HOVENWEEP 1977

edited by Julia E. Hammett and Nancy H. Olsen

ARCHEOLOGICAL REPORT NO. 4

Office of Sponsored Programs, San Jose State University, San Jose CA

Cover: Hackberry House, Hov 64

HOVENWEEP 1977

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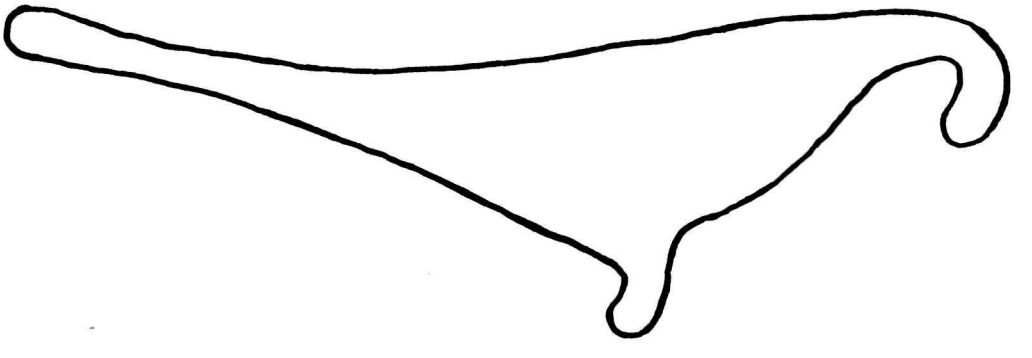
August, 1984

ARCHEOLOGICAL REPORT No. 4



Office of Sponsored Programs, San Jose State University, San Jose, CA

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The field crew included Herb Dallas, Loren Haas, Julia Hammett, Anita Hornback (lab director),Terry Jones, Nancy Olsen, Chris Pierce, Dottie Reaves, Mark Vallier, and Anne Woosley (faculty advisor). Support staff included Gayl Del Pero (statistician), Ranada Laughlin (cook), and Michael Pendleton (mechanic).

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The Hovenweep students would like to express their particular gratitude to Joseph C. Winter who dynamically led many of us into the field of archeology. We Hovenwoopers dedicate this report to you.

N.H.O.
Sunnyvale
August 1984

J.E.H.
Chapel Hill
July 1984

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INTRODUCTION

The fieldwork at Hovenweep in 1977 resulted from research carried out during the preceding three years by Joseph C. Winter and his students. Winter was interested in the development and nature of prehistoric agriculture in the Hovenweep area. His work was facilitated by cooperation between the National Park Service and San Jose State University, and grants from the National Science Foundation.

In the fall of 1976 Winter announced that he would be leaving San Jose State University. Several of his students wanted to continue work at Hovenweep. Their wishes were realized through the N.S.F. Student Originated Studies grant program. In the summer of 1977 these students along with a few new students and a faculty advisor conducted fieldwork at Hovenweep under the auspices of the already existing "Memorandum of Agreement" between the National Park Service and San Jose State University, and the N.S.F. S.O.S. grant program.

Unfortunately the students accomplished only a fraction of what they intended. Despite their best efforts, as the weeks progressed, morale and consequently the quality of their work deteriorated. By autumn there were serious differences of opinion between the students and the faculty advisor concerning the completion of the 1977 report and the future of the project as a whole. A preliminary report was put together by the faculty advisor using some of the student reports. By spring of 1978 the participants had gone their separate ways, trying to put the Hovenweep Project behind them and no final report was written.

Early in the summer of 1978 the Department of Anthropology at San Jose State University discovered that all the archeological field and lab records from 1977, numerous maps and all photographic materials from all four field seasons were missing from the archeology laboratory. The crew chief notes from two sites (Hov 520 and Hov 597) were not included in the files at San Jose State University and subsequently were located and are on file at the Mesa Verde Research Center. Unless the remaining records and data are recovered a complete technical archeological report for the 1977 season cannot be written.

In the spring of 1983 Drs. Wanna Pitts, Acting Dean of Graduate Studies and Research at San Jose State University and Richard Ellefsen, her Associate Dean, began an investigation of the unfinished project. Since 1978 representatives from Mesa Verde National Park had repeatedly urged San Jose State University to honor their Memorandum of Agreement by turning over a final report for 1977 fieldwork as well as maps and other research documents pertaining to the overall project. Their request was finally acknowledged. The deans began contacting former Hovenweep participants in order to complete the project and fulfill the agreement.

This report is intended to satisfy the request by the National Park Service for a final report about the 1977 fieldwork at Hovenweep. Section I, the archeological portion of this report is a very abbreviated version of the

archeological section in the preliminary report (Woosley, 1978) omitting most interpretations. Where possible we have elaborated on the technical descriptions of archeological phenomena, calling upon the rather scant recollections of the students. Our documentation is for the most part limited to photographs converted from color slides borrowed from the students' personal collections.

Section II of the report is made up of the students' individual project reports. Several of the student projects have produced noteworthy original work. Unfortunately, a few of the students were unable to complete their projects, particularly those pertaining to chemical analyses of soils, pollen or lithics and reports on these projects were never written.

This is, to the best of our collective knowledge, all that can be retrieved from that ill-fated season. We hope the knowledge gained will have been worth the effort.

SECTION I: THE 1977 ARCHEOLOGICAL EXCAVATIONS AT HOVENWEEP

Background

Eleven sites were tested by San Jose State University in 1977 (Fig.1). The students made a concerted effort to replicate excavation and sampling techniques that had been established during the previous field season by Joseph C. Winter. With 1977 field and lab records missing and several analyses unfinished, this section of the report must be limited to recollected field observations and incomplete excavation data. The following site descriptions were generated from information in the preliminary report (Woosley, 1978) and recollections of the following participants: Herb Dallas (Hov 47,57,70 and 537); Loren Haas and Dorothy Reaves-Haas (Hov 47,520,597, and 513); Julia Hammett (Hov 11, 47, 57, 64, 70, 437 and 597); Terry Jones (Hov 12, 64, 70 and 714); Nancy Olsen (Hov 70, 437 and 513); and Chris Pierce (Hov 47, 64 and 513).

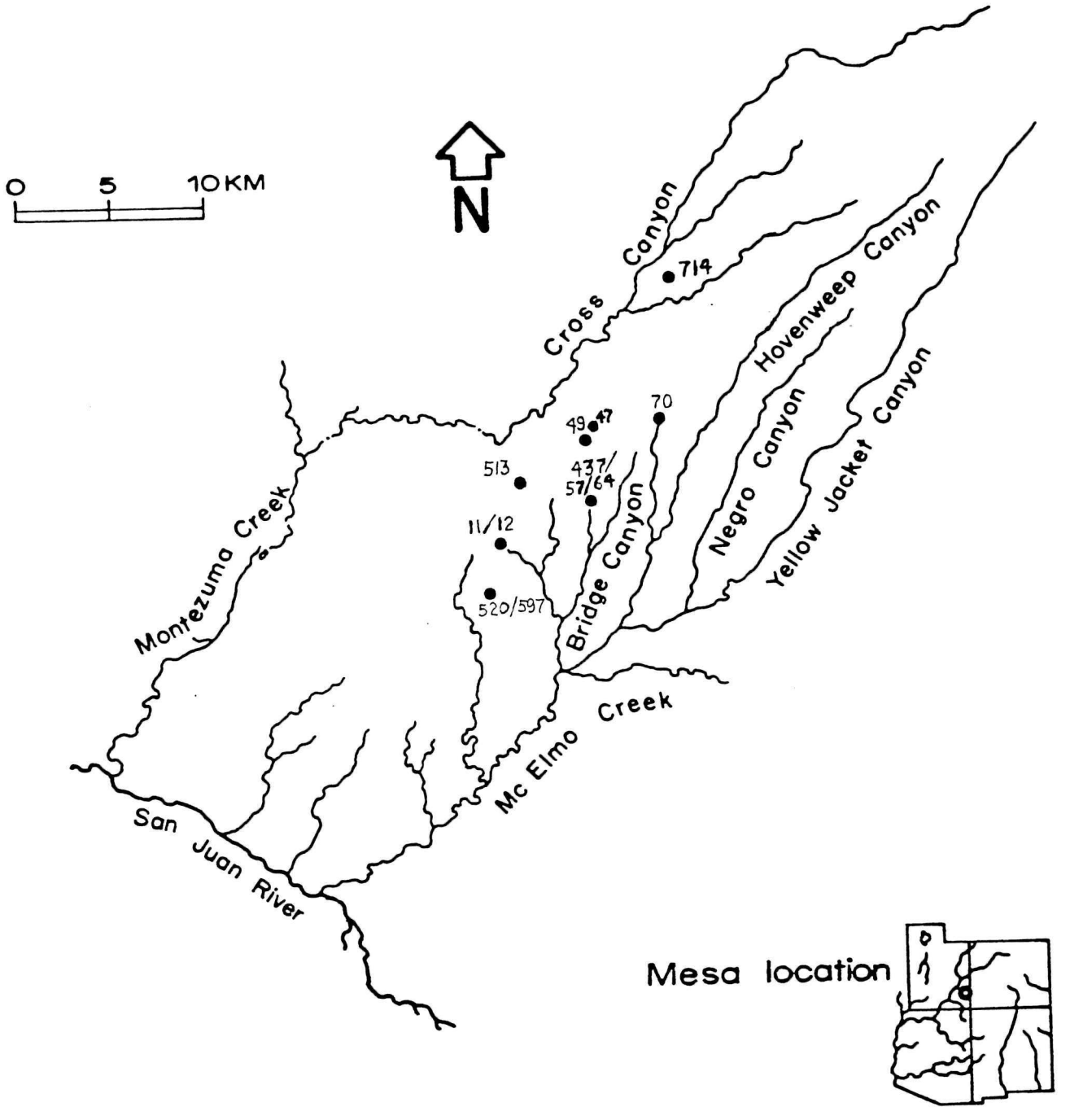


FIGURE 1: Location of 1977 Test Excavations

(after Winter, 1977)

Hovenweep 11 - 42SA1911

Unit House was first described by J.W. Fewkes (1919). It is one of several sites in the Hovenweep area suggested to be related to the winter and summer solstices (Ray Williamson, personal communication, 1977). At sunrise during summer solstice the sun shines through a porthole in the easternmost wall of Hov 11 and strikes the room corner that is diagonally opposite the porthole. This room corner was tested with a 1m x 2m unit (Fig. 2) in 1977.

Very little material was recovered from the room once wall fall was cleared away. Corrugated and Pueblo II/Pueblo III Black-on-White sherds were collected. Some rodent activity was observed in the form of a burrow filled with juniper berries.

A possible fire hearth in the southwest corner of the room was the only distinguishable feature uncovered. The feature consisted a small lense of ash and an unidentified charred material.

Hovenweep 12 - 42SA1955

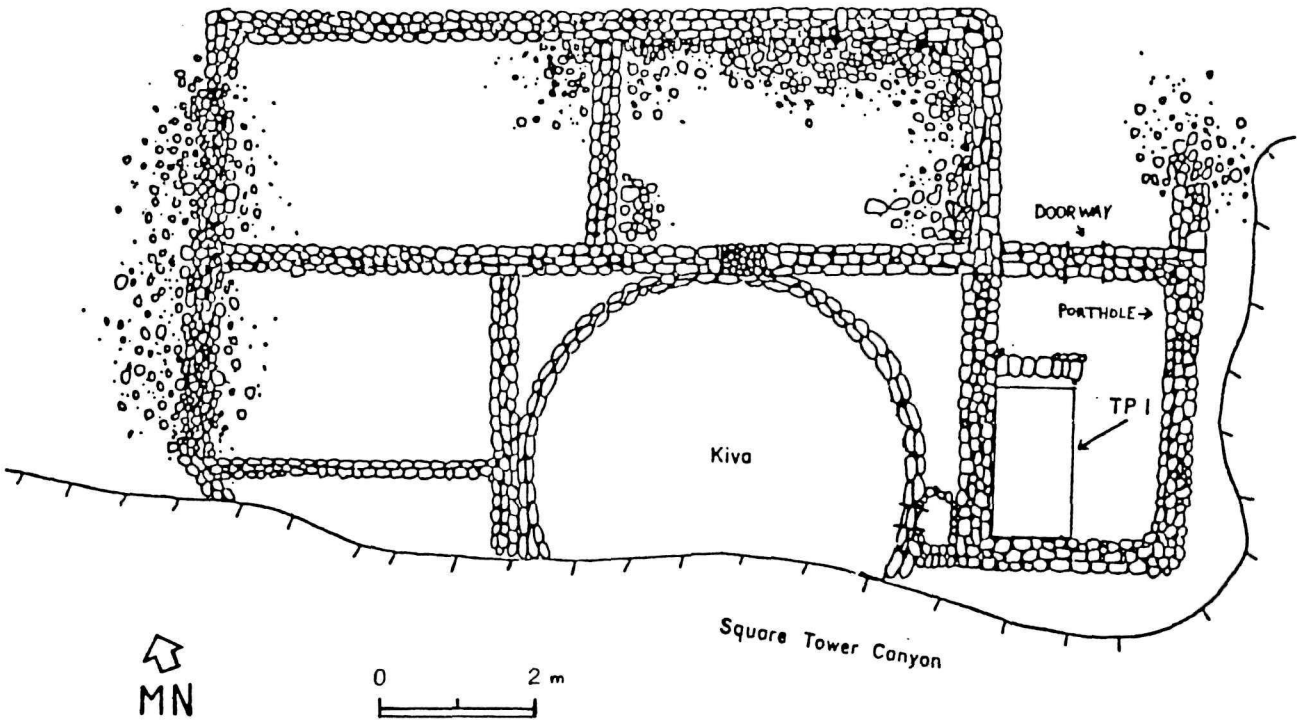
Twin Towers was previously tested in 1976 (Winter, 1977). In 1977 on 1m X 2m test unit was placed immediately outside the larger of the two towers (Fig. 3). Testing revealed a substantial amount of pecked stone blocks from the surface to approximately 100cm below surface where the first ceramic material was recovered. An ash deposit beginning at 110cm below datum produced burned corrugated sherds, bird bone fragments, lithics and corn cob fragments. A white calcified material similar to samples recovered from Hov 520 was also recovered. A good carbon-14 sample was collected from this ashy layer, but it has not been submitted for dating.

Hovenweep 47 - 5Mt116

Hov 47 is a mesa top site consisting of roomblock, kiva, tower and midden. Previous testing (Winter, 1977) unearthed carbonized maize and the pollen of cultigens and wild plants (Weir, 1977). Additional testing during the 1977 season (Fig. 4) was undertaken primarily to collect additional materials for the corn cob morphology study (see Reaves-Haas report in Section II). Two 1m x 2m units (T.P. 1-2 and 3-4) and two 1m x 1m units (T.P. 7 and 8) were put in the roomblock. T.P. 1-2 and 3-4 were established against visible stone walls and were excavated to an approximate depth of 90cm. Some plainware, corrugated sherds and a mano fragment were recovered from T.P.1. T.P. 2 contained a possible food processing area consisting of several large slabs surrounding an empty clay-lined space. A clay deposit was noted around and above the slabs. A similar deposit was observed on the grinding bins at Cutthroat Castle (Hov 70). The test pit exposed intersecting walls; only a few sherds and lithics were foud in this unit.

T.P. 5-6 located in the midden revealed a fairly shallow cultural deposit not exceeding 40cm. Sherds and lithics, including projectile points were collected. Unfortunately maize remains were not collected in appreciable amounts.

T.P. 8 produced a rich deposit of plant remains. Carbonized maize kernals were common both in room fill and in wall crevices. Grain impressions in mortar were also frequent. A few cobs and cob fragments were found. Fine mesh screens were used to recover small carbonized seeds and plant fragments from ashy deposits; maize, squash and bean seeds were recovered.



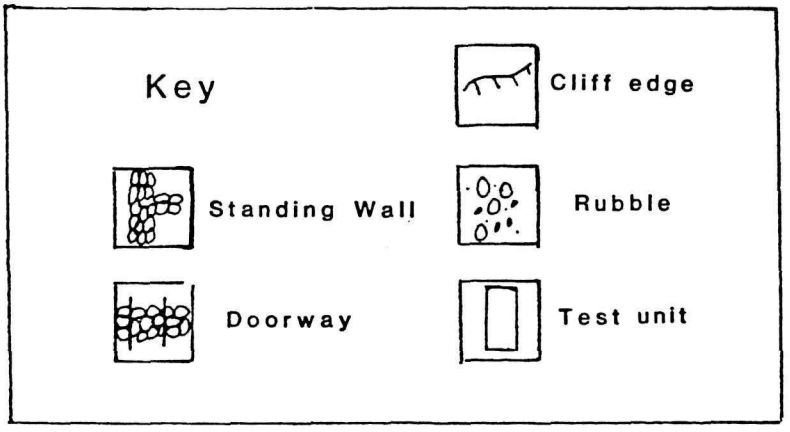


FIGURE 2

HOV-11

Unit House

(after Fewkes, 1919)

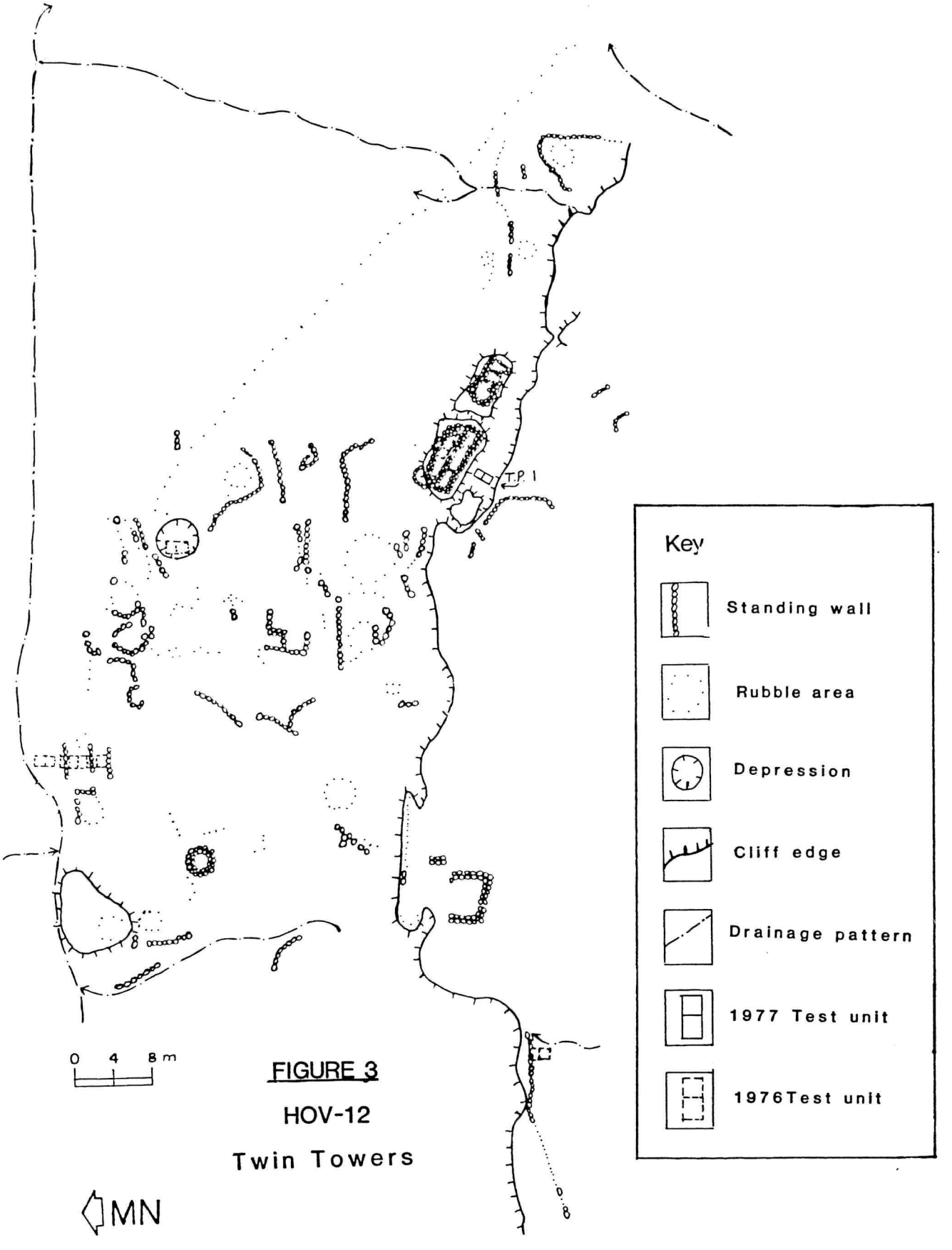


FIGURE 3

HOV-12

Twin Towers

(after Winter, 1977)

