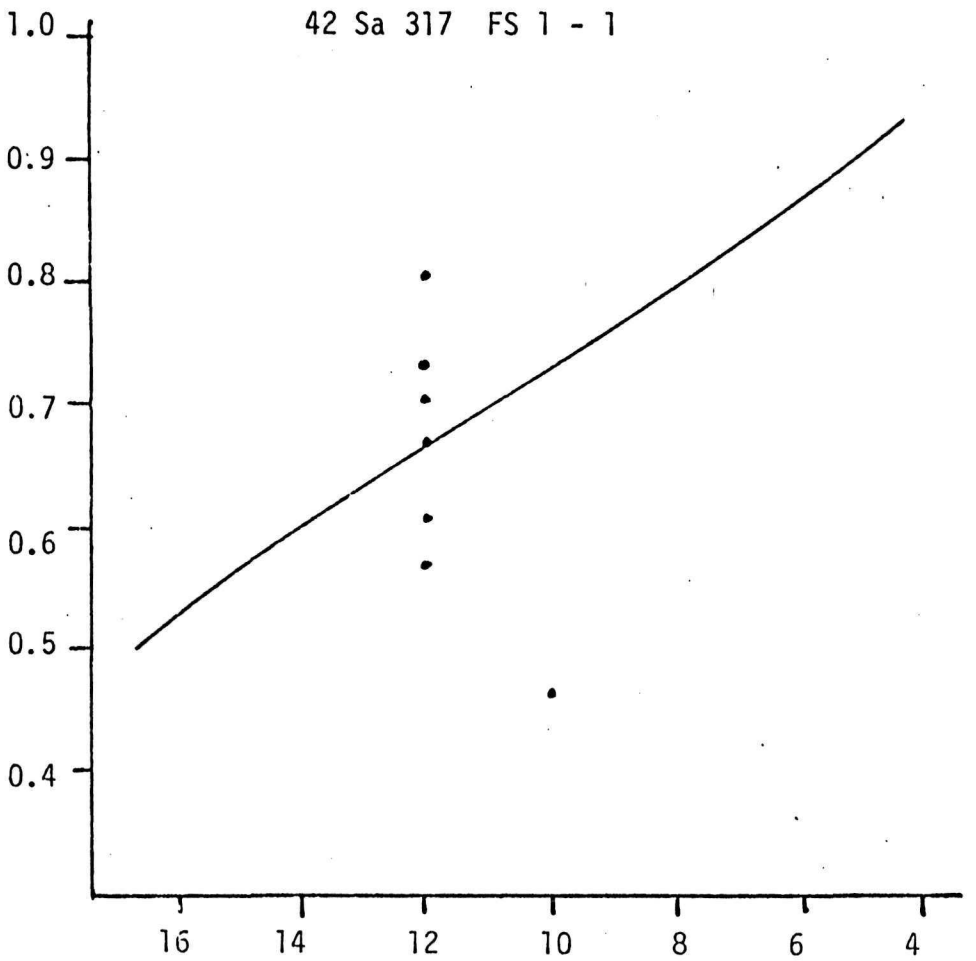
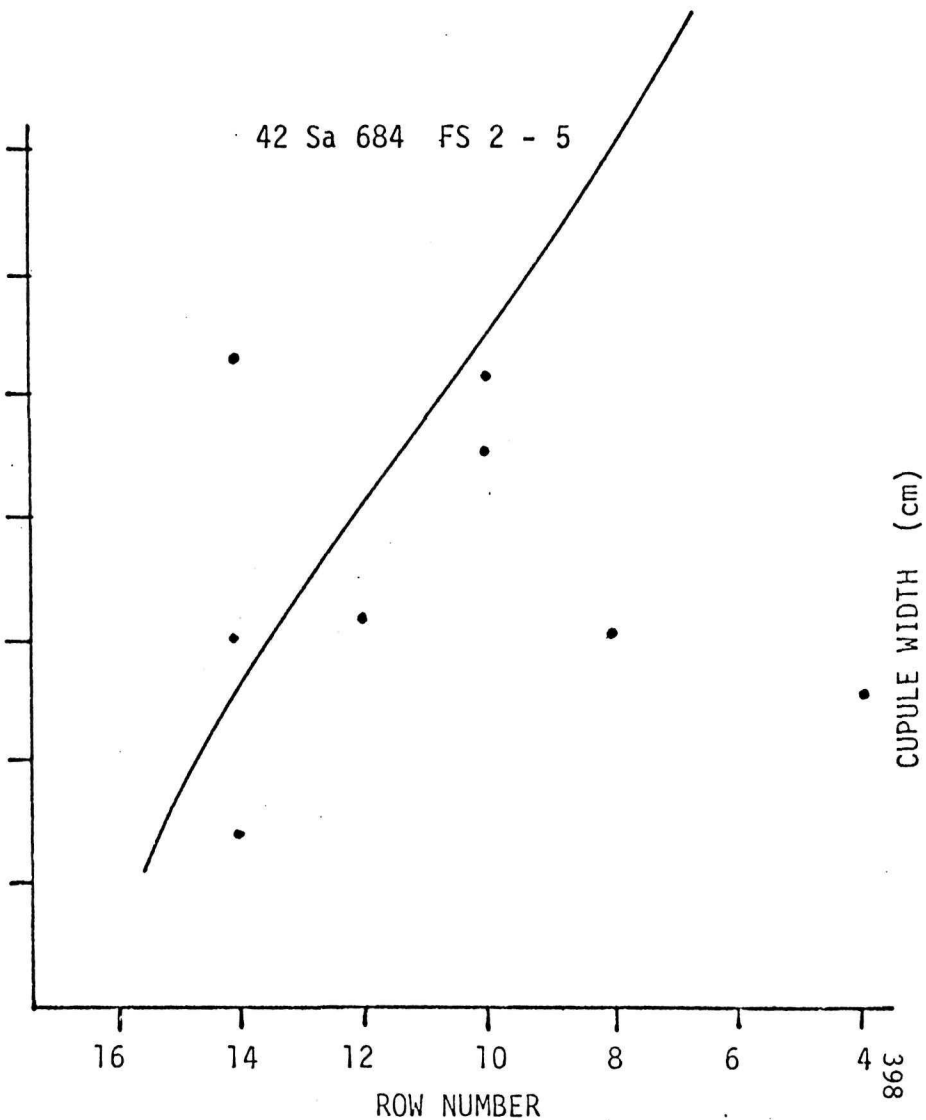