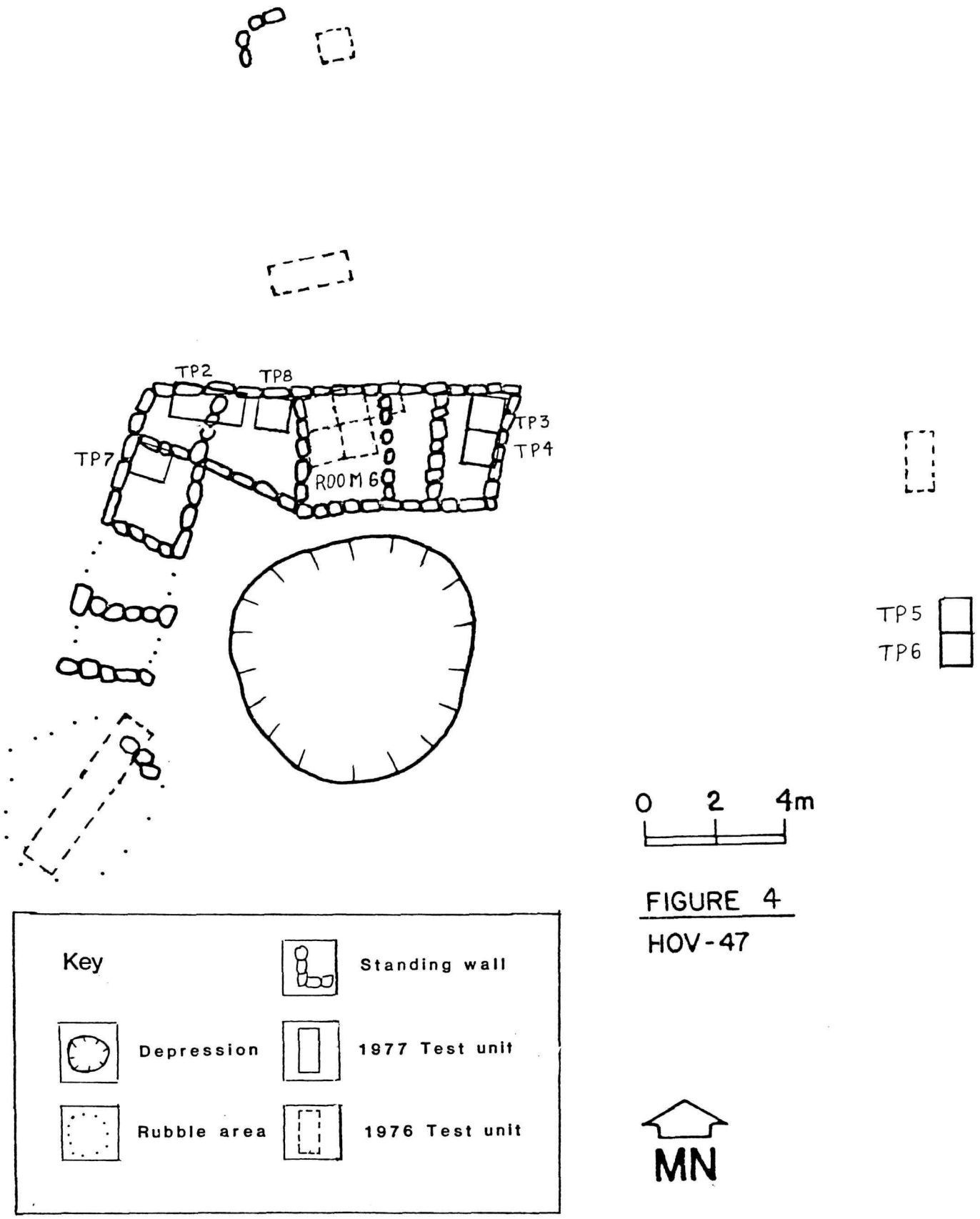


FIGURE 4

HOV-47

(after Winter, 1977)

Another interesting discovery in this test pit consisted of rounded upright stone slabs covered on the interior with clay (Fig.5). These were first thought to represent a grinding bin but were later interpreted as a possible roasting bin/oven. This slab structure contained fine ash and charcoal from which carbonized seeds, burned pottery, rodent and bird bone fragments, and egg shell were recovered. Adjacent to the slab feature, a hard packed clay surface partially covering horizontal stone slabs was uncovered. A smaller hole inside the slab feature appeared to be the remains of a post mold from a later structure. Charcoal from the roasting area has spilled into this hole, but wood remains from the post were still visible.

Hovenweep 57 - 5Mt602

Horseshoe House is located near the head of Hackberry Canyon above the seep and shelter in the pinyon-juniper woodland zone. Subsurface testing in 1977 was directed at the tower (Horseshoe House), water control structures situated on the canyon rim and the kiva in the shelter below (Fig. 6).

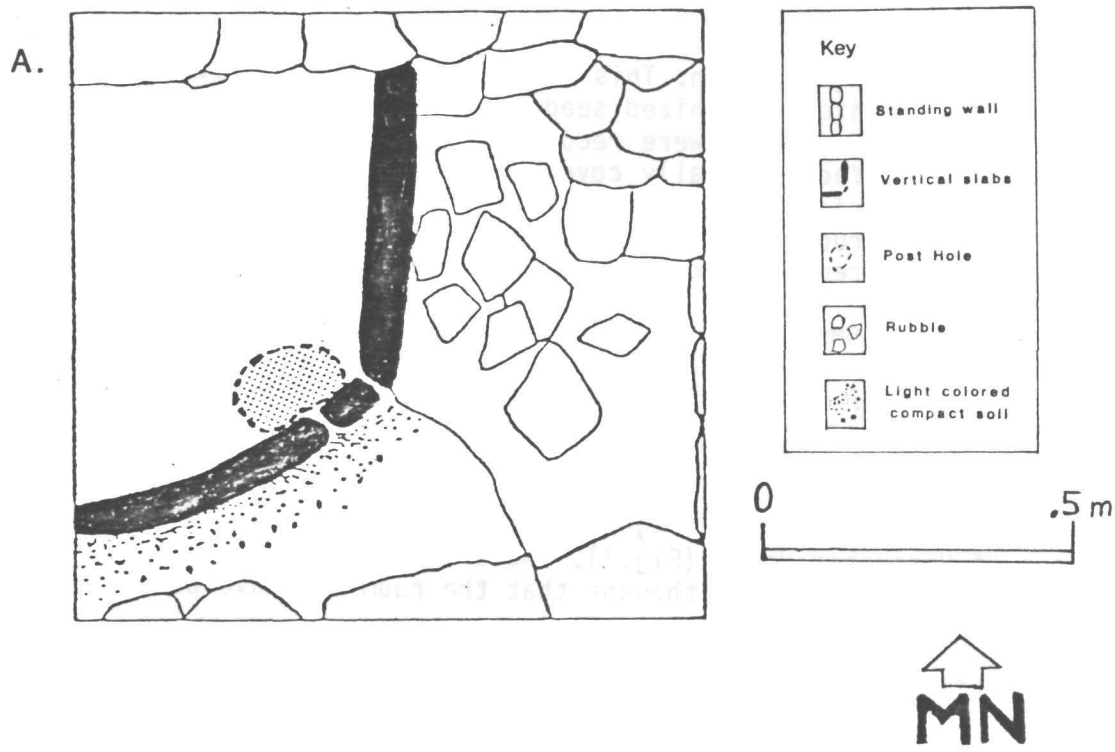
A 1m x 2m unit (T.P.3-4) was put in the middle room in the outer ring of rooms of Horseshoe House (Fig.7). No artifacts were encountered in the room, only rock rubble. It is thought that the room may have been previously excavated.

A rim dam or retaining wall extending westward from Horshshoe House for 17 meters was tested with a 1m x 2m unit. Testing of this wall was interrupted by a sudden rainstorm. The resulting water runoff demonstrated how rapidly silting processes could occur. Thirty centimeters of silt had been removed from the test unit before the storm. After the storm the test pit was completely refilled with silt (Fig.8). Below Horseshoe House is the canyonhead seep around which hand impressions and other rock art are visible (see Olsen report, Section II). A small kiva on the eastern side of the shelter was tested there. Interior structural features of the kiva included a bench running around the perimeter of the kiva, a deep hearth cut in the bedrock, and a vertical sandstone slab, presumably a deflector located next to the hearth. No sipapu was encountered. The hearth was 90cm deep and contained a fine white ash. No charcoal was mixed with the ash, indicating that all organic materials were oxidized by a hot fire. The floor was not plastered but traces of plaster were found on the overhang above the kiva. The interior overhang of the canyon rim may have served as a ceiling for the kiva. Above the kiva, negative handprints made with white mineral paint can be seen, imprinted on the seep ceiling (Olsen, 1980: Fig. 26).

Hovenweep 64 - 5Mt601

The Hackberry House complex (Hov 64), like Horseshoe House, is organized around a seep and shelter at the head of Hackberry Canyon. Hackberry House was previously excavated in 1976 (Winter, 1977). Three areas were tested during the 1977 season (Fig.9): a wall section under the shelter, a tower on the edge of the overhang and a rim dam just north of the tower (Fig.10a) which was previously described by Rohn (1972).

A.



B.

FIGURE 5 HOV-47, Test unit 8. Slab feature in Room 6.

FIGURE 6

HOV-57

Horseshoe House

(after Winter, 1975)

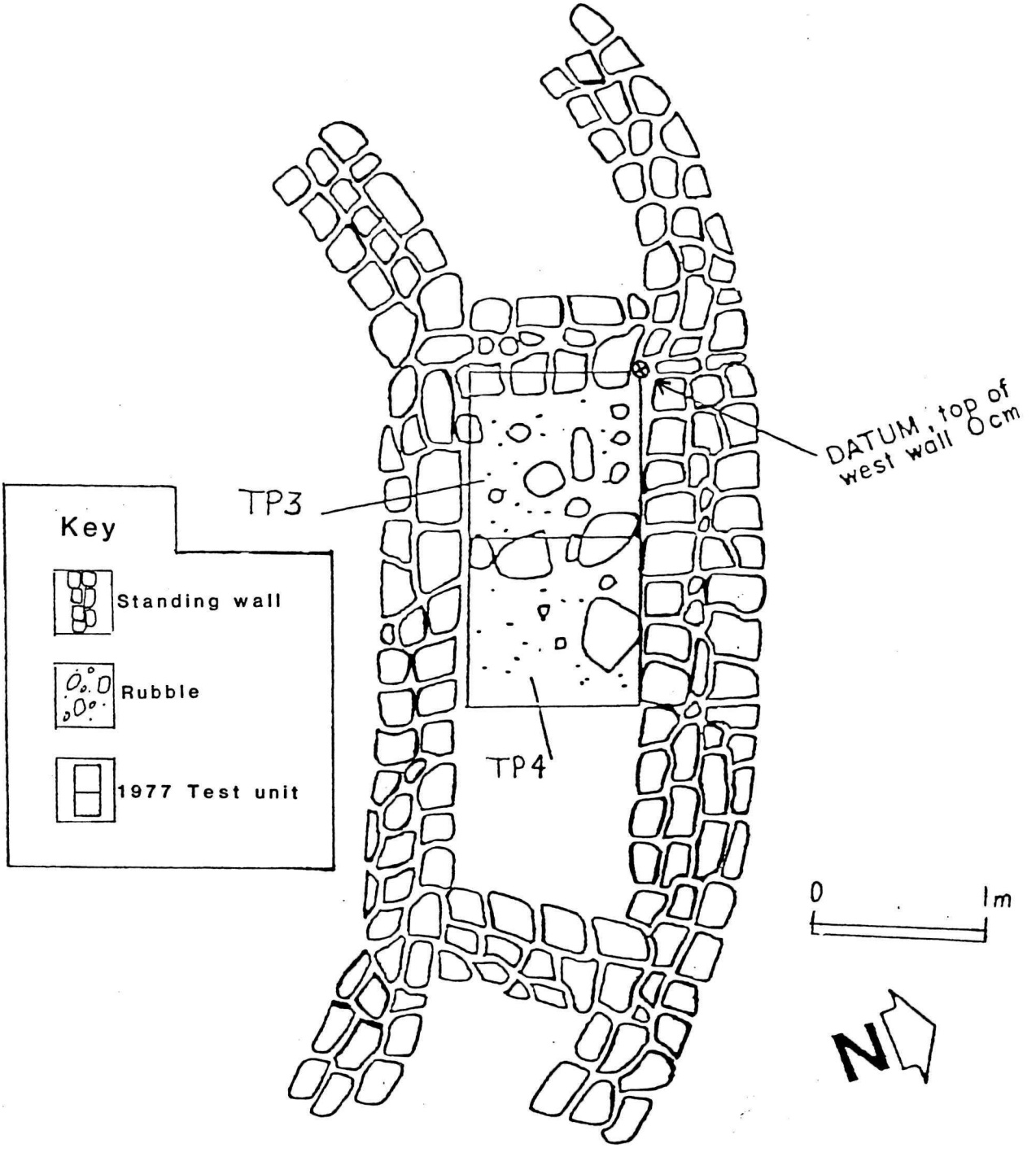


FIGURE 7 Test Unit Inside Room of Horseshoe House, HOV-57

Figure 8: Retaining Wall Next To Horseshoe House, Hov 57.

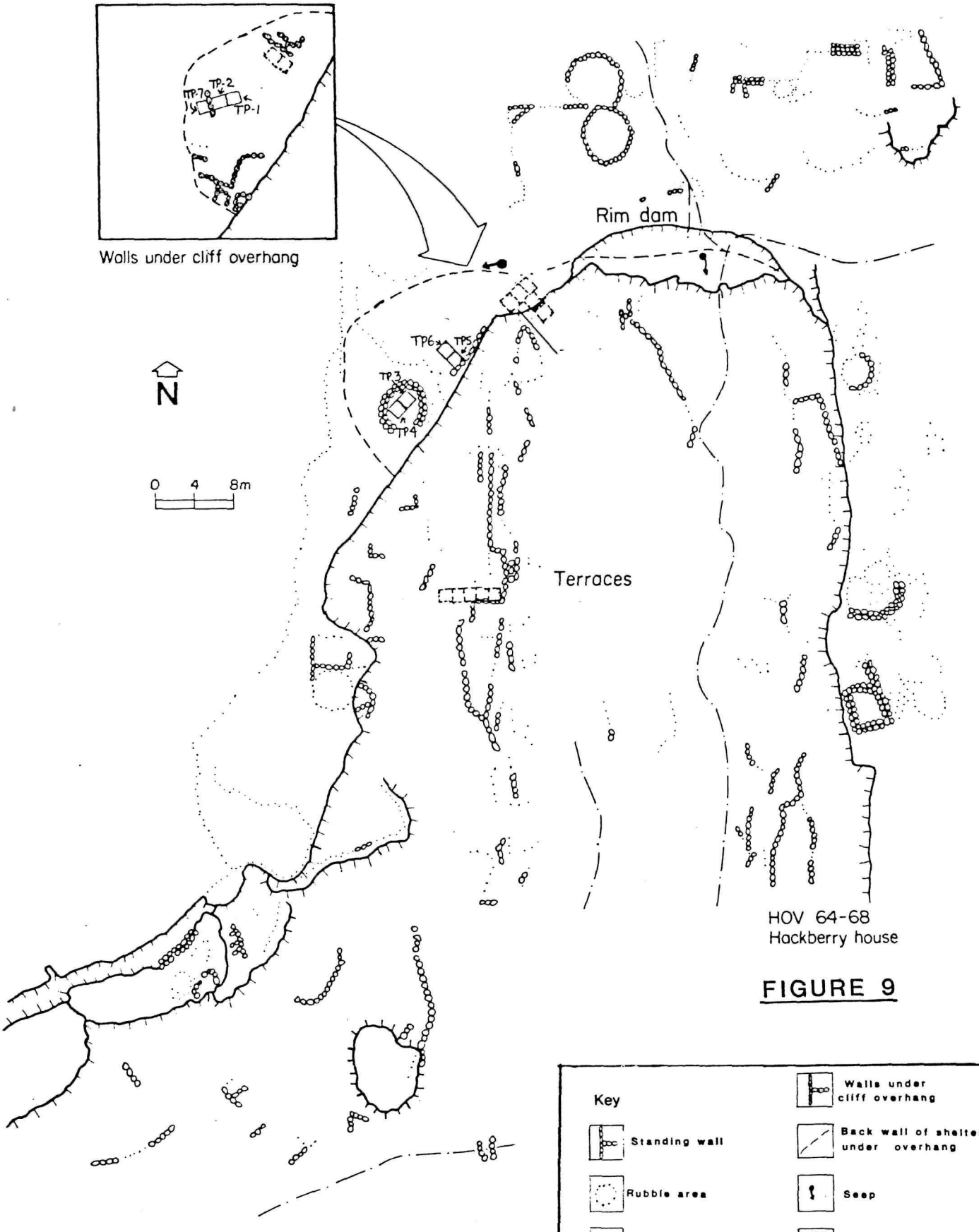


FIGURE 9

(after Winter, 1977)

Figure 10a Rim Dam and Tower Tested at Hov 64 (facing southwest).

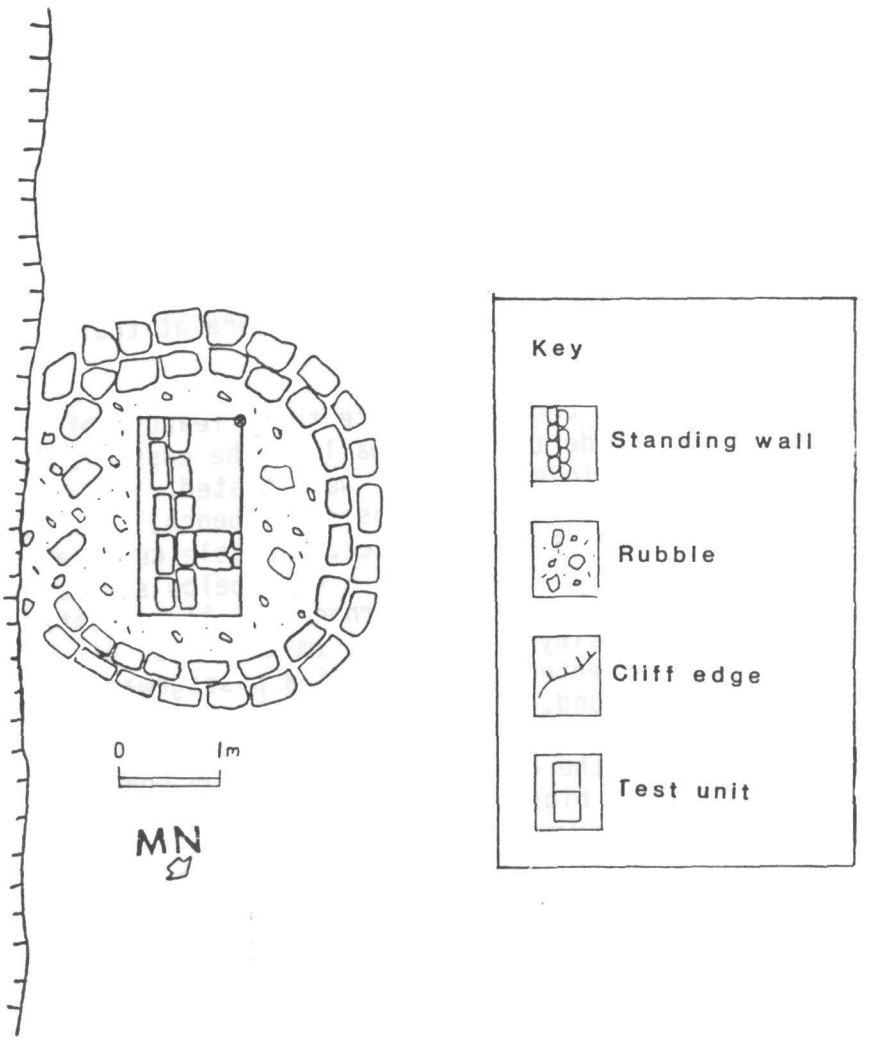


Figure 10b Plan view of tower tested at Hov 64.

Many perishable items were recovered from the 1m x 3m pit (T.p. 1-2-7) under the shelter. Among the materials were two separate pairs of mended pottery sherds. One pair had been perforated and mended with a twined cord made from material which was thought to be cotton. The other pair had been repaired with a sinew or leather strap. Seeds and corncobs, as well as historical artifacts such as early twentieth century newspapers, and old paper bottle labels were recovered from the shelter deposit.

A tower built on bedrock above the shelter was tested with a 1m x 2 m unit (T.P.3-4). While much of the tower masonry had collapsed into the canyon below, the subsurface deposit was relatively intact. Excavation revealed an east/west wall bisecting a north-south wall at a right angle (Fig.10b). The presence of this T-shaped feature indicated that the tower was divided into at least three rooms. Excavations were carried out to a depth of approximately two meters below surface datum. Bedrock was not reached at that depth but the test unit was not continued. Cultural materials found in the lower meter of the excavated deposit included a stone axe, projectile points, other lithics, bone, and Pueblo II/III black-on-white sherds.

Hovenweep 70 5Mt603

Cutthroat Castle (Fig. 11) is situated in the pinyon-sage zone at the head of a tributary to Hovenweep Canyon. The site complx is composed of towers, kivas, roomblocks, granaries and an extensive water control system. Hov 70 was not previously tested by San Jose State personnel, however on the basis of the surface features, Winter (1975) felt that the major building took place during Pueblo III time, with some indication of earler occupation. The 1977 testing focused on the tower area in the western portion of the site and a roomblock and a possible water control feature at the eastern end of the site complex (Fig.12).

The "Castle" is the central architectural feature of the complex (Fig.11). An area outside the north wall of the castle's square tower and the kiva depression within the castle were tested. The southeast corner of the kiva's 1m x 2m unit (Fig. 13) exposed the bench, four pilasters and hearth with an upright deflector stone in place. Little cultural material was encountered; tar paper and nails found a 40cm below surface signaled earlier disturbance. It was subsequently learned that Al Lancaster had exposed the entire kiva earlier (Woosley, 1978). The 1m x 2m test pit outside the square tower (Fig. 14) was excavated in search of a passageway from the tower to the outside, but none was found.

A roomblock across the drainage and east from the Castle was tested (Fig. 15). Upright slab bins were uncovered approximately 90cm below datum. The corners of these bins were sealed with mortar from the inside and a deposit of clay lined their floors. The bins are believed to have been part of a grinding activity area (cf. Mughouse, Spruce Tree House). Excavation below the bins revealed a much coarser style of wall construction, which may signify an earlier period of occupation, predating the walls and associated bins.

Figure 11: Cutthroat Castle Ruin, Hov 70.

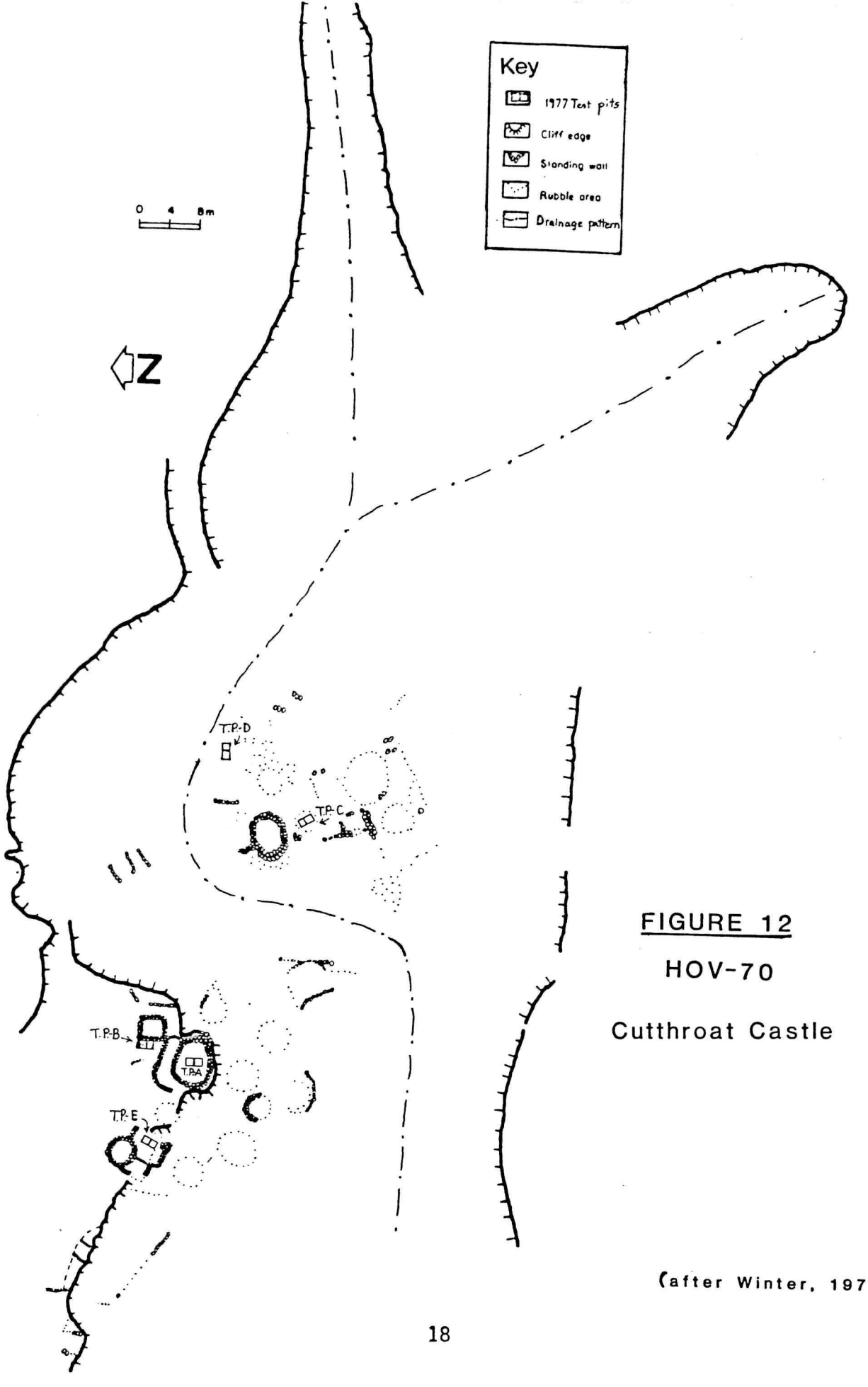


FIGURE 12

HOV-70

Cutthroat Castle

(after Winter, 1977)

Figure 13: Cutthroat Kiva, Hearth and Deflector, Hov 70

Figure 14: Test Pit Outside of Cutthroat Tower, Hov 70

Figure 15a: Slab Bins in Roomblock at Hov 70 (facing north).

Figure 15b: Closeup of Northernmost Bin at Hov 70.

Hovenweep 437 - 5Mt4157

Hov 437 is a series of check dams in a drainage approximately 250 meters north of Hackberry House (Fig. 16). The dams are spaced 10 to 25 meters apart along the course of the drainage however many of the dams are not easily visible since erosion and silting have buried them. The drainage channel has changed course and now flows around them. Three of the dams were tested in 1977 (Fig. 17). Ceramic sherds, lithics, and soil samples were recovered.

Hovenweep 513 - 42SA5910

Nearly 100 meters south of Little Cajon Lake, Hovenweep is a possible prehistoric reservoir. The preliminary interpretation was based on the presence of a visible stone wall extending for 60 meters around the southern end of a gradually sloping depression in the slickrock (Fig. 18). Testing indicated that the wall was man-made, built directly on slickrock (Fig. 19). Testing also exposed a feature at the eastern side of the reservoir which appeared to be stones arranged like steps which led to the deep end of the reservoir.

Hovenweep 520/597 - 42SA5849/5851

Hov 520 and 597 are twin unit pueblos located on a ridge above the southern edge of Little Ruin Canyon, both of which were previously tested in 1976 (Winter, 1977). Further testing in 1977 was conducted to recover materials for the corn morphology study (see Reaves-Haas, Section II).

The 1977 tests of Hov 520 centered in and around the contiguous rooms (Fig. 20). An ashy pit feature, possibly a hearth was found at the northeast end of T.P.2 in the floor at the corner of a room (Fig. 21). The room's floor was less than 10cm thick and rested on sterile soil.

T.P.5-6 was excavated into the slab lined structure southwest of the roomblock. A fire pit was uncovered 60cm below datum. No corn was recovered from any of the test units.

The tests at Hov 597 were more productive in terms of maize remains. The 1977 testing concentrated in and around the roomblock to the north of the kiva and in the two rooms southwest of the kiva (Fig. 23). Excavation of T.P.1-2 uncovered a north/south wall between two rooms in the roomblock. T.P.5-6 revealed the eastern exterior wall of the roomblock. The southernmost of the two east/west walls extended a meter past this eastern exterior wall but failure to find a parallel northern wall continuation indicated that this was the end of the roomblock. T.P. 3-4 in the rooms southwest of the kiva yeilded the remains of two superposed floors. This type of superposition had previously been noted in the main roomblock during the 1976 excavations (Winter, 1977).

Corn was recovered from Room 6 in the central part of the roomblock and from Room 2 southwest of the kiva depression. Smashed vessels were also recovered from Room 2 and from the area immediately outside the eastern edge of the roomblock.

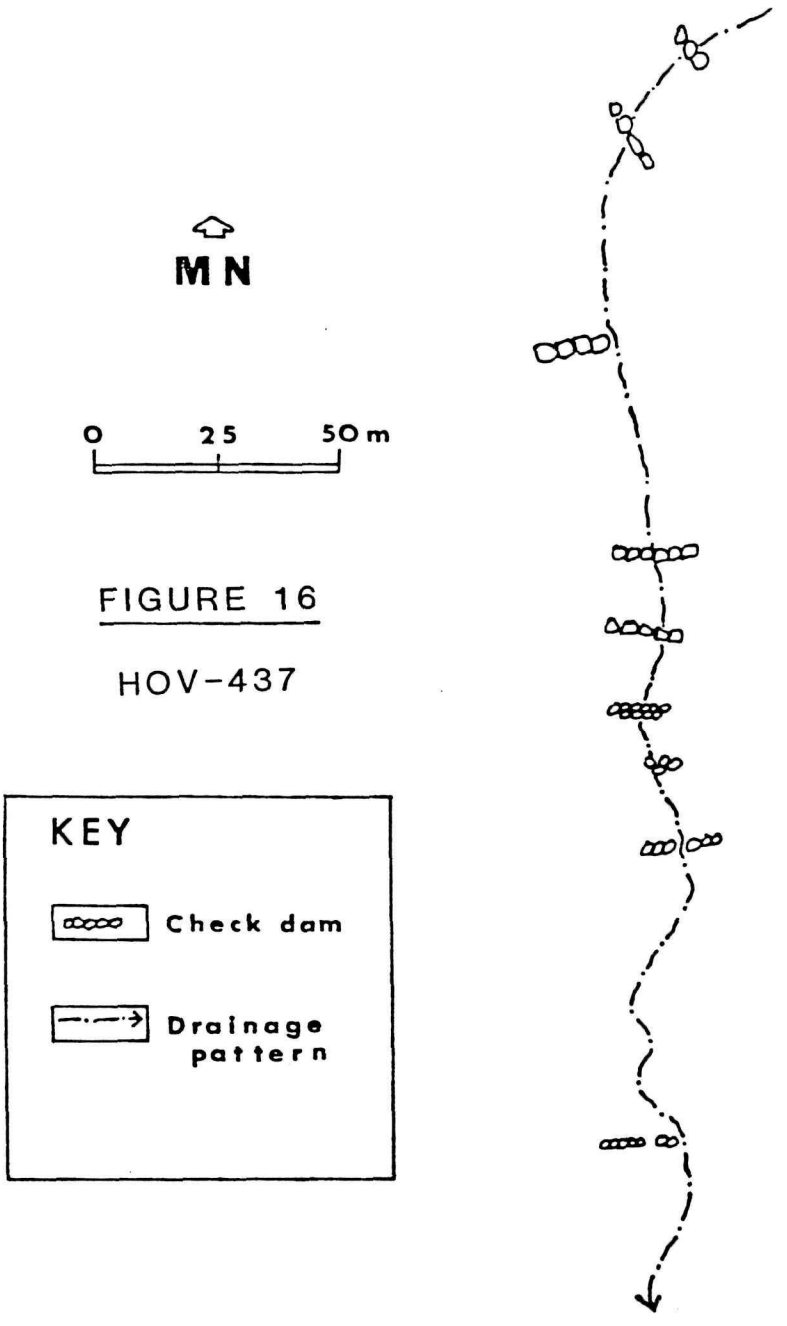


FIGURE 16

HOV-437

(HOV-64 is aproximately 250m to south)

Figure 17: Checkdam at Hov 437.

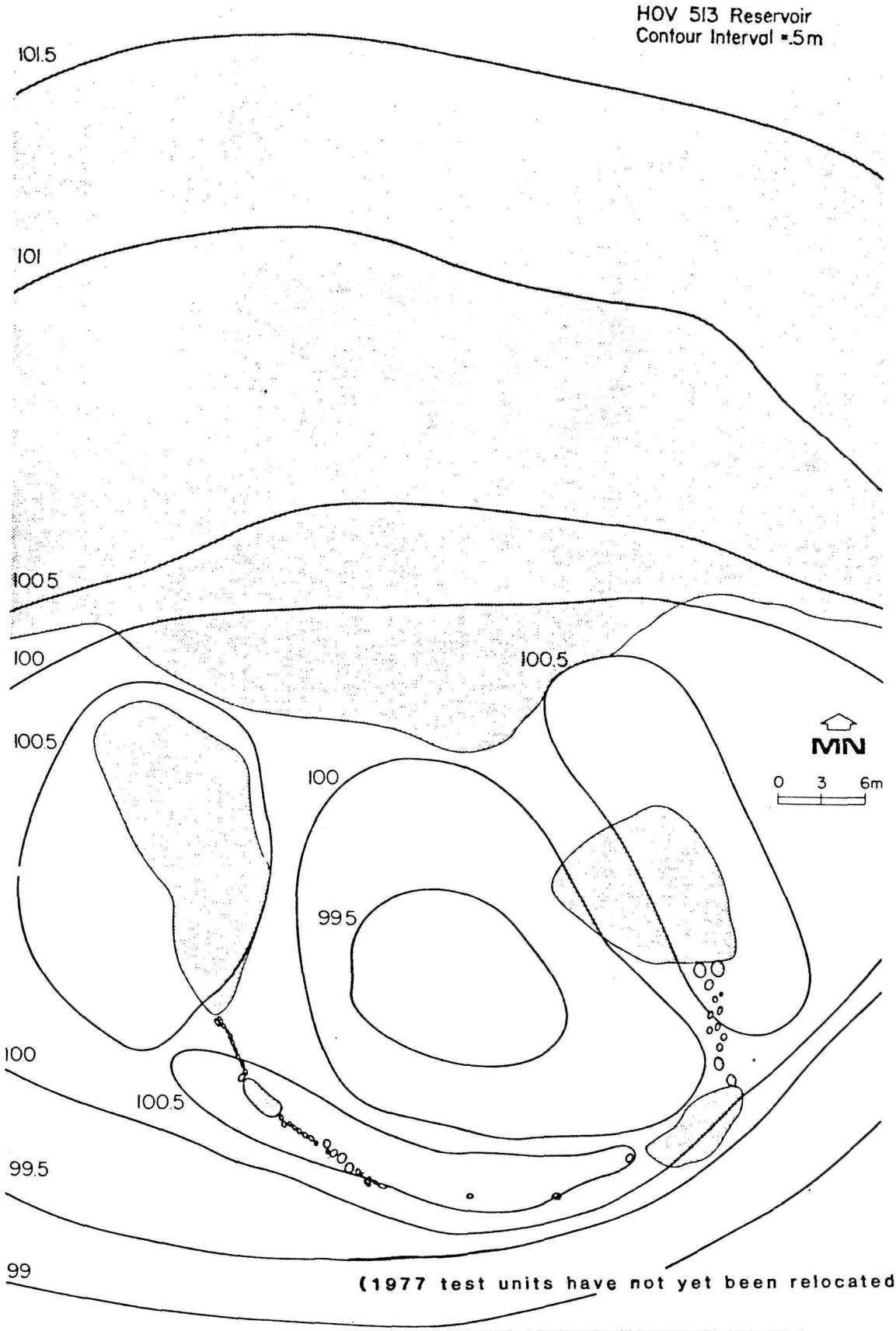


FIGURE 18
HOV-513

(from Winter, 1976)

Figure 19: Testing at Hov 513.

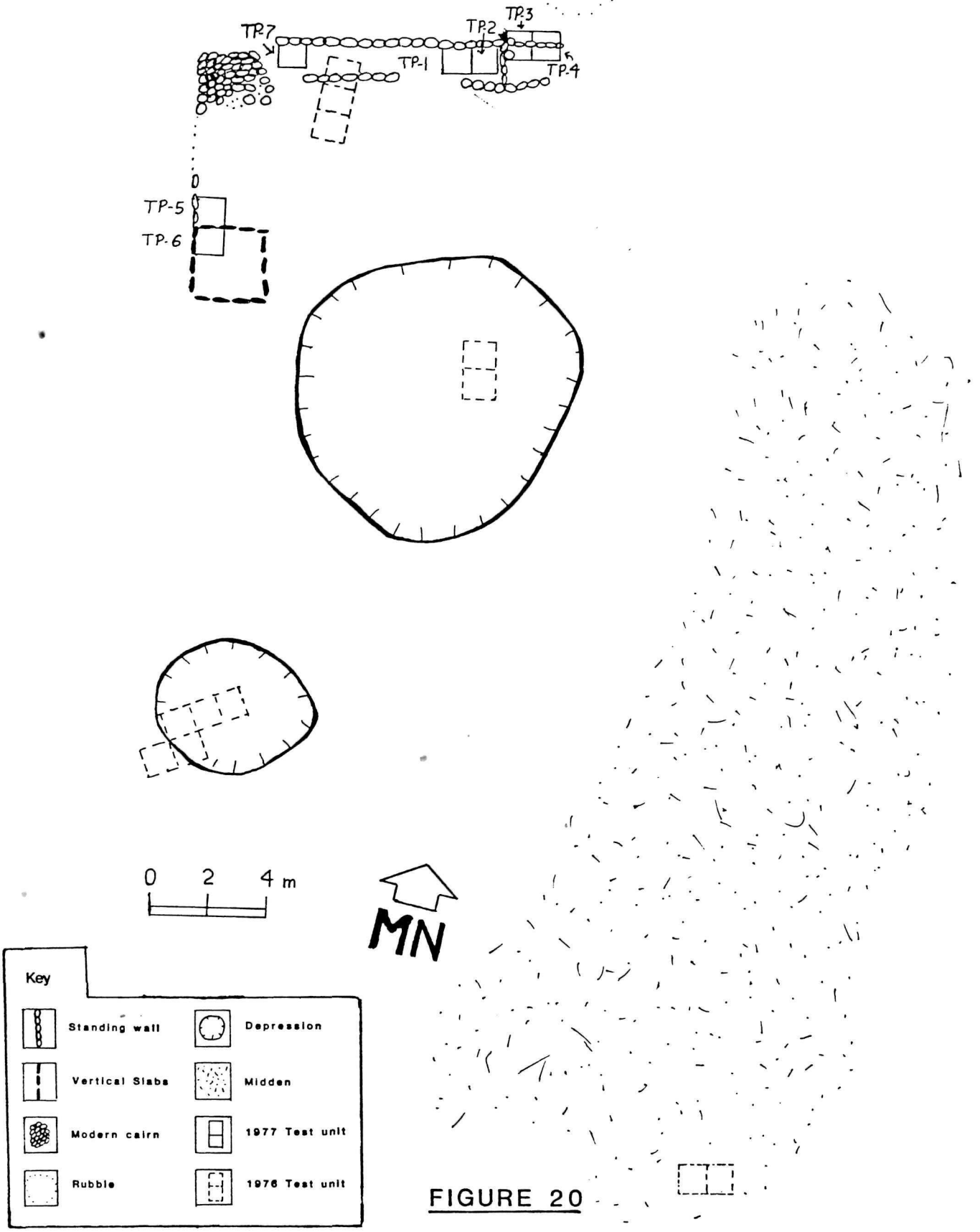


FIGURE 20

HOV-520

(after Winter, 1977)

Figure 21: Ash Pit, T.P. 1-2 Hov 520

Figure 22: Fire Pit, T.P. 5-6 (looking east) Hov 520.