Figure 9 b.



Maiz do Ocho

Maiz de Ocho may be represented by the remainder of the maize in the collections based on row number, cupule width, and rachis diameter. The origin and diffusion of Maiz de Ocho from northwestern Mexico into the Southwest has received much attention (Galinat and Campbell 1967; Galinat and Gunnerson 1963; Galinat and Ruppe 1961: Galinat et al. 1970). This race becomes more important in the Southwest as the mesas became unsuitable for cultivation of indigenous races. Maiz de Ocho was commonly planted in the moist soils along the rivers (Galinat et al. 1970).

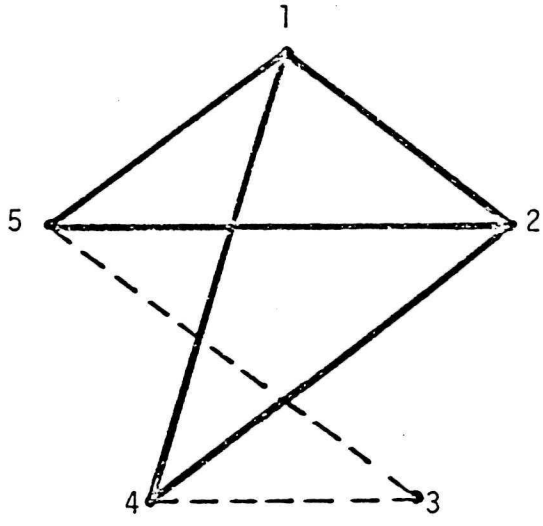
Discussion

Some unusual forms of cobs were recovered from the sites at Glen Canyon. These unusual cobs with deformations, spiralling rows, and reduced row numbers may represent samples from populations which were under physiological stress at the time of cultivation. Also, they may represent the normal range of variation within a given population. An examination of the average cupule width (Figure 1) and the rachis diameter (Figure 2) indicates that among the samples there is relatively little variation (less than 1 mm and less than 3 mm, respectively) in the mean values of these characters. The compaction of kernels as measured by cupules per 2 cm length of cob (Figure 3) is more variable and may reflect variation in the growing conditions.