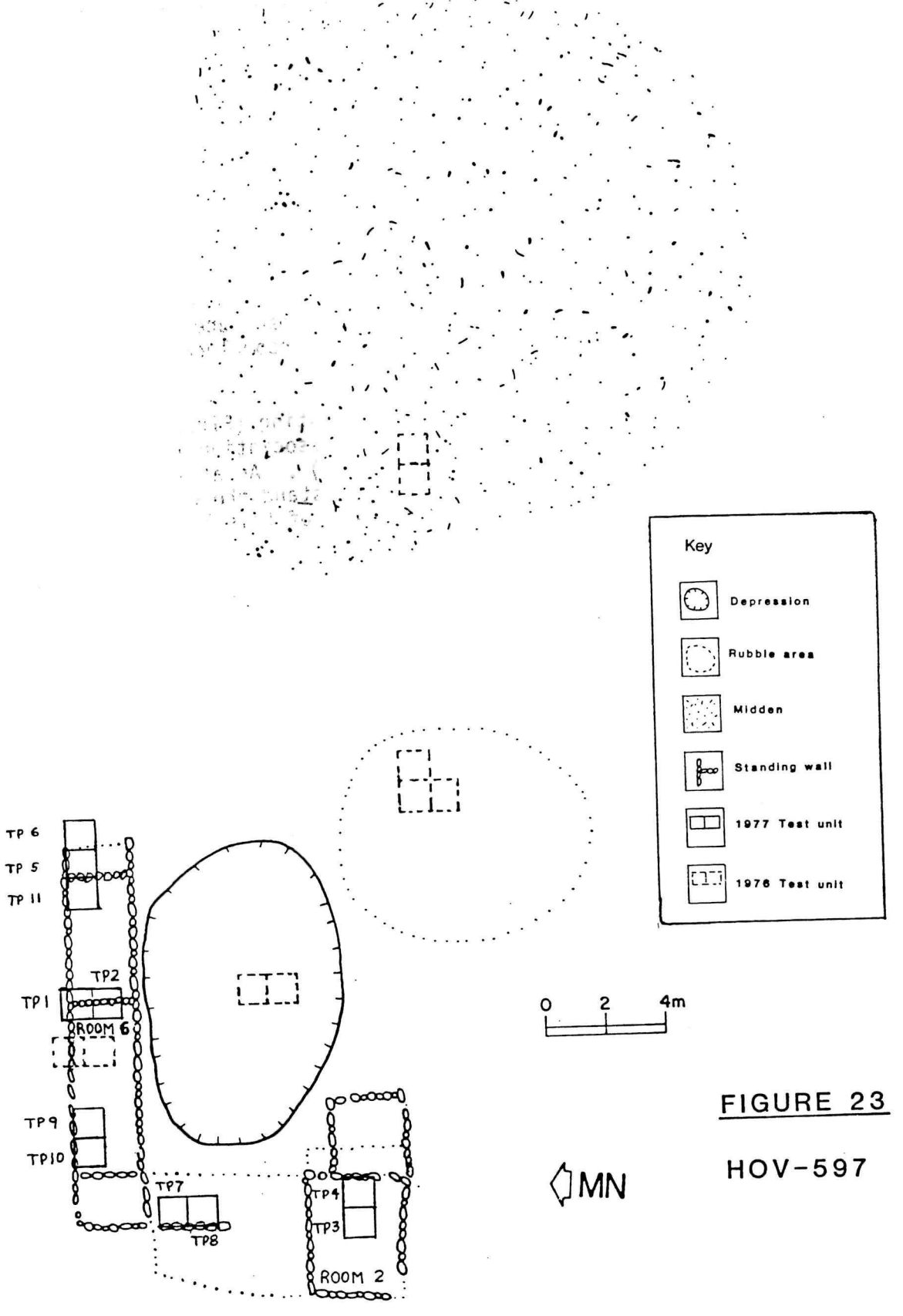


FIGURE 23

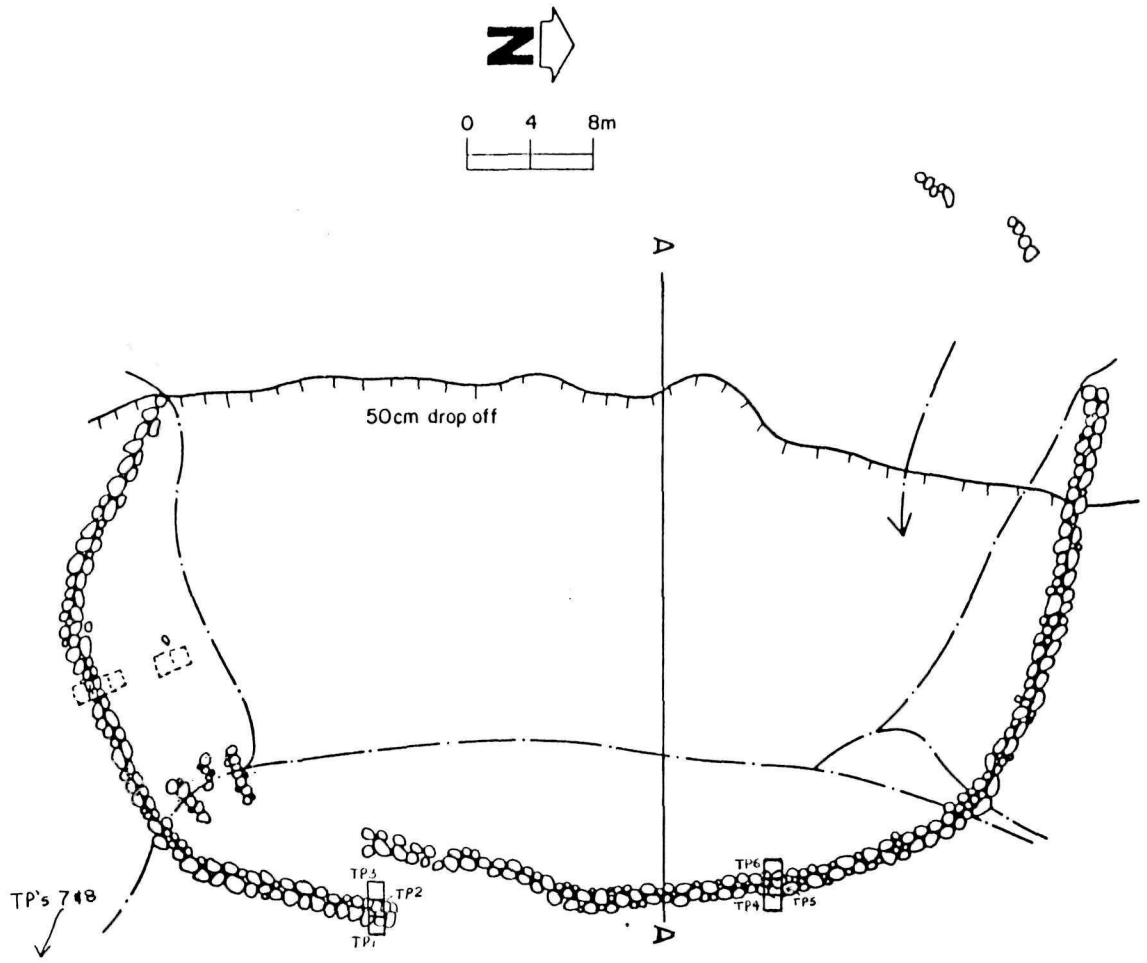
HOV-597

(after Winter, 1977)

Hovenweep 714 - 5Mt116

This is a large Pueblo III ruin complex perched on the eastern rim of Cow Mesa overlooking Big Ruin Canyon. Previous subsurface testing at the site sampled areas in a tower-kiva, an associated roomblock, the midden and the reservoir wall (Winter, 1977).

The 1977 work extended the reservoir testing (Figs. 24 & 25). A layer of compact charcoal or peat had been found in association with the reservoir wall during the 1976 excavations (Winter, 1977:39) . An attempt was made to locate more of this compact layer in order to understand the construction and operation of the reservoir wall, but no more of this layer was found.



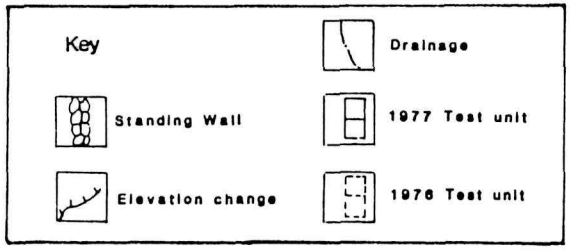


FIGURE 24

HOV-714

Big Ruin Reservoir

(after Winter 1977)

Figure 25: Testing Reservoir Wall, Hov 714

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SECTION II: THE 1977 STUDENT PROJECT REPORTS

The 1977 Garden Experiments at Hovenweep

By Julia E. Hammett and Anita B. Hornback

The purpose of the experimental gardens was to investigate the processes and effects of Pueblo style agriculture at Hovenweep. Two gardens were grown, 1) a plot watered by hand (hence forward called "hand watered plot") and 2) a plot in which Pueblo-type water control techniques were used where the plants were solely dependent upon direct rainfall and surface runoff (hence forward known as "flood watered plot"). Comparisons were made between the two gardens to determine which plants did best in each of the environments, and what agricultural techniques were feasible for the Hovenweep area.

METHODS

Our intention was to simulate the Pueblo complex of seeds and farming techniques. Gardening techniques were devised from 1) information about historic Hopi (Forde, 1949; Bradfield, 1971) and Zuni (Cushing, 1920) techniques, and 2) observations of Hovenweep Anasazi water control techniques (Winter, 1974, 1975, and 1976).

Preparation

Two locations in the vicinity of the archeological camp were chosen for the garden plots. The location with conditions most suited for the water control tests was selected for the flood watered plot. Specifications of the two plots are given in Table 1.

In mid-April of 1977 the garden plots were prepared for planting. Both were cleared of brush and their soil was turned. (See Figure 33) Several sections of the flood watered plot (Fig. 26) were left alone for the continuation of weed experiments initiated in 1975 and 1976 (Litzinger, 1976 and 1977). Wire mesh fences were erected around both gardens extending 30cm deep into the ground and 150 cm above the ground.

Unlike the hand watered location, the plot chosen for the flood water experiments had been used for several years as a food garden, originally by a park ranger and later by the archeology field camp. The garden was situated behind a retaining wall on a small shallow drainage. Mesa top soil and manure were added to raise the slope of the plot to a more level surface (Litzinger, 1975:183). At the deepest point in the plot the depth from surface to slick rock was only a meter. Water contol devices including checkdams and small ditches were constructed above the garden to direct water runoff to the plot (Figure 27).

Planting

Seeds were drawn from seed banks, private seed collectors and commercial stores. An attempt was made to obtain seed types most similar to types planted by the Hopi. The seeds planted in the gardens are listed in Table 2.

For the hand watered plot a set of plants was started in San Jose and transported to Hovenweep. These transplants did not fare very well and all seed types were replanted at Hovenweep.

Table 1: Garden Specifications

Hand Watered Garden

Elevation: 1597m

Exposure: South/Southeast

Vegetation Zone: Disturbed mesa-top sage containing Artemisia, Juniperus, Ephredra, Gutierrezia, Sisymbrium, and various members of the Gramineae family.

Slope: 3° from NE to SE; 4° from NW to SW.

Topography: Fairly flat with drainages beginning just outside the plot on both east and west sides.

Dimensions: 10m X 11.5m

Flood Watered Garden

Elevation: 1591m

Exposure: South/Southwest

Vegetation Zone: Disturbed area (Litzinger 1976:183-184) in transition zone between sagebrush/juniper and canyon rim zones.

Slope: Drainage surrounding garden is 6° NE to SW. Fill in garden has been corrected to 4° N to S.

Topography: In a small shallow drainage on mesa above slick rock associated with canyon edge.

Dimensions: 11m X 18m (approximate)

TABLE 2: Plants Grown in Experimental Gardens

Pre-Spanish Cultivated Plants	
Zea mays	Corn
Cucurbita moschata	"Cheese Pumpkin"
Phaseolus vulgaris	Kidney Bean
P. lunatus	Lima Bean
P. multiflorus	Aztec Bean
Lagenaria leucantha	Gourd

Plants Introduced after Spanish Contact	
Capsicum annuum	Chili peppers
C. frutescens	
Cucurbita pepo	Squash
Citrullus vulgaris	Watermelon
Helianthus annuus	Sunflower
Vicia faba	Broad Bean

Wild Plants Often Associated with Farmfields	
Solanum jamesii	Wild Potato
S. fendleri	
Physalis sp.	Ground Cherry