Correlation coefficients based on sample size (Rohlf and Sokal 1969) were determined for the five characters examined in all the samples (Figures 10 - 12). In the overall collections for the 1977 excavation season, the following characters were positively correlated at a significant level: 1) cob diameter and rachis diameter; 2) cob diameter and number of rows of kernels; 3) rachis diameter and number of rows of kernels; 4) rachis diameter and average cupule width; and 5) cob diameter and average cupule width. The following characters were

Figure 10.

Correlation of five maize characters for the total samples from 1977 Glen Canyon excavations (42 Sa 317, 42 Sa 683, and 42 Sa 684).



Level of significance of correlation coefficients among five characrers:

1- cob diameter
2- rachis diameter
3- number of cupules per 2 cm length
4- average cupule width
5- number of rows of kernels

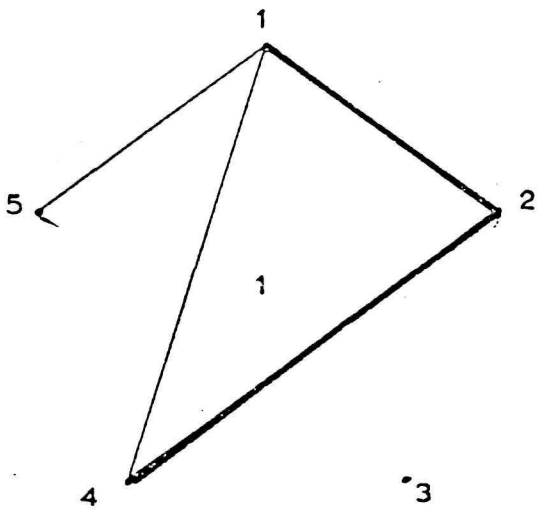
positive correlation (highly significant at 1% level)

positive correlation (significant at 5% level)

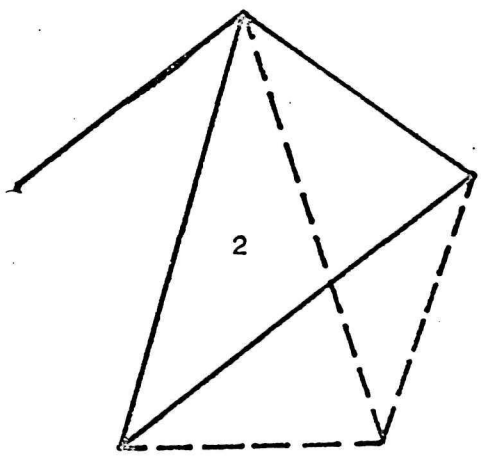
negative correlation (highly significant at 1% level)

negative correlation (significant at 5% level)

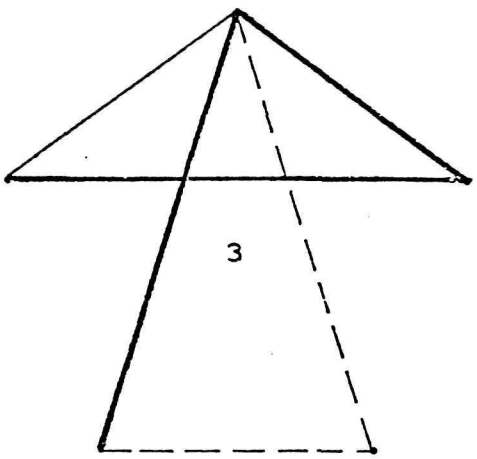
Figure 11. Correlation of five maize characters (samples 1, 2, 3, 4, & 6).



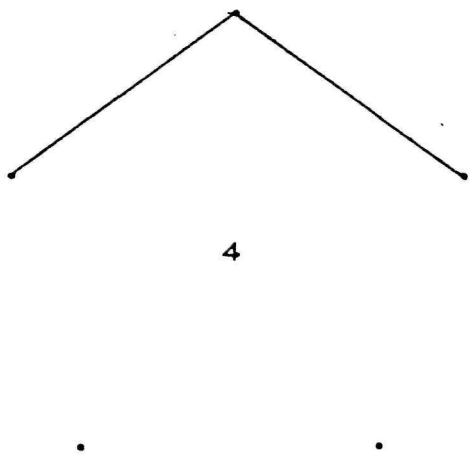
42Sa683 FS 1 - 4



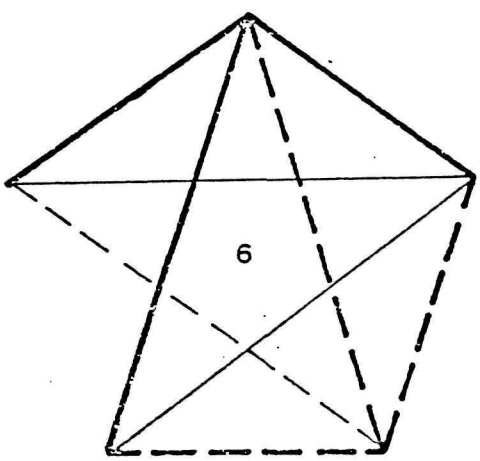
42Sa 683 FS 7 - 6



42Sa683 FS 3 -- 3

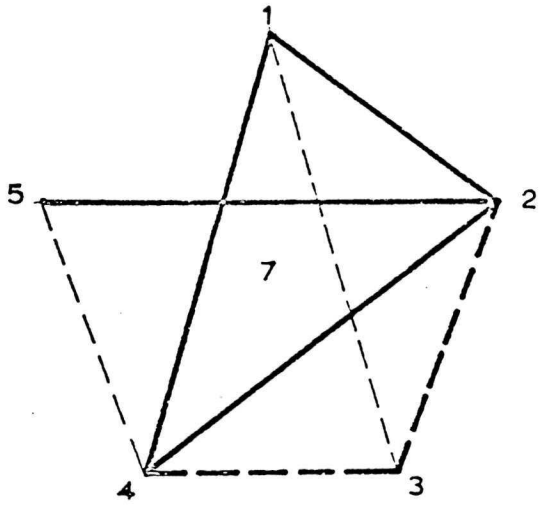


42Sa683 FS 2 - 5

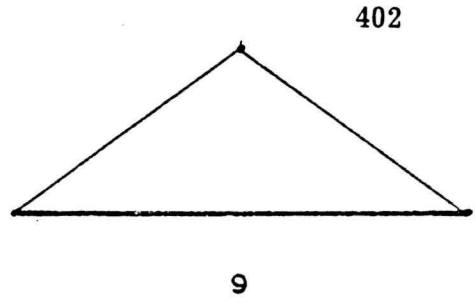


42Sa683 FS 12 - 11

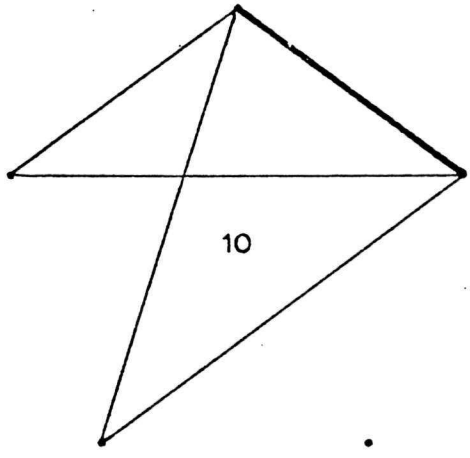
Figure 12. Correlation of five maize characters(samples 7, 9, 10, 11, & 12).