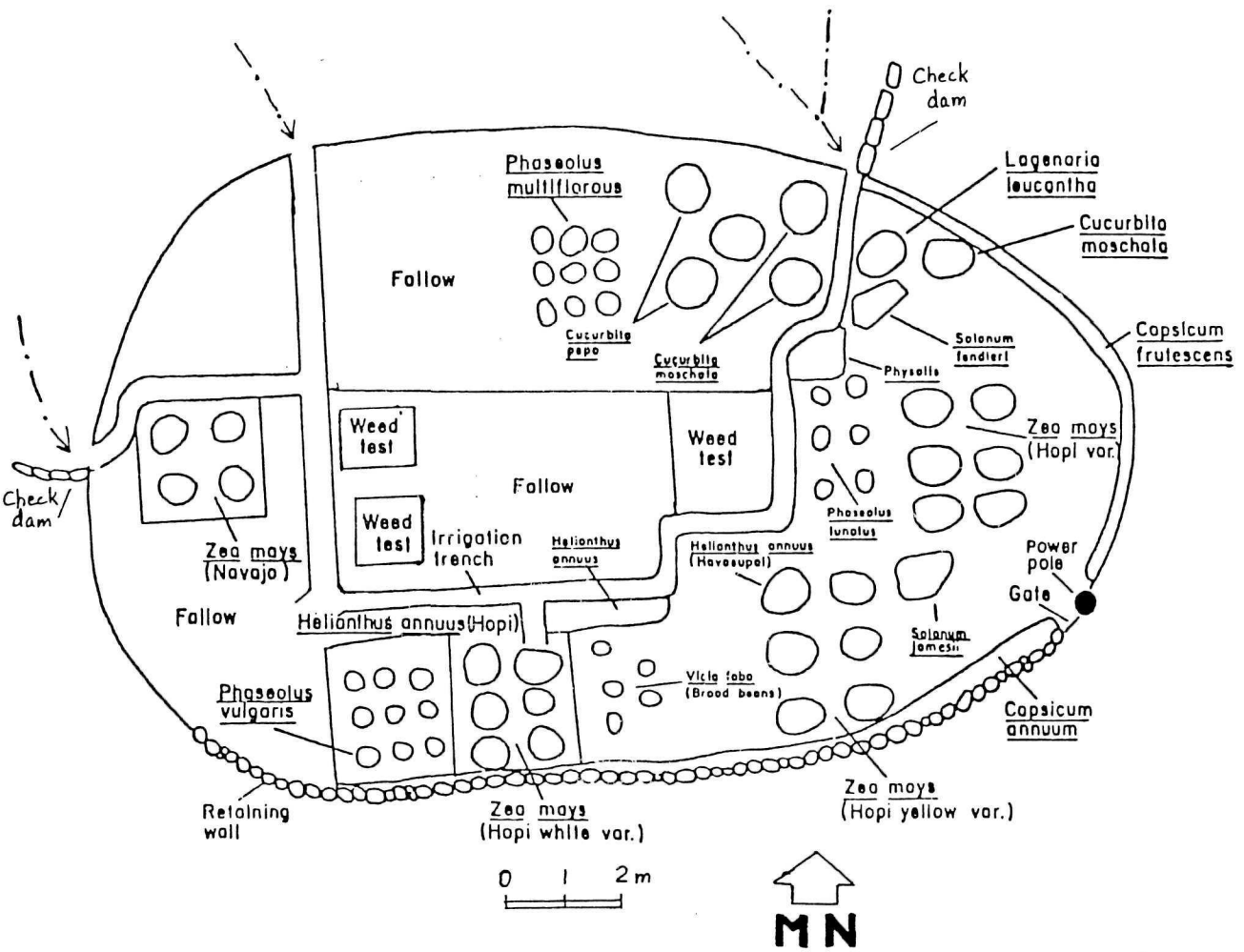

FIGURE 26 Plan View of Flood Watered Garden

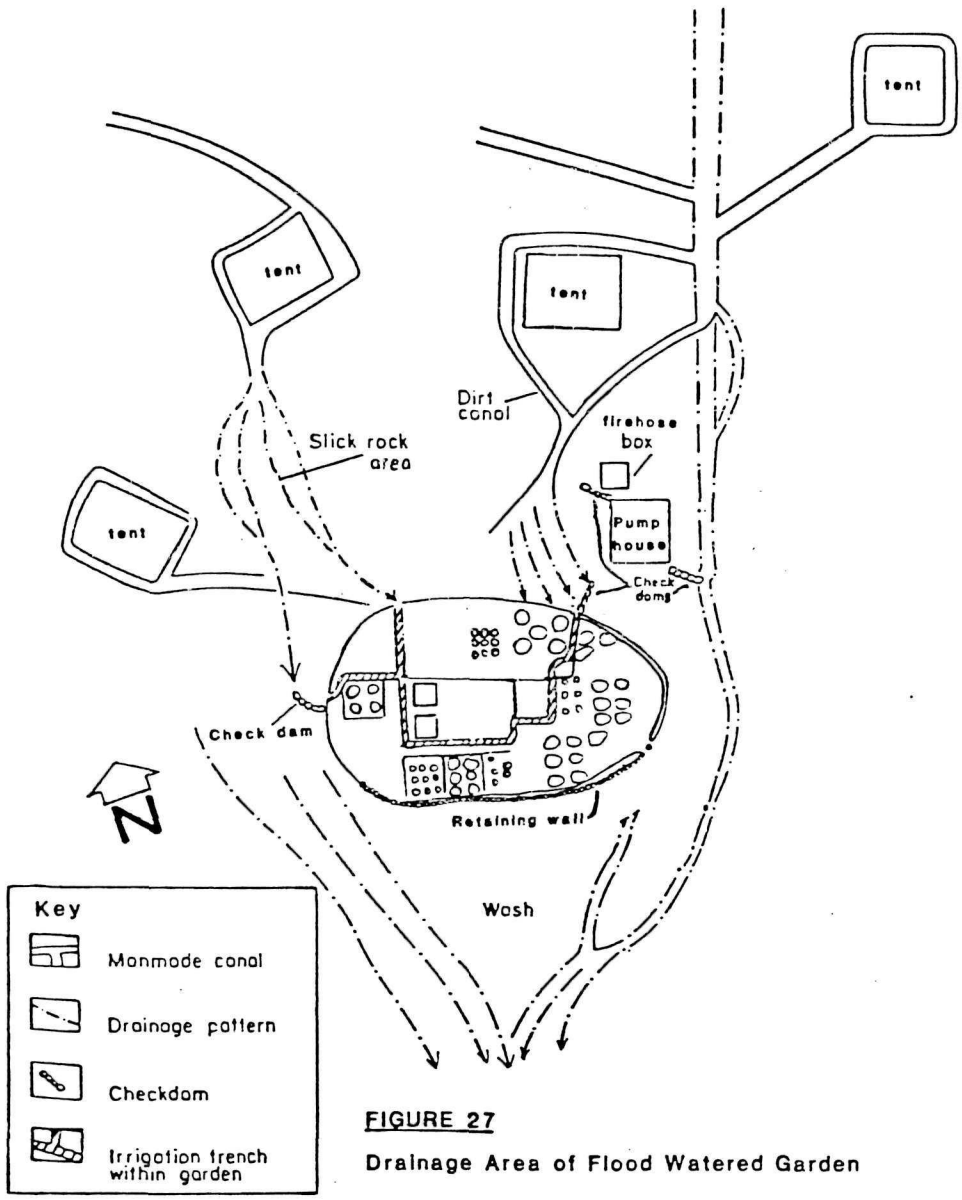

FIGURE 27

Drainage Area of Flood Watered Garden

TABLE 3: PLANTING SCHEDULE FOR EXPERIMENTAL GARDENS

	MAY								JUNE								JULY			
	1st week		2nd Week		3rd Week		4th Week		1st Week		2nd Week		3rd Week		4th Week		1st Week		2nd Week	
	Hand Plot	Flood Plot	Hand Plot	Flood Plot	Hand Plot	Flood Plot	Hand Plot	Flood Plot	Hand Plot	Flood Plot	Hand Plot	Flood Plot	Hand Plot	Flood Plot	Hand Plot	Flood Plot	Hand Plot	Flood Plot	Hand Plot	Flood Plot
Zea mays (corn)																				
Hopi Blue variety				X		X						X*	X	X*						
Hopi Yellow variety						X						X*	X	X*					X	
Hopi White variety						X				X		X*	X							
Navajo Tribe variety										X			X						X	
Red & Black variety													X							
Red & Yellow variety													X						X	
Phaseolus vulgaris (kidney bean)										X		X*	X							
Phaseolus lunatus (lima bean)												X	X							
Phaseolus multiflorus (scarlet runner bean)				X								X*	X							
Vicia faba (broad bean)						X							X							
Helianthus annus																				
Havasupai variety				X						X			X							
Hopi variety				X						X*			X							
Citrullus vulgaris (watermelon)													X							
Cucurbita moschata (pumpkin)						X						X*	X							
Cucurbita pepo (squash)				X								X*	X							
Capsicum annuum (chili pepper)				X						X*			X							
Capsicum frutescens (chili pepper)				X								X*	X							
Lagenaria leucantha (gourd)						X						X*	X							
Physalis sp. (ground cherry)						X						X*	X							
Solanum fendleri (wild potato)				X								X*	X							
Solanum jamesii (wild potato)												X*	X							

*reseeded

The planting schedule was based on the calendar used in 1929 at Walpi on the 1st Hopi mesa (Forde, 1931). When possible the various seed types were planted at more than one time to increase the likelihood that some of the plants would be successful (Table 3).

Seeds in both plots were planted in "hills" using a technique described by Forde (1934). Funnel shaped holes were dug with a smaller hole at the bottom of the funnel (See Figure 28). The seeds were placed in the smaller hole which was then covered with soil. The surplus soil from digging the hole was placed in a mound shaped ring around the funnel. Planting specifications for different types of plants are listed below.

Table 4 :Planting Specifications

Plant type	#Seed/Hole	Hole Depth	Spacing Between Holes
Corn	10-20	30-40cm	50cm
Beans	2-3	10-15cm	10-50cm
Sunflowers	1	3-5cm	20-50cm
Gourd	1	10-15cm	50cm
Squash*	1	10-15cm	50cm
Chili Peppers	2-3	5-10cm	50cm
Wild Potato	1	5-10cm	15cm
Ground Cherry	Seed scattered with minimal soil cover		

*germinated in wet paper towel before planting

A Zuni waffle garden was also constructed in the hand watered garden (Figure 29) and used as an herb green.

Measurements of the plants including germination, growth and survival rates were recorded. Notes were taken on the development of each of the plants, their height, width, and general health conditions.

Maintenance

As the experiment progressed hazards affecting the gardens were observed. These included: 1)wind, 2)pests, 3)disease, 4)flood and 5)drought damage. When possible, hazards were eliminated to minimize crop damage.

The greatest threat of wind damage came from the direction of the canyon edge. To protect the flood watered plot from such damage a wind break of juniper branches was constructed against the fence along the side of the garden facing the canyon rim. The preexisting cover of sagebrush surrounding the hand watered garden effectively protected this plot from the wind, making further human intervention unnecessary.

Several pests endangered plant growth. Because previous tests at Hovenweep demonstrated the destructiveness of rabbits (Litzinger 1977), fencing was errected prior to the 1977 experiments. More traditional Pueblo techniques, which involved traps, snares, and rabbit drives were not feasible on the National Monument lands. Mice were a minor nuisance until the seeds

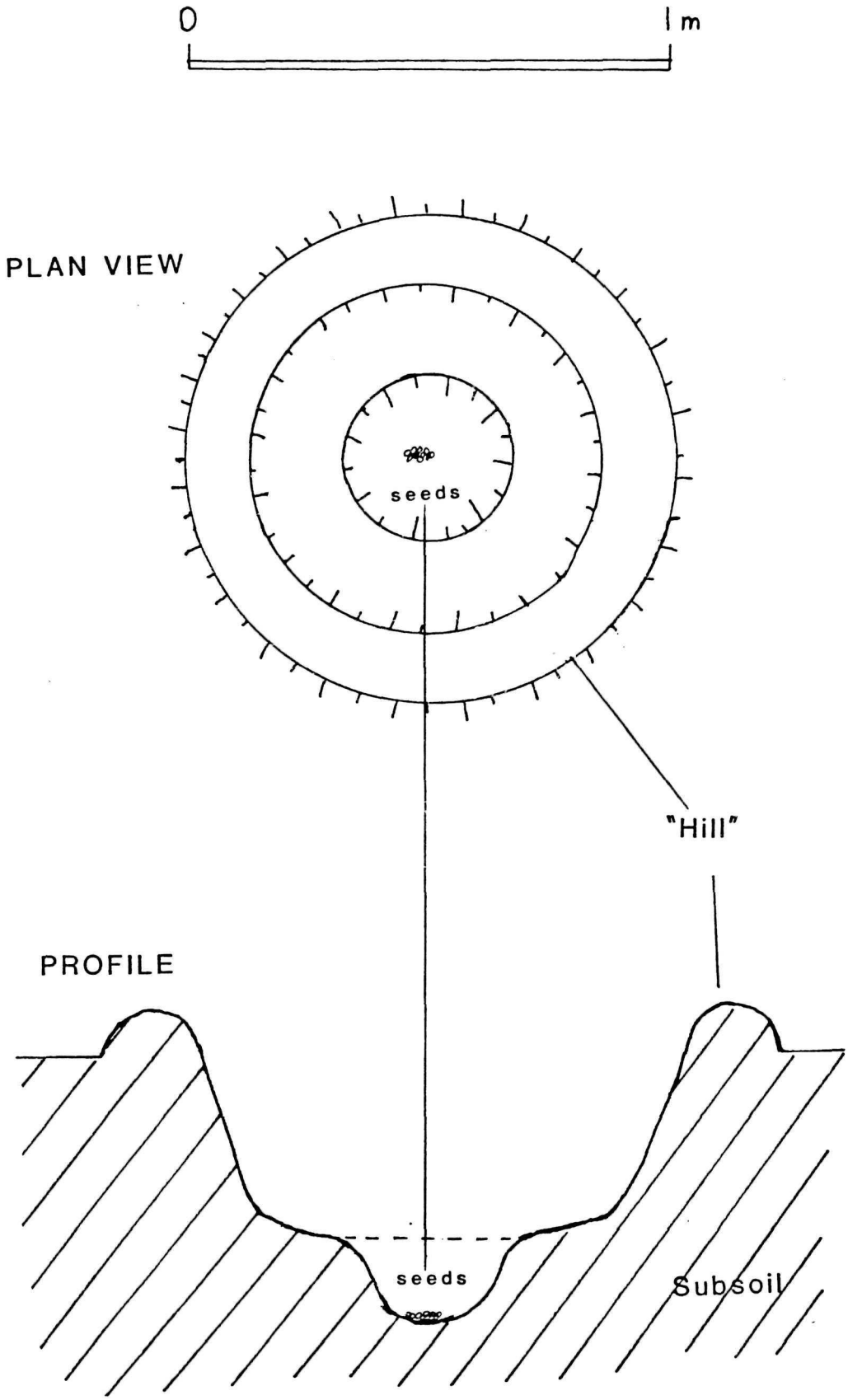

FIGURE 28 "Hill" Structure used for Planting Seeds

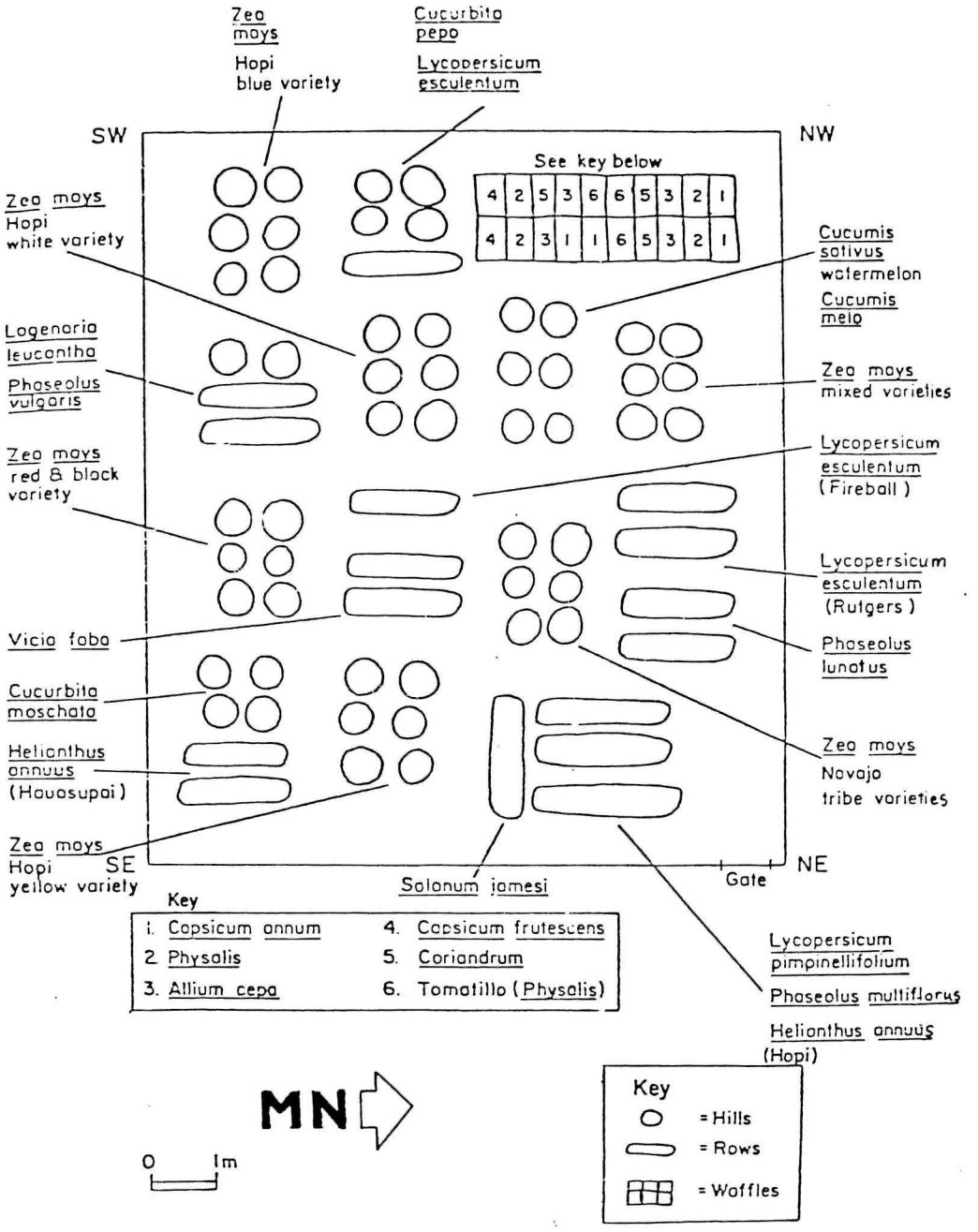

FIGURE 29 Plan view of Hand Watered Garden

had germinated. They appeared primarily interested in the corn which was planted fairly deep. Birds were deterred with the use of wind chimes devised from sheep scapula (Cushing 1920). Other bones or sticks could have been used prior to the introduction of sheep into the area.

The most harmful damage to the Phaseolus vulgaris plants was caused by a disease called "root rot." This disease is caused by a complex of organisms particularly a fungus called Fusarium solani f. sp. phaseoli. Other fungi and parasitic insects are also involved in the disease complex (Keenan, et al., 1974; Jenkins et al., 1975). The disease results in the roots of the plant being destroyed, thus killing the plant. This disease was a serious problem to the commercial dry farmers growing pinto beans in the Hovenweep area at the time of the study. It is not known if the drought conditions affected the spread of the disease, but our observations indicated the disease was prevalent in the commercial fields when the drought was at its worst. In the experimental gardens we found that the disease most seriously affected the Phaseolus vulgaris plants in the flood watered plot. Nothing was done to combat this disease but observations of the effects of the disease were noted.

Still another hazard was water damage. The same storms that brought essential moisture to the crops also damaged them when the water was not properly managed. Helen Sekaquaptewa (1969) described a time during a severe rainstorm in 1907 on Hopi Third Mesa when the people failed to tend their fields. The ensueing flood waters cut deep channels that left approximately 700 acres of prime land ruined for flood water farming practices. Similarly on a much smaller scale, the experimental plots had to be tended to prevent soil erosion and to direct water flow. This necessitated working during downpours to make sure water control devices were operating to direct water where needed and to ensure that surplus water was able to escape leaving the plants unharmed.

To ensure that a relatively controlled comparison between the two gardens was possible, no attempts were made to alleviate drought stress in the flood watered plot aside from 1) the water control devices (mentioned above) and 2)some small shades that were put over corn plants in the flood watered plot during the hottest hours of the day for a period of a few days in early August.

RESULTS

Table 5 summarizes the germination and survival rates for the gardens. The hand watered plot fared better overall than the flood watered plot, with the exception of a few types of plants. Observations of the two gardens indicated that the more domesticated plants did better in the hand watered garden, while some of the less domesticated plants actually did better in the flood watered plot. For example the single Havasupai variety sunflower plant that grew in the flood watered plot produced more mature seeds than all the rest of the Helianthus plants in both plots together. The ground cherry plants were not measured but observations indicated that the ones in the flood watered plot were more robust in size and produced more fruit.

Productivity of the gardens was relatively poor, especially for corn and squash. While all surviving bean and sunflower plants produced some food, only one corn plant of the red and yellow variety planted in the hand watered plot produced even an ear of corn. Only one squash flower, a male, ever developed.

TABLE 5: GERMINATION AND SURVIVAL RATES FOR THE EXPERIMENTAL GARDENS

	Total Seeds Planted (#)		Germination		Germination		Survival		Survival	
	Hand Plot	Flood Plot	Hand Watered		Flood Watered		Hand Watered		Flood Watered	
			#	%	#	%	#	%	#	%
Zea Mays (Corn)	78	220	47	60	21	10	42	89	17	94
Hopi Blue variety	9	60	6	67	9	15	6	100	9	100
Hopi Yellow variety	18	60	8	44	1	2	6	75	1	100
Hopi White variety	9	60	6	67	8	13	6	100	7	88
Navajo Tribe variety	15	40	10	67	3	8	8	80	0	0
Red and Black variety	9	-	8	89	-	-	8	100	-	-
Red and Yellow variety	18	-	9	50	-	-	8	89	-	-
Phaseolus vulgaris (Kidney Bean)+	12	12	6	50	2	17	3	50	1	50
Phaseolus lunatus (Lima Bean)+	8	12	4	50	9	75	4	100	5	56
Phaseolus multiflorus (Scarlet Runner Bean)+	12	12	6	50	6	50	4	67	0	0
Vicia faba (Broad Bean)+	11	16	3	27	12	75	6	33	4	33
Helianthus annuus (Sunflower)	26	48	6	23	7	14	6	100	7	100
Havasupai variety	12	23	4	33	1	4	4	100	1	100
Hopi variety	14	25	2	14	6	24	2	100	6	100
Citrullus vulgaris (Watermelon)+	4	-	1	25	-	-	1	100	-	-
Cucurbita moschata (Pumpkin)	4	7	2	50	0	0	2	100	0	0
Cucurbita pepo (Squash)	16	15	1	6	0	0	1	100	0	0
Capsicum annuum (Chili Pepper)	*	85	*	*	0	0	*	*	0	0
Capsicum frutescens (Chili Pepper)	*	50	*	*	0	0	*	*	0	0
Lagenaria leucantha (Gourd)	6	6	6	100	3	50	6	100	2	67
Physalis sp. (Groundcherry)+	*	*	*	*	*	*	*	*	*	*
Solanum fendleri (Wild Potato)	-	12	-	-	0	0	-	-	0	0
Solanum jamesii (Wild Potato)	15	11	8	53	0	0	3	38	0	0

KEY

+ : seed from commercial source (the rest are from seed banks or private collectors)
- : not grown in this garden
* : grown but not quantified

Predictably the intermittant heavy rainfall had a much greater effect on the plants in the flood watered plot than in the hand watered garden. The relationship between rainfall and plant success is demonstrated in graphs of germination and survival rates of four corn varieties in the two gardens (Figs. 30-31).

The climate of the Hopi mesas during the recent past has been characterized by moist winters and springs, which end with intense rains in time for seed germination. Early summer tends to be relatively dry. Late summer brings a short period of intense rain showers that trigger the corn plants into fruit production. Early August and September is often marked by a dryer period. By October the dry season is usually over and a wet season begins which typically lasts until planting time the next year. This pattern is demonstrated by the four climate diagrams of weather stations on the Hopi Mesas (Fig. 32). Diagram A is based on a relatively moist period during the latter part of the 1930's. The others are based on more recent data.

To interpret our findings it is important to consider the drought conditions that existed throughout much of the United States in the summmer of 1977. The Hovenweep weather data from 1971 to 1977 (the time period immediately preceeding and including the study) demonstrate the relatively dry summers. (Fig. 32, Diagram C). Winter moisture, however, has been greater than that found in the recent past on the Hopi mesas. Overall at Hovenweep there has been more moisture and a slightly shorter growing season than on the Hopi mesas.