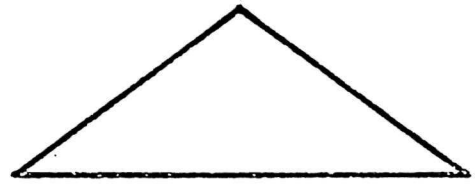
42Sa683 FS 8 - 10



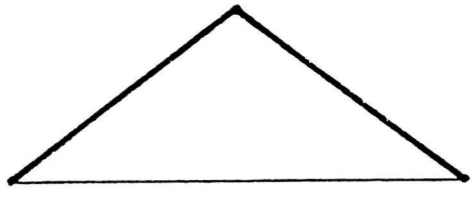
42Sa683 FS 6 - 13



42Sa683 FS 14 - 4



42Sa 684 FS 1 - 1



42Sa317 FS 1 - 1

negatively correlated at a significant level: 1) number of cupules per 2 cm length and number of rows of kernels; and 2) number of cupules per 2 cm length and average cupule width. Similar analysis was made for the samples in each feature (Figures 11 and 12). It is interesting to note that the greatest number of correlations of characters is found with the two rat midden collections and with the largest sample from a general fill. One could interpret that the samples with the largest number of correlations could represent material from a uniform population which was either collected and stored separately or from a population with little phenotypic variation. The samples with few correlations could represent samples from pure or mixed populations where genetic, environmental, and selection factors were variable. If selection factors account for maize ears with a number of correlated characters and less variability, then it must be determined if human or rodent agents were responsible (e.g., selection by man for special ears for particular purposes from one or many populations, or by rodents accumulating maize from a cache, or by rodents raiding a single corn field, etc.).

Also of particular interest is the presence of cobs with holes bored into the butts. Although no sticks were found inside the cobs, they do resemble the corn on the stick as illustrated from earlier Glen Canyon excavations (Cutler 1966). This type of maize artifact may represent corn prepared for storage. Another interpretation is that these cobs may be remnants of a corn preparation in which the ear, with the kernels in the milk stage, was roasted over a fire and eaten. This renders the corn more palatable and sweeter. This practice is still carried out by the Tarahumara Indians of northwestern Mexico (Bye unpubl. data).

Only one sample of a whole ear enclosed in the husks was recovered. This specimen is small and possibly immature at time of deposition. The kernels appear to be decayed beyond usefulness for analysis.

Phaseolus

The three beans represented in the collections from 42SA683 are all members of P. vulgaris, the kidney bean. This species has been recovered in other sites in the general area of Glen Canyon including Alkali Ridge (P-I through P-III) (Jones 1946) and Zion National Park (ZNP-21) (Jones 1955). The following describes the beans:

SAMPLE 42Sa683, FS-3-7: one seed: 9.3 mm x 7.2 mm x 5.2 mm. Dark blue with traces of brown in seed coat. The pattern is identical with Hopi Blue Dye, the Southwestern type C 29 (Kaplan 1956).

SAMPLE 42Sa683, FS-6-12: one seed: 8.4 mm x 7.0 mm x 5.4 mm. A small "bolito" type similar to the Southwestern type C 21 which has been reported from Turkey House, Casa Grande, Arizona (a Hohokam-Anasazi site) (Kaplan 1956, Mesa Verde (Kaplan 1965a) and Tehuacan Pueblo (Kaplan 1967).

SAMPLE 42Sa683, FS-14-5: one seed: 14.1 mm x 7.7 mm x 6.2 mm. Brown seed coat and dark eye ring. Similar to Southwestern type C 17 which has been collected previously among the Hopi and Zuni (Kaplan 1956).

The P. vulgaris, C 11, represents the most common bean utilized in the American Southwest from pre-pottery times to the contemporary period. There are no new insights into the ethnobotany of this bean type which can be drawn from this specimen.

Cucurbita

All of the cucurbita remains are referable to the genus Cucurbita based on rind characteristics, seeds, and peduncles (Table 4). Although it is not possible to determine the species of cucurbit based on rinds alone, it appears that two types were grown. Rinds of type 1 consist of two subepidermal inner layers. The

Table 4.

Description of bean remains from 1977 Glen Canyon excavations (42 Sa 683).

Provenience	sample size	determination	length	width	thickness	anterior end	posterior end	color
FS 3 - 7	1 (whole)	Phaseolus cf. acutifolius var. latifolius	9 mm	7.5 mm	5 mm	truncate	round	black, glossy
FS 6 - 12	1 (whole)	Phaseolus cf. acutifolius var. latifolius	8.5 mm	7.5 mm	5.5 mm	truncate	round	orange-brown
FS 14 - 5	1 (whole)	Phaseolus vulgaris	14.3 mm	7.5 mm	6 mm	slightly apiculate	round	faded violet-brown, with faint strip; eye dark brown

layer under the subepidermal layer is composed of parenchymatous cells that are rectangular in shape. The lower layer has isodiometric parenchymatous cells. Rinds of type 2 consist of only one subepidermal inner layer of isodiometric cells.