For Pueblo farming techniques to be feasible today at Hovenweep, 1) the soil depth must be adequate to retain moisture for plants to draw upon during the dryer part of the growing season, and 2) protection from late and early frosts must be available. Sufficient rainfall for germination in the the spring and fruit production in the late summer and fall, are also critical. With the deep root structure of the corn plant, deep soiled areas at Hovenweep should be productive for this food plant, given adequate showers in spring and late summer. The water control devices would serve to maximize the moisture directed to the fields in the dryer years and would make less desirable locations more productive in moister years.

CONCLUSIONS

The garden experiments produced information regarding the current feasibility of various Pueblo style farming techniques at Hovenweep. The data demonstrate that moisture and length of frost free periods are critical factors affecting this complex of plants. The wilder plants tended to do better than the more domestic as available moisture decreased. Adequate overall moisture is not enough to ensure crop success. Success is dependent upon heavy rainfall in early spring for germination, in late summer for fruit production, and a growing season of sufficient duration.

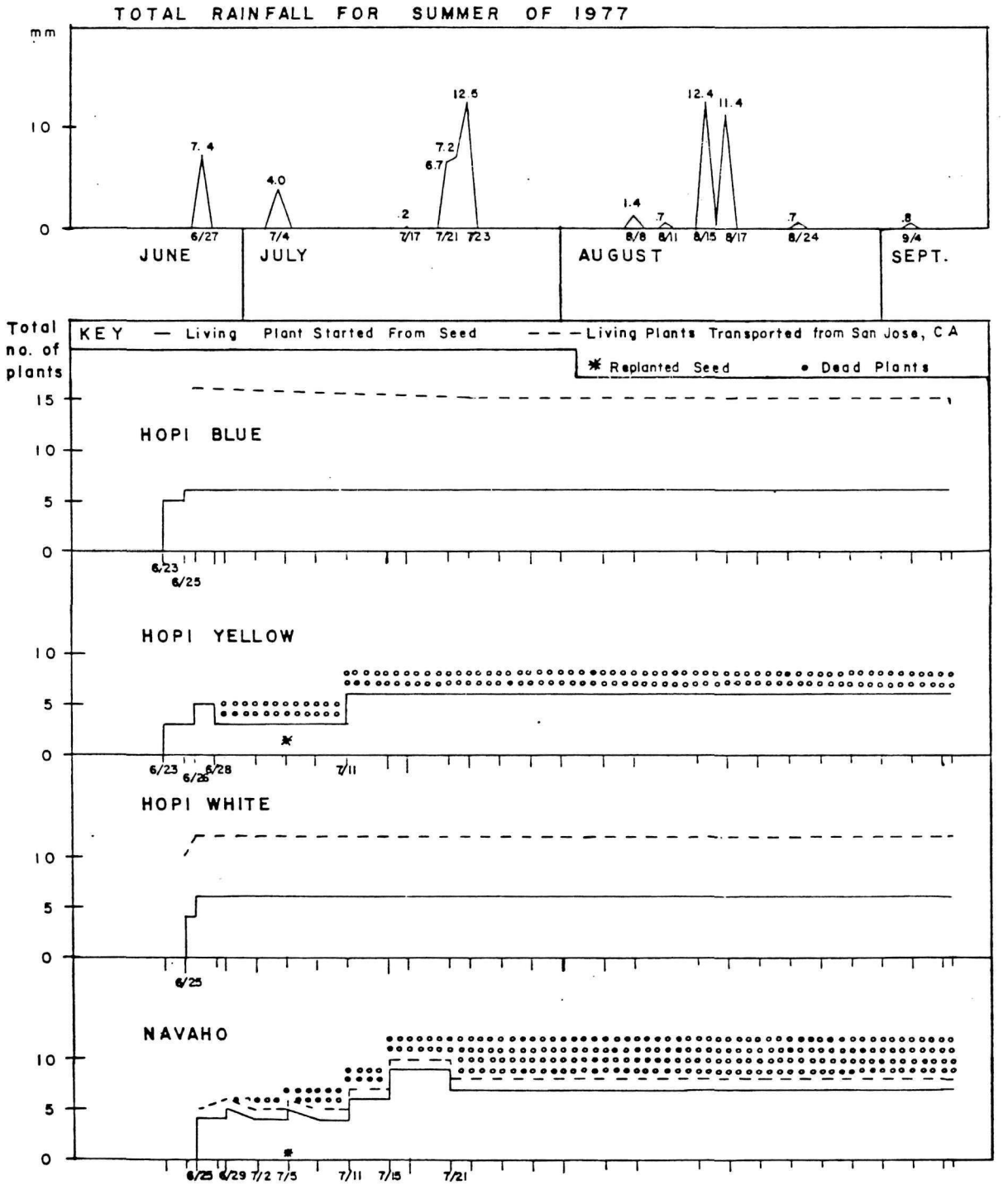

FIGURE 30 Comparison of Rainfall to Number of Corn Plants in Plot Watered by Hand

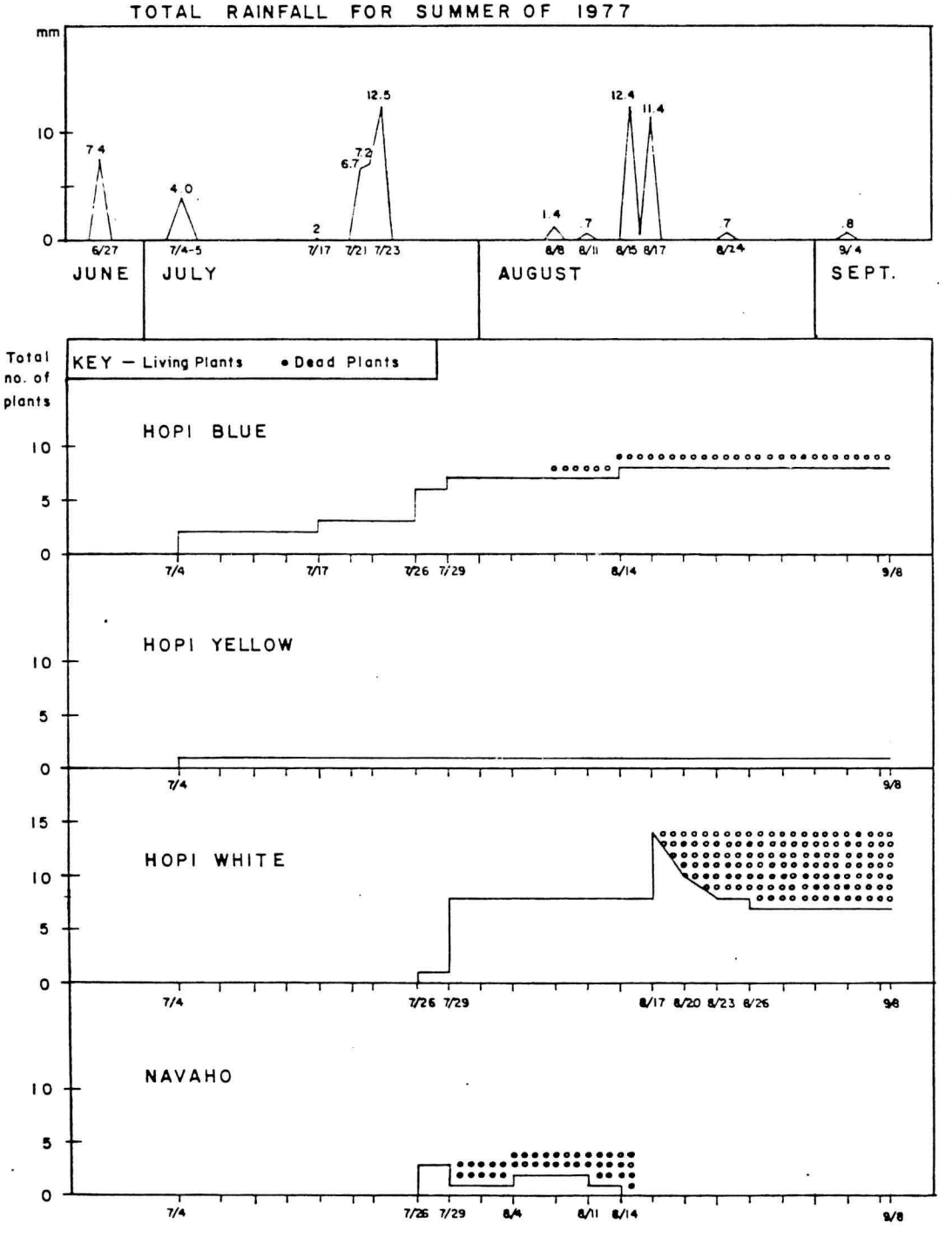

FIGURE 31 Comparison of Rainfall to Number of Corn Plants in Flood Water Plot

KEY TO CLIMATE DIAGRAMS. Source: Walter, 1979

The letters and numbers on the diagrams indicate the following (see especially Group "B"): **a**,station; **b**,height above sea level; **c**,number of years of observation (where two figures are given, the first indicates temperature and the second precipitation); **d**,mean annual temperature (in degrees Centigrade); **e**,mean annual precipitation (in millimeters); **f**,mean daily temperature minimum of the coldest month; **g**,absolute minimum termperature (lowest recorded); **h**,curve of mean monthly temperature (1 division = 10°C); **i**,curve of mean monthly precipitation (1 division = 20 mm,,i.e., 10°C = 20 mm); **j**,period of relative drought (dotted) for the climate region concerned; **k**,corresponding relatively humid season (vertical shading); **l**,months with a mean daily minimum below 0°C (black), = cold season; **m**,months with absolute minimum below 0°C (diagonally shaded) i.e., with either late or early frosts. Not all of the above are available for every station. Where data are missing, the relevant places is the diagrams are left empty.

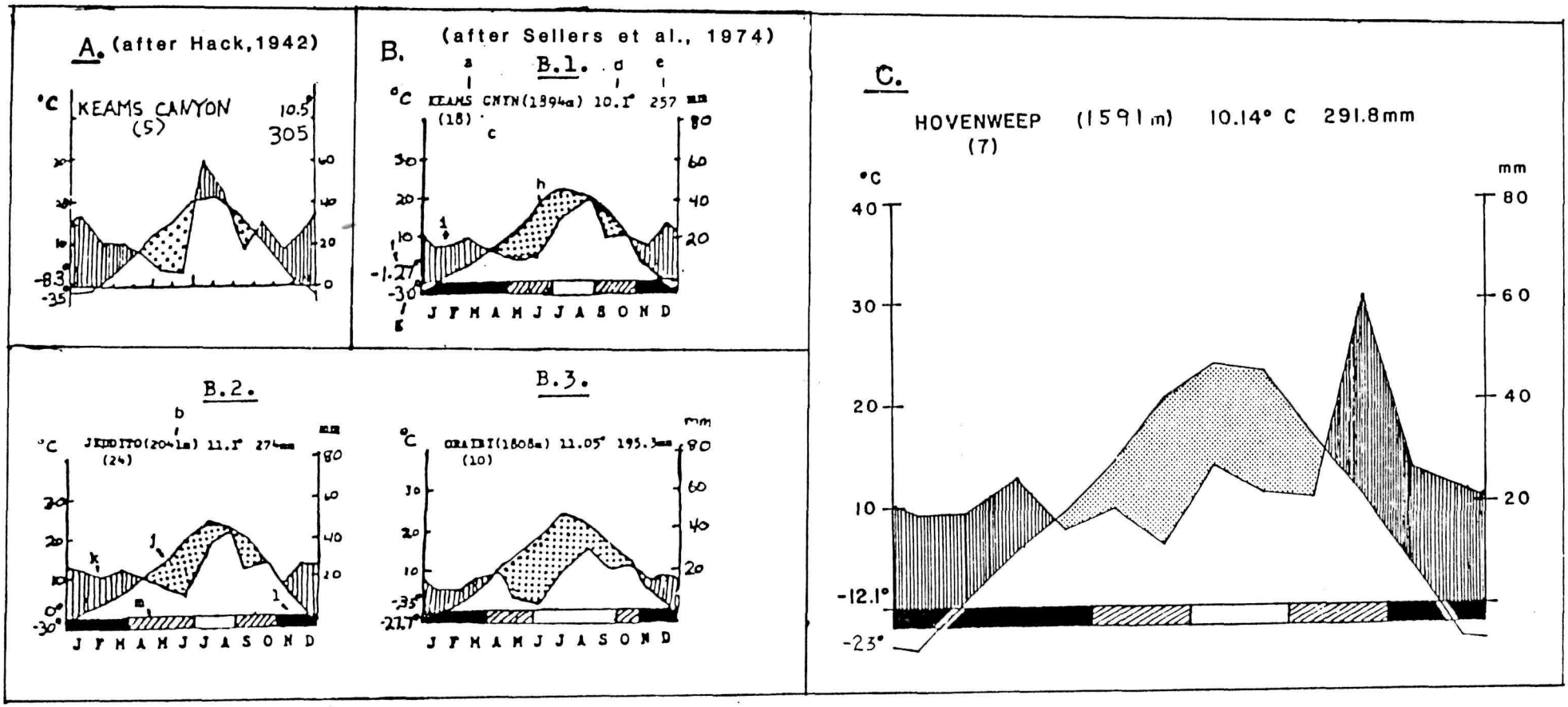

FIGURE 32 Climatic Diagrams for Hopi Mesas and Hovenweep

(after Hammett, 1980)

It is possible, given the general direction of the prehistoric migration at the time of abandonment at Hovenweep that temperature, not moisture drove them south. Were moisture the most critical factor, they should have migrated north. It appears that a slight reduction in moisture was tolerable in exchange for an increase in length of growing season. Of course it is important to remember that these are recent data and may not reliably reflect past climatic events and relationships. Nevertheless they suggest that rainfall is not the only critical consideration in reconstructing past Pueblo agricultural behavior.

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DENDROCLIMATOLOGICAL STUDY OF PINYON PINE IN HOVENWEEP CANYON

by Loren Haas

Dendroclimatological studies of living trees are important to southwestern archeology because they allow a climatological interpretation of wood samples taken from archeological sites. A recent example of this was a study done in Mesa Verde National Park (Fritts, et al., 1975) where living trees were extensively tested by dendrchronological methods. The data gathered from this study were combined with existing weather records and archeological wood samples to reconstruct the local paleoenvironmental changes.

The basis for this type of interpretation is that the variation in width of annual tree-rings is related to environmental influences, chiefly precipitation. Temperature and other factors can be important, but in the Southwest precipitation is primary (Stokes and Smiley, 1968). Many dendrochronologists have also pointed out that autumn, winter, and spring precipitation exert the greatest influence on tree-ring growth. Rainfall during the growing season of June, July and August has a negligible affect on tree-ring growth (Douglass, 1919; Schulman, 1956; and Fritz, 1965).

Two factors make Hovenweep a good area for a dendroclimatic study. First, there is the presence of pinyon pine (Pinus edulis) which is a species considered especially sensitive by dendrochronologists (Fritts and Shatz, 1975). Second, accurate weather data are available as a result of the presence of an official weather station on the monument since 1954.

Hovenweep Canyon, northwest of the monument, was chosen for sampling. Beginning at an elevation of about 1770 meters, the canyon lies within the Pinyon-Juniper vegetation zone (Litzinger, 1976). The study area included significant portions of canyon bottom, canyon side and mesa top physiographic zones. This area varied from 1770 to 2100 meters in elevation, and from ten to thirty kilometers from the weather station.

The study area was sampled systematically. A grid system was imposed over the area dividing it into 312, 40 acre (16.19 hectacres) sections. Sections were numbered 1 through 312, begining in the northwest, (working east and south). Begining with number 1, every tenth section was selected for sampling. This resulted in 32 sections representing approximately ten percent of the total sampling area. One tree from the approximate center of each selected section was cored, using a Swedish increment borer.

A predetermined procedure was followed for every test section. A mature tree , free of any obvious disease or scars, was chosen and cored with the increment borer. Coring was done away from branches and visible disturbances. On slopes the trees were cored from the side to avoid distortion in the core from tree deformation. Field obvservations recorded include: section number, elevation, angle, and direction of slope, as well as diameter and height of the tree. Brief descriptions of the geography and vegetation of the immediate area were made.

In the laboratory the cores were mounted and measured. Each core was glued onto a grooved mount, shaved flat and sanded with graded sand paper. The ring widths were then measured under a microscope using a device built by the author. This consisted of a screw driven platform on which the mounted core was placed. The crosshair in the microscope was panned from ring to ring using the screw, and the distance covered was read on a vernier caliper.

Considerable practice and experimentation were required before the rings could be read with accuracy. Changes in lighting and surfacing made big differences in the ease of measuring the rings. Comparing the skeleton plots of the ring patterns helped point out anaomalies such as double and missing rings in some cases. One core from section 250 proved to be unreadable. The tree ring averaged only .12 millimeters as compared to an average for all trees of .43 millimeters. The tree-ring pattern also did not correlate with the other trees. This tree apparently lived a very marginal existence due to disease or competition from other plants which caused it to have an erratic ring pattern. Consequently, it was elminated from the study.

When the ring widths were converted into average ring widths for each tree, they showed a relationship to elevation (see Table 6). There was a gradient towards increased ring size as the sampling areas gain in elevation towards the head of Hovenweep Canyon. A comparison of the average ring widths from the sixteen highest and fifteeen lowest samples reveals the former with an average width of .47 millimeters and the latter with .38 millimeters. These findings correspond to the weather patterns for the area, as precipitation increases with elevation along Cajon Mesa (Winter, 1975, and Litzinger, 1976).

A comparison of the average ring widths of the mesa top, canyon side, and canyon bottom samples is of interest. The mesa top samples had an average ring width of .43 millimeters, while the canyon side averaged .38mm and the canyon bottom .54mm. The difference between these figures is due to the terrain. The canyon bottom samples generally have the best and deepest soil and receive considerable runoff from the mesa tops and canyon sides. The canyon sides have the thinest soil and a great deal of runnoff, while the mesa tops have deeper soil and less runoff than the canyon sides. So while the precipitation may be the same for the areas, the terrain influences the effective moisture available to the trees.

In order to compare the annual variation in tree-ring growth between different trees, it is necessary to calculate their ring index for each year. In this study, the ring index will be considered, the ratio of the ring growth for one year compared to the average ring width for the time period considered. In general, the index is calculated using a ten to twenty year running mean for each ring, instead of an average for the entire time period studied. This allows for the difference in response over a long time period to a given set of environmental factors caused by aging (Stokes and Smiley, 1968). This study encompasses only nineteen years which minimizes this effect. The ring indexes for individual cores must then be correlated to form a combined ring index for the area (see Table 7).

Table 6: Average Tree Ring Widths in Study Area

Elevation (Meters)	Section	Terrain	Ave. Ring Width (mm)
2103	30	MT	.40
2085	1	CS	.45
2073	10	CS	.52
2067	40	MT	.64
2061	20	CS	.60
2043	99	MT	.52
2012	60	CS	.31
2012	80	MT	.48
2012	140	MT	.48
1982	50	CB	.33
1976	89	MT	.44
1951	130	MT	.21
1951	180	MT	.32
1951	190	CS	.35
1951	70	CB	1.08
1951	120	CS	.27
1939	110	CB	.28
1939	210	CS	.38
1927	150	CS	.34
1927	170	CS	.26
1927	200	CS	.31
1893	220	MT	.26
1890	160	CB	.37
1890	260	MT	.79
1875	230	CS	.50
1866	300	MT	.22
1841	280	MT	.29
1835	240	CB	.65
1793	270	CS	.40
1793	290	CS	.34
1793	310	CS	.32

MT = Mesa Top
CS = Canyon Side
CB = Canyon Bottom

Average Ring Width for Highest 16 = .47mm
Average Ring Width = .43mm
Average Ring Width for Lowest 15 = .38mm

Table 7: Tree-Ring and Precipitation Index

Season (Sept.-May)	Combined Tree Ring Index	Precipitation Index	Correlation*
1975-76	1.16	.86	.78
1974-75	1.53	1.73	.88
1973-74	1.10	.69	.41
1972-73	1.47	2.20	.67
1971-72	1.15	.82	.60
1970-71	.95	1.08	.88
1969-70	.87	.75	.84
1968-69	1.04	.99	.95
1967-68	.75	.67	.88
1966-67	.86	.77	.88
1965-66	1.06	1.30	.82
1964-65	1.04	1.34	.79
1963-64	.67	.57	.82
1962-63	.68	.89	.76
1961-62	.88	.89	.99
1960-61	.81	.99	.72
1959-60	.93	.80	.84
1958-59	.94	.65	.55
1957-58	.99	1.02	.97

*Correlation = [P.I./P.I.-T.R.I.]/P.I.