The one whole peduncle and the few whole seeds are characteristic of C. pepo. The outer rinds of the larger fragments appear to be slightly furrowed and striped green and white. For the most part, the cucurbit remains were uncharred.

Discussion

Only C. pepo can be positively identified in the sites from the 1977 Glen Canyon excavations. A green and white striped pumpkin type was probably grown for food. A second type may have been grown as seen from fragments of a second rind type. This species is the oldest of the cultivated cucurbits in the American Southwest and was established before the diffusion of C. mixta and C. moschata into the region (Whitaker and Cutler 1965; Whitaker and Bemis 1975).

Conclusions

Three major types of food plants were found from sites 42SA6317, 42SA683, and 42SA684 of the Glen Canyon region of Utah. The majority of the maize (Zea mays) belong to the Pima-Papago race while a smaller number can be assigned to the Maiz de Ocho complex. Cobs with smaller rachis diameters may represent some effects of teosinte introgression by way of hybridization with such cultivars as Reventador. However, it is more likely that the rachis character may be due to ranges of normal variation in the other cultivars and/or due to development under stressful environmental conditions. Beans were recovered. One cultivar, Phaseolus vulgaris, represents the common bean, type C 11, which has had a long history in the American Southwest from pre-pottery

times to the present. Two beans have been tentatively determined as tepary, P. acutifolius var. latifolius, and may represent the first archeological report of this bean from the Glen Canyon region. Further study is needed on these beans because they do not clearly represent any known modern or archeological types. The pumpkin squash is the third cultivated food plant found. Most of the remains suggest that this cucurbit is Cucurbita pepo, the oldest cultivated species known from the Southwest. Two types of cucurbit rinds were found.

The data and determinations of cultivated food plants from these sites in Glen Canyon suggest that the older, indigenous cultivated food plants were grown by the inhabitants of the area for the times sampled. The inhabitants relied primarily upon one type of maize, the Pima-Papago race which was common in the Southwest. There is evidence of diffusion of Maiz do Ocho into the area but no archeological evidence for northward diffusion of Cucurbita mixta or C. moschata. An old type of the common bean was also grown. If the identification can be confirmed, the tepary could be added to the bean diet of the inhabitants. The tepary is known from other Southwestern sites at around 1000 years before present. The oldest domesticated squash of the Southwest was cultivated for food.

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Addendum 1:

Statistical Data from Maize Measurements

by Barry C. Johnston

1. Materials and Methods

Twelve samples of archeological maize cobs, from twelve proveniences and totaling 247 cobs, were received for analysis. These cobs were numbered and to each was given a four-digit number; the first two digits represented the sample number (numbered as received), and the last two digits represented the cob number (numbered as drawn from the plastic bag, but generally whole cobs were drawn first). Each numbered cob was placed in its individual plastic bag, to facilitate investigation of errors and spot-checking of data.

For each of the cobs received, the following dimensions were measured:

1. Cob length in cm. The total length of the cob received was measured. In some cases, the cob had been subjected to some pressure, causing it to become curved in an arc, rather than straight. In such cases, the ruler was bent in a similar arc, to estimate the length of the cob when straight. Measured with a 15 cm pocket ruler to the nearest 0.1 cm.
2. Number of rows. Limits of variation within each cob, if the number of rows is not uniform. Two hand-counts made per cob.
3. Maximum cob diameter in cm. The widest point in each cob was chosen by sight, and measurement made of the maximum and minimum diameters at that point. This was done because many of the cobs were elliptical in cross-section, having been subjected to pressure and flattened to a greater or lesser degree. It was measured with a vernier caliper with a direct-reading dial, to the nearest 0.01 cm.

4. Rachis diameter, in cm. If the cob was long enough and not decomposed, it was broken at the point of greatest diameter, and the rachis diameter was measured; the least and greatest measurements were recorded. In many cases, the rachis had also become elliptical, for the same reasons as mentioned in (3.) above. It was measured with a vernier caliper with direct-reading dial, to the nearest 0.001 cm.