To compare the combined tree-ring index to the weather, a precipitation index must be calculated. This index is the ratio of each season's precipitation to average precipitation for that season through the time period studied (see Table 7). September through May will be considered the season in this study. Although the weather station at Hovenweep has been in operation since 1954, only since 1957 have observations been made regularly. This leaves a nineteen year period for calculating a precipitation index.

The correlation of the combined tree-ring index to the precipitation index may be seen as their percent of similarity. This calculated by subtracting from the precipitation index (P.I.) the difference between the precipitation index and the tree-ring index (T.R.I.) and dividing by the precipitation index (% similarity = [P.I./P.I.-T.R.I.]/P.I.). These figures are given in Table 7. The similarity varies from .99 to .41, with an overall average of .79.

The similarity of the two indexes can also be shown in graphic form. In Figure 33, the two indices are plotted together. The tree-ring index follows the precipitation index fairly well. The tendency of the tree-ring index to not rise as high as the precipitation, as in 1974-75 and 1972-73, is most likely due to the tree being unable to use the extra moisture because it is limited by some other environmental factor. I believe the indices diverge seriously only near the oldest rings, perhaps due to cumulative error in reading the tree-rings.

A comparison of the precipitation index to the tree-ring indicies for mesa top, canyon side, and canyon bottom does not provide the expected results. Cores taken from trees on slopes are generally considered the most reliable because the tree is more sensitive to precipitation. This is because a slope has better drainage preventing a water table building up and ruining the responsiveness of ring width to precipitation. Correspondingly, mesa top sites should be less sensitive than the canyon side and the canyon bottom least sensitive of all. In this study the precipitation index had a similarity of .81 to the mesa top, .77 to the canyon side, and .72 to the canyon bottom. The mesa top and canyon side followed their expected pattern in relation to the canyon bottom, but not in relation to each other. This discrepancy has no obvious explanation. Perhaps a larger sample would elmininate it.

The plots of the tree-ring indices for the three physiographic areas (Figure 34) show more variation than the combined tree-ring plot. This illustrates the variability caused by topographic variation. Of course, plots for individual trees show even more diversity. The necessity of a large sample is demonstrated by this variability.

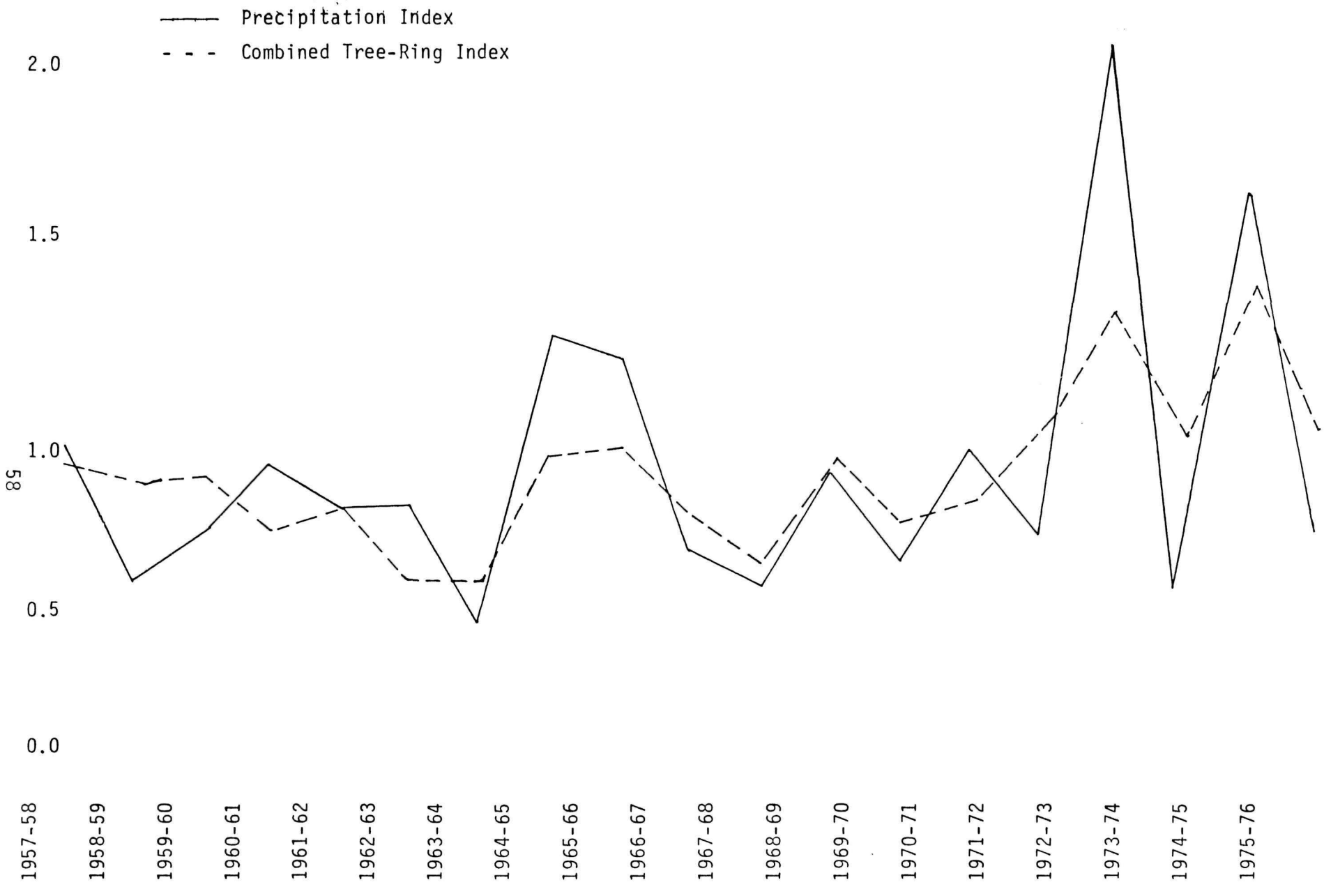

Figure 33: Comparison of Precipitation to Tree Rings

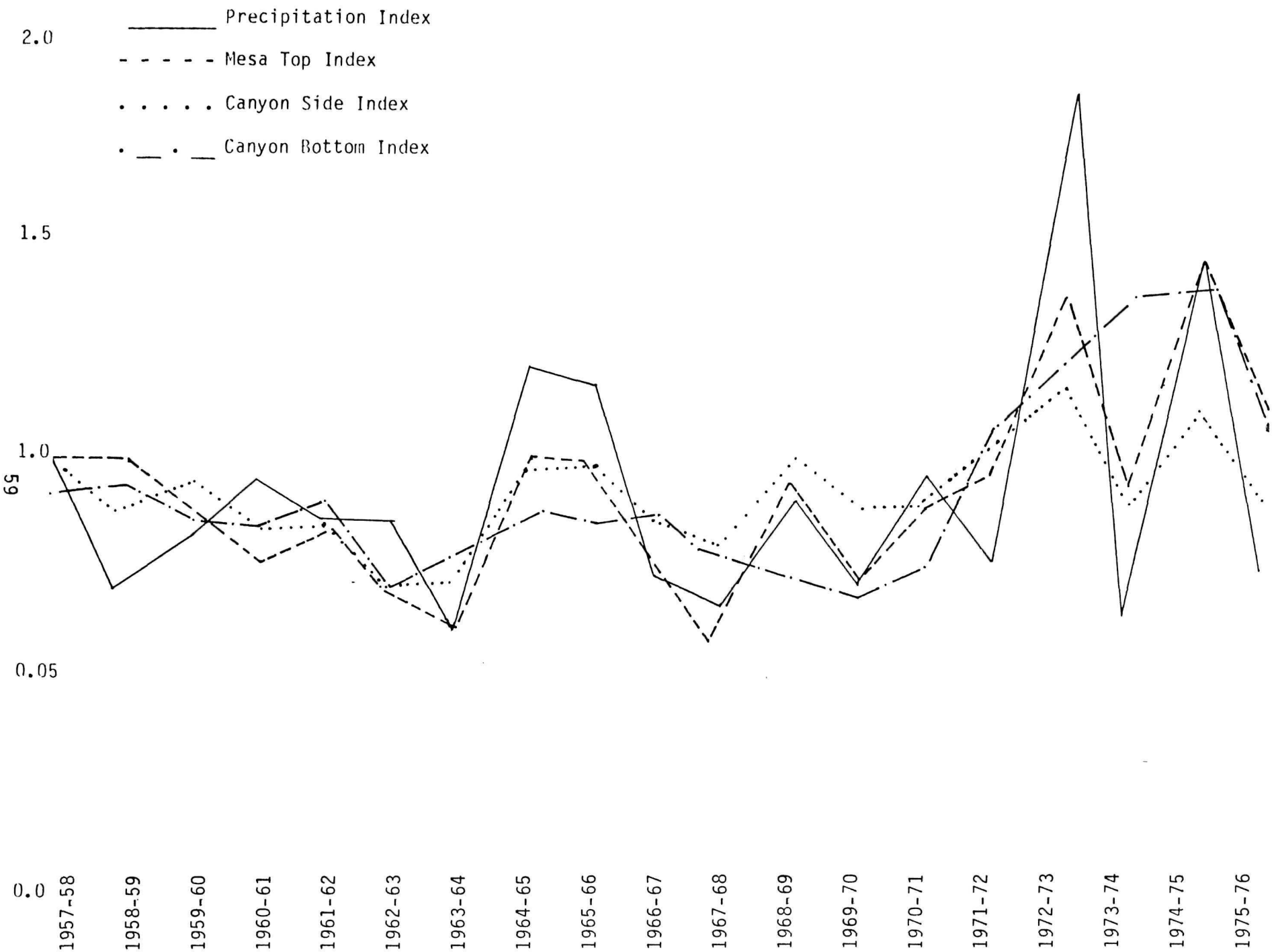

Figure 34: Comparison of Precipitation in Three Physiographic Zones

Summary

1. The increase of average tree-ring width with elevation corresponds with obvserved weather patterns.

2. Terrain seems to affect ring width. Canyon bottoms have the widest, followed by mesa tops, and canyon sides having the narrowest.

3. In this study terrain did not have the same influence on sensitivity to precipitation as in other studies.

4. The tree-ring index and precipitation index correlated well, demonstrating the relation of tree growth to precipitation.

A large number of samples are needed to insure accuaracy, and thus far few adequate dendrological specimens have been recovered at Hovenweep. Nevertheless, the success of this study indicates that it is possible to reconstruct the precipitation patterns from archeological wood samples of pinyon pines.

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AN EXPERIMENT IN DETECTING FARM FIELDS THROUGH PALYNOLOGY

by Terry Jones

Introduction

My research sought to determine if the experimental gardens could be detected in the pollen rain on Cajon Mesa (Figure 35) and if possible to make inferences about pollen rain from prehistoric agricultural fields. If a concentration of cultigen pollen is detectable as an anomaly in the natural pollen rain, it might then be possible to set up parameters for recognizing and defining the locations of prehistoric farm fields.

Project Design

In order to find what percentages of cultigen pollen were indicative of agricultural activity, I planned to make two surface pollen collection transects through the area intended for the experimental garden (Figure 36). The first transect was to be run before the garden was planted in order to determine how the natural vegetation was reflected in the surface pollen rain. The purpose was to provide a baseline for comparison with a second transect to be collected at the end of field season after the plants in the garden had passed sexual maturity and released their pollen. My hypothesis was that the second transect would show a noticeable increase in cultigen pollen (or more precisely an increased representation of plant families and genera of which the cultivated plants were members).

The project was to consist of three phases; (1) field collection of soil samples at Square Tower Canyon and study of the natural mesa vegetation, (2) laboratory extraction of pollen grains from the soil samples and (3) analysis of results produced in the laboratory (e.g. comparison between the two transects).

Field Procedure

Within several days of our arrival in the field in early June, 1977 the pollen collection transect line was set up between the edge of Square Tower Canyon and another unnamed canyon, 500 meters to the northeast. The transect ran through the natural vegetation from canyon edge to canyon edge crossing through the center of the area planned for the experimental garden (Figure 36). During the first week of field work, surface soil samples were taken at 5m (in the immediate vicinity of the garden) and 10 m (away from the garden) intervals along the transect. A total of 50 samples was collected and stakes were put in the ground at the collection points, so that the second set of samples could be taken from the same locations. The soil samples were collected with a clean trowel and placed in sterile, plastic bags, then sealed to prevent contamination.

In September 1977, after the plants in the experimental gardens had passed sexual maturity, 50 more samples were collected along the same transect.

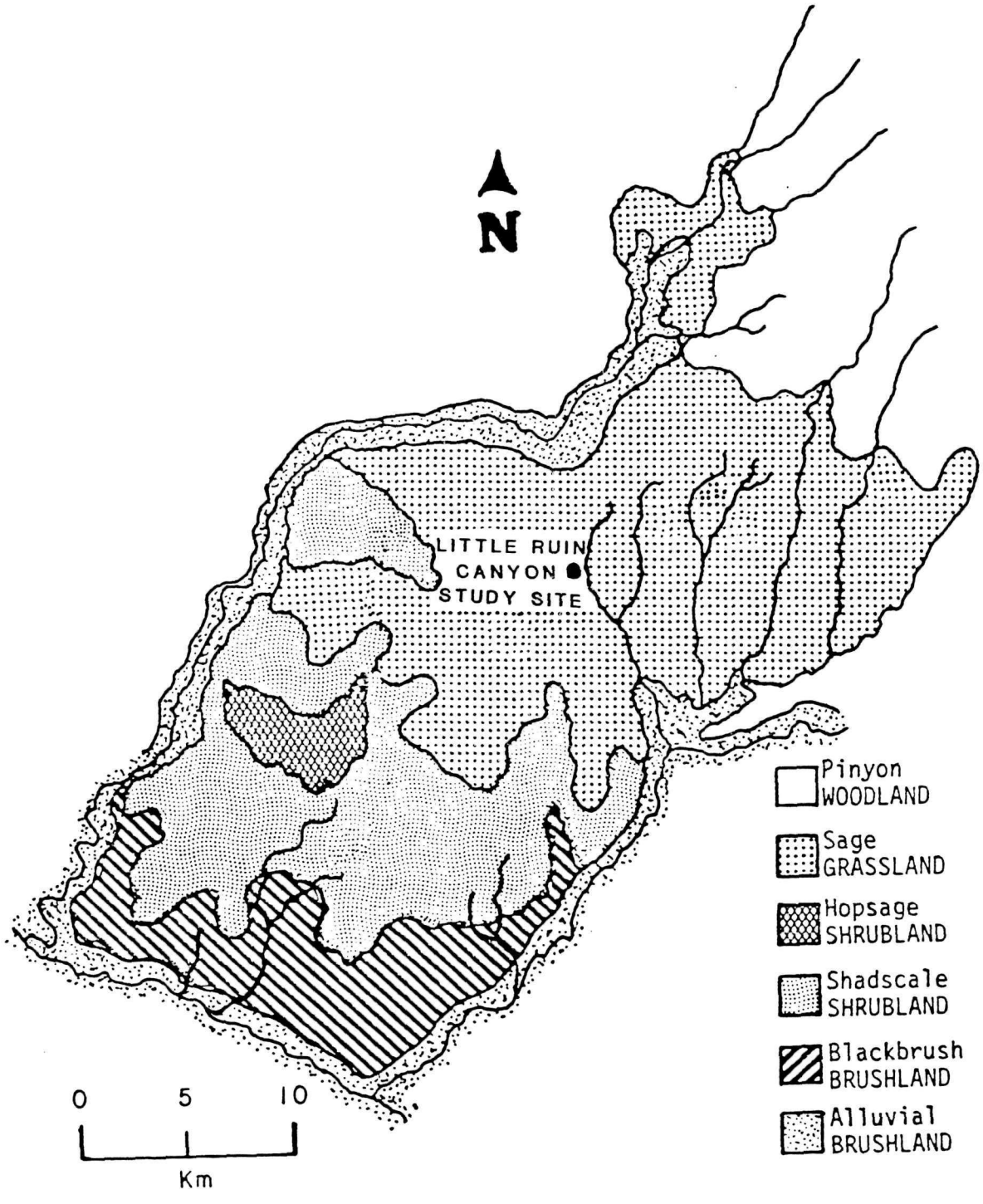

FIGURE 35 Cajon Mesa Vegetation Zones

(after Winter 1977)

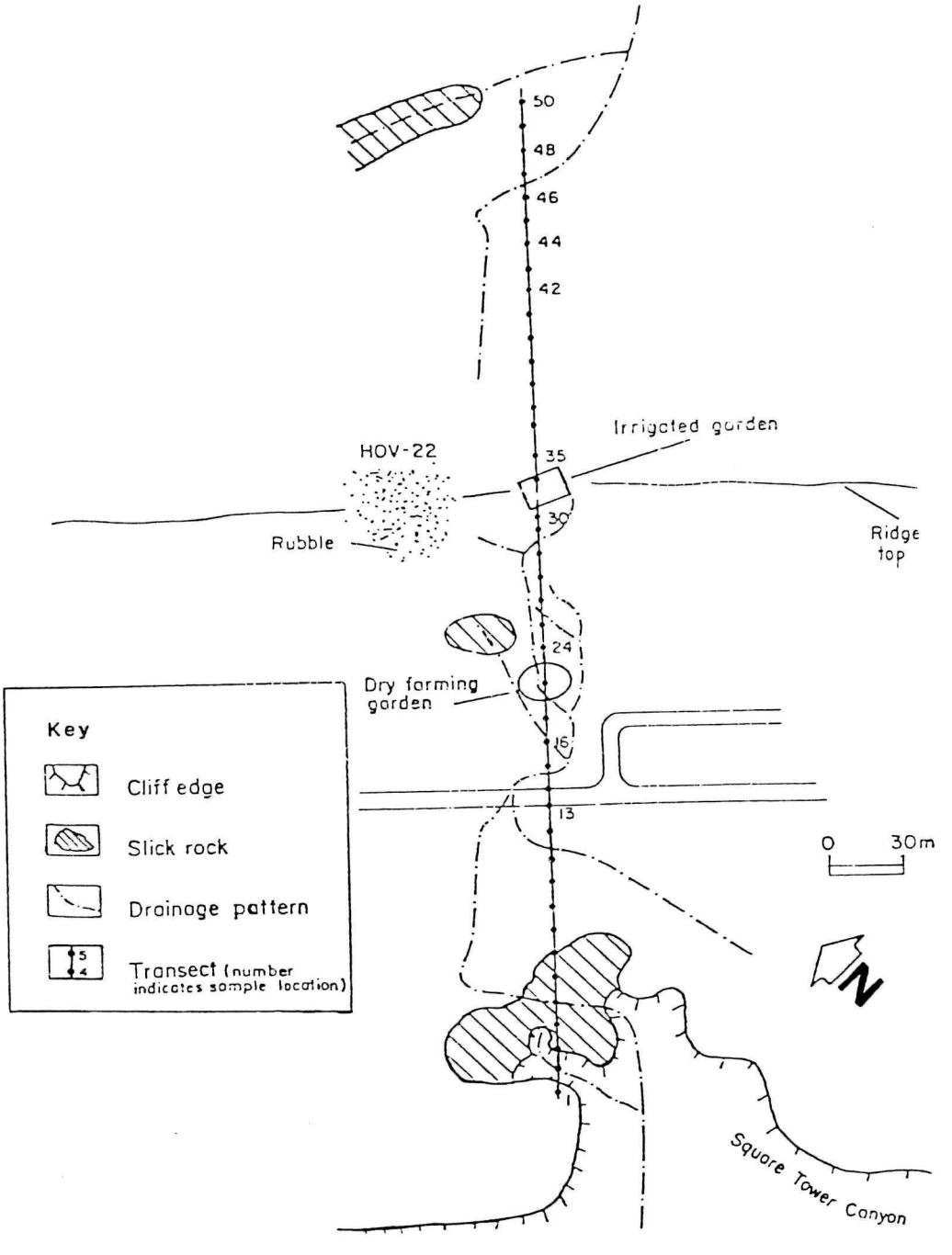

FIGURE 36 Pollen transect

During the interval between transects an attempt was made to inventory the flora of the Sage-Grassland association represented at Hovenweep, in order to better interpret the pollen data. This vegetation unit was previously mapped and described by Litzinger (1975) and Weir (1976). Combining their information with additional plant survey work, species lists for the area of the pollen study (Tables 8 - 10) were generated.