5. Cupule width in cm. Five different cupules were chosen and their widths measured at the highest point of lignification. If the cob was fragmentary, or in cases where the cob had only 8 rows (hence 4 cupules), fewer than five cupule measurements were made. It was measured with a vernier caliper with a direct-reading dial, to the nearest 0.001 cm.

6. Number of cupules per 2 cm length. This variable was measured at two different locations as near the point of greatest diameter as possible, and those two measurements were averaged by hand before recording. It was measured using a 15 cm pocket ruler and recorded to the nearest 0.05 units.

In addition to the above numerical measurements, the following unordered characters were recorded for each cob:

7. Wholeness. It was recorded as "+" or "-", subjectively, but usually depending on whether a taper was distinguished at both ends of the cob.

8. Variation in number of rows.

Character	Value
A	Uniform row no.
B	Row no. reduced upward
T	Gaps between pairs of rows, uniform row no.
t	Gaps between pairs of rows, row no. reduced upward
K	Row no. jumbled and confused
s	Rows spiralled

9. Position of maximum diameter.

Character	Value
a	Largest abt. 1/3 of way from base
b	Largest at base
c	Largest abt. 1/2 of way from base

10. Condition of cob.

Character	Value
Δ	Decomposed (Crumbling, or whole rachis missing)
D	Damaged (impacted by a hard object or tool
*	Hole bored in rachis at base (to make an ear-on-a-stick)

11. Cob type. This was classified within each sample, informally on the basis of cob-characters seen that were not measured, for example, symmetry/asymmetry of cupules, height of lignification around cupules, length of glumes, etc.

Some of the data was not recorded and was left blank (converted to 0.00 in the later computer program, discussed below). The reasons for the zero values in the characters are listed below, using the character numbers indicated above.

1. Cob length in cm. Cob length was always recorded.
2. Number of rows. The cob diameter was longitudinally fragmented, so that the diameter was never fully present.

3. Maximum cob diameter in cm. The whole diameter was never fully present.
4. Rachis diameter in cm. The whole diameter was never fully present, or else the rachis was badly decomposed.
5. Cupule width in cm. Some or all of the cupules had decomposed and fallen off the rachis.
6. Number of cupules per 2 cm length. Decomposition had made the individual cupules indistinguishable, or they had fallen off.

Characters 7 through 11, the non-numerical characters, were not used for the computer program and the statistical calculations to follow.

2. Description of Program ZEA1.

The data for the numerical characters, and the cob number, were punched into computer-cards for input to Program ZEA1 (copy of the Program is on file, Midwest Archeological Center, Lincoln, Nebraska). One card was made for each cob.

After initialization of the summed variables, ZEA1 reads one data card. If this card is found to be the beginning of a new sample (i.e., the first two digits of the cob number are incremented), ZEA1 sets the data from this card aside, and calculates statistics for the sample just completed. If this card is not the beginning of a new sample, ZEA1 puts the data into final form for printing and calculating sample statistics. The characters for which two or more measurements have been made (cob diameter, rachis diameter, cupule width) are averaged within each cob, and the average value of each is stored. If no data have been recorded for a character, the program stores 0.00 for that character.

Then, for each cob, ZEA1 determines whether the value of each character is zero. If it is zero, nothing is done; if it is not zero, the counters for number, sum-of-values, and sum-of-squares are all incremented.

The reading continues, as mentioned above, until a new sample is encountered, and then ZEA1 calculates the mean, standard deviation, coefficient of variation, and confidence interval in coefficient of variation, for each character within the sample. The calculations are made using the number of non-zero values for each character, rather than the number of cobs in the sample. The calculation of confidence intervals uses Function T5, the critical values of the t-distribution for $\alpha = 0.05$. These calculations are listed in part 2 of the printed output, called "sample statistics".

ZEA1 then calculates the correlation coefficients of each of the five measured characters with respect to each of the others. This is done using Subroutine LINFIT, a linear-regression least-squares routine. This subroutine has been altered so that the only data-pairs compared are those for which both values are non-zero. The number of degrees of freedom of each correlation coefficient, this is the minimum of the two sample sizes listed in part 2 of the output for the two characters being compared.

This process continues until all samples have been read and the statistics for them calculated, then ZEA1 lists all the data from which statistics were calculated, for the total of all samples, then calculates mean, standard deviation, and correlation coefficients for each character in the total of all samples.