Laboratory Procedures

Soil samples were transported to San Jose State University where the pollen extraction was to be done. In order to extract the pollen, the soil samples were exposed to a series of chemical baths, each of which dissolved a particular soil element while leaving the pollen grains intact. The steps of pollen extraction follow:

1) Removal of carbonates with hydrochloric acid.
2) Hydrocloric acid washed out to a pH of 3.
3) Silicates removed with hydroflouric acid.
4) Hydroflouric acid washed out to a pH of 5.
5) Organic debris floated out with a solution of "Calgon" water softener (a mild base).
6) Calgon washed out.
7) Samples screened through micro-mesh to sort pollen grains by size.
8) Samples dyed with saffronine safranine.
9) Pollen concentrated using swirling technique.
10) Preparation of slides.

Results

Because of the time constraints only 16 of the 100 samples were put through the extraction process. All of these samples were collected during the first transect. Of the 16 only a few samples were mounted onto slides for pollen identification. At the time of the preliminary report additional extraction and pollen identification was promised, however, this was never accomplished. Identifications that were made from the few mounted slides were never quantified. The remainder of the samples were mislocated.

Summary and Conclusions

For a variety of reasons this experiment was never followed through to completion. Foremost was the realization that while in theory the project seemed to have merit, in reality it was not well enough controlled to provide useful information. Specific problems of the study are listed below:

1) The experimental gardens were much too small to provide an amount of pollen comparable to what would have presumably been produced by a prehistoric field. Also, only a handful of plants reached maturity in the gardens.

2) There was an extremely high probability of collecting cultigen pollen in the first control transect because a)gardens had been grown in the same location in past field seasons, and b) there was a preponderance of prehistoric sites in the area of the transects.
3) The physical setting of the transects, particularly in relation to soil formation (or lack thereof) made surface soil sampling meaningless. Soil on the mesa top is extremely thin and constantly eroding, bringing about continual mixing of old soil (and pollen) with younger materials.

Table 8: List of All Plants Found Within the Sage-Juniper-Grassland Area

The following plants are dominant within this zone:

Artemisia tridentata
Atriplex canescens
Chrysothamnus depressus
Cowania mexicans
Ephedra torreyana
Juniperus osteosperma
Opuntia hystricina
Rhus trilobata
Xanthocephalum sarothrae

The following trees did not occur within the study area, but were clos by as well as being anemophilous, thus their pollen could be present in the samples:
Celtis occidentalis
Pinus edulis
Populus fremontii
Salix exigua
Tamarix pentandra

The following trees occurred within the study area:

Fraxinus anomala
Quercus gambelii
Quercus turbinella

Shrubs:

Amelanchier utahensis
Berberis repens
Brickellia california
Eurotia lanata
Gossipium hirsutum
Grayia spinosa
Lycium pallidum
Prunus virginiana
Ribes aureum
Sarcobatus vermiculatus
Sheperdia argentea
Yucca angustissima

Grasses:

Agropyron desertorum
Aristida longiseta
Bouteloua gracilis
Bromus dnomalus
Elymus salinus
Hilaria jamesii

Table 8 - Continued

Grasses : (continued)

Oryzopsis hymenoides
Phragnites communis
Poa pratensis
Sitanion hystrix
Sprobolus diroides
Stipa comata
Vulpia octoflora

Forbs:

Arabis pulchra
Aster arenosus
Astragalus spp.
Calochortus nuttalli
Castilleja chromosa
Chaenactis douglasii
Cirsium neomexicana
Cryptantha gracilis
Cymopterus bulbosus
Draba reptans
Echinocereus coccineus
Heterotheca villosa
Leptodactylon pungens
Lomatium gravii
Penstemon augustifolia
Phlox longifolia
Senecio longilobus

Herbs:

Amaranthus californica
Appocynum canabium
Asclepias capricornum
Carex occidentalis
Chenopodium fremontii
Commandra umbellata
Convolvulus arvensis
Corydalis aurea
Delphinium nelsonni
Descurainia pinnata
Echinocactus whippleii
Eruastrum diffusum
Eriogonum densum
Erodium cicutarium
Euphorbia fendleri
Gilia sinuata
Halogeton glomeratus
Haplopappus ameroides

Table 8 - Continued

Herbs: (continued)

Hedeoma drummondii
Helianthus annuus
Juncus longistylis
Lactuca serriola
Lappula redowski
Lepidium campestre
Linum lewisii
Marrubium vulgare
Melilotus alba
Mentzelia punila
Mirabila multiflora
Oenothera coronopifolia
Plantago purshii
Phacelia corrugata
Polygonum sanathchense
Ranunculus testiculatus
Rumex hynenosepalus
Salsola pesifera
Sisymbrium altissum
Sphaeralcea angustifolia
Stanlyea pinnata
Strepyanthus cordatus
Swertia albomarginata
Taraxacum officinale
Towsendia incana
Tragopogon dubus
Typha latifolia
Xanthium spinosum
Zygadenus paniculatus

Table 9:List of all Plant Species Found in the Experimental Gardens

Domesticated Species:	Date of Blossom
Zea Mays var. Blue	8/20/77
var. White	8/20/77
var. Yellow	8/14/77
var. Red and Black	8/14/77
var. Mixed	8/14/77
var. Navaho Tribe	8/17/77
Cucurbita pepo	8/1/77
Phaseolus vulgaris	9/1/77
P. multiflorus	8/5/77
P. lunatus	8/26/77
Vicia faba	7/29/77
Lagenaria leucantha	8/29/77
Helianthus annuus var.Havasupai	8/29/77
H. annuus var.Hopi	8/29/77
Coriandrum sativum (non-native)	8/15/77
Solanum jamesii	8/1/77
S. fendleri	8/5/77
Physalis sp.	8/14/77
Cucurbita sp. (Dixie Queen Watermelon, non-native)	8/5/77

Weed Species:

Amaranthus californicus
Descurainia pinnata
Erodium cicutarium
Euphorbia fendleri
Lactuca serriola
Lepidium campestre
Melilotus alba
Salsola pestifera
Sitanion hystrix
Solanum elaeadgnifolium

Several Unidentified Grasses

Table 10:Description of All Plants Found Within the Study Area

Most botanical descriptions from Hovenweep Appendix 1975. Pollen information from Weir (1976).

Gymnospermae Ephedraceae - Ephedra Family

Ephedra torreyana S. wats — Mormon Tea
Common, medium, ternate, broomlike shrub also found in Pinyon-Juniper Woodland and infrequently in other zones. Vernal-aestival, anemophilous (Munz:1959).

Cupressaceae - Cypress Family

Juniperus osteosperma — Utah Juniper
Common shrub to small tree co-dominant with Pinyon in Pinyon-Juniper Woodland. Its occurence (without pinyon) in the upper regions of the sage-grassland can be interpreted as an ecotonal occurence found on canyon rims, ridges, and talus slopes. Vernal, Anemophilous (Weir:1976).

Amaranthus californica — Pigweed
Common, small, annual, coarse herb forming prostrate mat frequently in disturbed areas. Occurs as weed in experimental gardens. Aestival, anemophilous (Munz:1959). Frequently utilized plant of Pueblo Indians for many purposes.

Anacardiaceae - Sumac Family

Rhus trilobata Nutt. ext. & G. — Squawbush
Common, small slender-stemmed shrub usually growing in clumps. Found on canyon rims and talus slopes also in Pinyon Woodland and Shadescale Shrubland. Used for basketry by present day Pueblo Indians and probably aboriginally. Vernal, entomophilous. (Jaeger:1940).

Apocynaceae - Dogbane Family

Apocynum cannabinum — Indian Hemp
Occasional erect perennial herb from a spreading root system with woody stems. Located in arroyos. Fibers possibly used in weaving. Vernal-aestival, entomophilous (Wormington:1947).

Asclepiadaceae - Milkweed Family

Asclepias capricornum — Milkweed
Occasional perennial herb with inflorescence forming an umbel. Found in disturbed areas and along arroyos. Aestival, entomophilous utilized for numerous purposes by Pueblo Indians (Fewkes:1896).

Berberidanceae - Barberry Family

Rare small shrub, found along talus slopes. Vernal entomophilous.

Table 10 - Continued

Boriginaceae-Borage Family

Cryptantha gracilis — Cryptantha
Common small annual herb. Vernal, entomophilous.

Lappula redowsski — Stickseed
Common small annual herb. Located in disturbed places. Vernal-aestival, entomophilous.

Cactaceae - Cactus Family

Echinocactus whippleii — Fishook Cactus
Uncommon perennial succulent found on canyon rims, ridges and talus slopes. Vernal-aestival entomophilous.

Echinocereus coccineus — Hedgehog Cactus
Common perennial succulent. Found in most zones of this area on talus slopes and canyon rims. Vernal-aestival, entomophilous.

Opuntia hystricina — Prickly Pear
Common perennial succulent. All vegetation zones of this area on talus slopes and canyon rims. Vernal-aestival, entomophilous.

Capparidaceae - Caper Family

Cleome serrulata — Beeweed
Infrequent annual herb in mesa habitats such as along arroyos in canyon bottonms. Semi-cultivated in fields as an important food source by present day Pueblo Indians and probably aboriginally aestival, entomophilous.

Compositae - Sunflower Family

Artemisia tridentata — Big Sagebrush
Common medium sized woody shrub. Dominant species of this zone. Leaves used as spice and medicinally. Aestival-autumnal, anemophilous.

Aster arenosus — Dwarf Aster
Common small annual forb also found in Pinyon Woodland and Shadescale Shrubland. Vernal-aestival, entomophilous.

Brickellia california — California Brickelbush
Small perennial shrub with a woody base on rocky ledges and talus slopes. Aestival-autumnal, anemophilous.

Chaenaltis douglasii — False Yarrow
Common small annual forb. Vernal-aestival anemophilous.

Chrysothamnus depressus — Little Rabbitbrush
Low bush forming dense clumps. Common in all zones mostly in canyon bottoms. Plant used by present day Pueblo Indians for windbreak around gardens (Vestal:1940) and for dye (Whiting:1939). Aestival, entomophilous.

Cirsium neomexicanum — Thistle
Occasional, tall annual forb found in canyon bottoms and disturbed areas. Especially along roads. Vernal-aestival, entomophilous.

Table 10 - Continued

Compositae - Sunflower Family (continued)

Happlopappus ameriodes — Goldenweed
Annual herb usually found in aulluvial soil in rocky habitats. Vernal-aestival, anemophilous.

Helianthus Annuus — Common Sunflower
Large, common annual herb. Probably domesticated. Found in disturbed areas and frequently along roadsides.

Heterotheca villosa — Hairy Golden Aster
Common perennial forb with a semi-woody base. Found on canyon rims, disturbed habitats and roadsides. Aestival, entomophilous.

Hymenoxys acaulis — Perky Sue
Common perennial forb. Usually found on talus slopes. Vernal-aestival entomophilous.

Lactuca serriola — Wild Lettuce
Common low annual herb. Introduced from Europe. Aestival, entomophilous.

Senecio longilobus — Groundsel
Common perennial stem with woody stem. Occurs in disturbed areas due to grazing. Aestival, entomophilous.

Taraxacum officinale — Dandelion
Infrequent small perennial herb. Found in moist areas. Introduced from Europe. Vernal-aestival entomophilous.

Townsendia incana — Easter Daisy
Common small perennial herb. Also found in Pinyon-Juniper Woodland and on talus slopes. Vernal, entomophilous.

Tragopogon dubius — Salsify
Occasional perennial herb from a thick tap root. Found in disturbed areas and roadsides. Introduced from Europe. Vernal-aestival entomophilous.

Xanthium spinosum — Cocklebur
Common annual weedy herb of moist habitats in all zones. Aestival, anemophilous.

Xanthocephalum sarothrae — Snakeweed
Small common perennial shrub from a semi-woody base. Found in all vegetation zones. Found in extremely disturbed areas particularly those that have been overgrazed. Aestival-autumnal, entomophilous.

Table 10 - Continued

Convolvulaceae - Morning Glory Family

Convolvulus arvensis — Bindweed
Common small perennial deep-rooted herb with trailing stems. Found in disturbed habitats. A very troublesome weed in local fields and orchards. Vernal-aestival. Introduced from Europe.

Cruciferae - Mustard Family

Arabis pulchra — Rock Cress
Occasional medium slender stemmed perennial forb from a stout root. Found also in Pinyon-Juniper Woodland. Occurs on canyon rims and talus slopes. Vernal, entomophilous.

Descurainia pinnata — Pinnate Tansy Mustard
Common annual weedy herb found along arroyos and canyon bottoms. Foliage eaten today by Pueblo Indians and possibly prehistorically. Aestival, entomophilous.

Draba reptans
Common small annual forb in all vegetation zones. Vernal, entomophilus.

Lepidium campestre — Pepper Grass
Common small annual herb. Vernal, entomophilous.

Sisymbrium altissimum — Tumbling Mustard
Common annual herb in disturbed areas. Also found in Pinyon-Juniper Woodland. Introduced from Europe. Common under Juniperus along roads. Vernal-aestival, entomophilous.

Stanleya pinnata — Princes's Plume
Common large perennial herb with a woody base. Found also in Pinyon-Juniper Woodland. Occurs on canyon rims, canyon bottoms and talus slopes. Indicator of seleium in soils.

Streptanthus cordatus — Twist Flower
Common perennial herb in rock habitats of all vegetation zones. Vernal, entomophilous.

Cucurbitaceae - Gourd Family

Cucurbita pepo — Whiteflower/Bottle Gourd
Cultivated, annual, long-running branched-tendril pubescent vine. Planted in experimental garden. Probably introduced from old world tropics.

Cyperaceae - Sedge Family

Carex occidentalis — Western Sedge
Occasional perennial narrow leaved grass-like herb. Found near semi-permanent streams. Aestival, an emophilous. Used aboriginally for basketry.

Table 10 - Continued

Eleagnaceae - Oleaster Family

Sheperdia argenta — Buffalo Berry
Rare, stout tree like shrub. Vernal, entomomphilous.t

Euphorbiaceae - Spurge Family

Euphorbia fendleri
Common small low-growing annual herb. In most physiographic provinces. Vernal-aestival, entomophilus.

Fagaceae - Beech Family

Quercus gambelii — Gambel Oak
Occasional tree found on canyon rims and talus slopes. Vernal-aestival, anemophilous.

Quercus turbinella — Shrub Live Oak
Occasional shrub. Found on canyon rims and generally in rocky habitats in isolated populations. Vernal, anemophilous.

Fumariaceae -Fumitory Family

Coryclalis aurea — Golden Smoke
Common perennial herb on talus slopes. Vernal, entomophilous.

Gentianaceae - Gentian Family

Swertia albomarginata — Green Gentian
Common biennial herb. Aestival, entomophilous.

Geraniaceae - Geranium Family

Erodium cicutarium — Filaree
Common small, weedy annual herb. Found in disturbed habitats. Found as weed in test gardens. Vernal-entomophilous.

Table 10 - Continued

Graminae - Grass Family

Agropyron desertorum — Crested Wheat Grass
Common perennial grass with erect slender culms. Also in Pinyon-Juniper Woodland.

Aristida longiseta — Red Threeawn
Common perennial often bunched grass in lower mesa benches and a colonizer in sand dunes. Vernal-aestival anemophilous.

Avena sativa — Wild Oat
Introduced annual grass. Occurs as weed in experimental gardens. Vernal-aestival, cleistogamous.

Boutelous gracilis — Blue Grama
Occasional perennial grass.

Bromus anomalus — Nodding Brume
Occasional annual grass with slender culms. Found in arroyos, canyon bottoms, moist habitats, and seeps. Aestival, anemophilous.

Elymus salinus — Wild Rye
Occasional perennial grass. mental gardens. Many varieties. Vernal-aestival, anemophilous cliestogamous (possibly).

Hydrophyllaceae - Water Leaf Family

Phacelia corrugata — Scorpion Weed
Occasional annual or biennial herb in moist and disturbed habitats. Vernal-aestival, entomophilous.

Juncaceae - Rush Family

Juncus longistylis — Rush
Common perennial herb from short rootstocks in moist habitats. Presently and also perhistorically used in basketry.

Labiatae - Mint Family

Hedeona drummondii — Mock Pennyroyal
Occasional perennial herb from a woody base. Found on arroyo edges and rocky ledges. Aestival, entomophilous.

Marrubium vulgare — Horehound
Common perennial herb of disturbed habitats, such as roadsides. Naturalized from Europe. Vernal-aestival, entomophilus.

Table 10 - Continued

Graminae - Grass Family (continued)

Poa pratensis — Bluegrass
Common perennial grass with erect tufted culms usually found in canyon bottom alluvium. Early aestival, anemophilous. Introduced from Europe.

Sitannion hystrix — Squirreltail Grass
Common perennial grass with stiff erect culms. Found on arroyo banks (associated with Artemisia tridentata and Chrysothamnus nauseous) canyon rims, and canyon bottoms. Early aestival, anemophilous.

Sporobolus airoides — Alkalai Sacation
Common perennial grass from tufts. Early aestival, anemophilous.

Stipa conata — Needle and Thread
Common perennial grass from tufts. Early aestival, anemophilous.

Vulpia octoflora — Fescue
Occasional highly variable annual grass. Aestival anemophilous.

Zea mays — Maize
Coarse annual cultigen in experimental gardens. Many varieties. Vernal-aestival, anemophilous cliestogamous (possibly).

Hydrophyllaceae - Water Leaf Family

Phacelia corrugata — Scorpion Weed
Occasional annual or biennial herb in moist and disturbed habitats. Vernal-aestival, entomophilous.

Juncaceae - Rush Family

Juncus longistylis — Rush
Common perennial herb from short rootstocks in moist habitats. Presently and also perhistorically used in basketry.

Labiatae - Mint Family

Hedeona drummondii — Mock Pennyroyal
Occasional perennial herb from a woody base. Found on arroyo edges and rocky ledges. Aestival, entomophilous.

Marrubium vulgare — Horehound
Common perennial herb of disturbed habitats, such as roadsides. Naturalized from Europe. Vernal-aestival, entomophilus.

Table 10 - Continued

Leguminosae - Legume Family

Astragalus spp. — Milkvetch/Locoweed
Several species of this genus occur in the study area. All are common perennial forbs with stems arizing from a taproot or oblilque rhizome. All are aestival, entomophilous.

Melilotus alba — White Sweet Clover
Common weedy annual herb found in disturbed habitats. Cultigen introduced from Europe aestival, entomophilous.

Phaseolus vulgaris — Kidney Bean
Cultivated annual twining herb in experimental garden. Aestival entomophilous-cleistogamous.

Liliaceae - Lily Family

Calchortus nuttallii — Sego Lily
Common perennial forb from a corm. Found in all vegetation zones. Late vernal entomophilous.

Yucca angustissima — Narrow Leaf Yucca
Common perennial plant with short candices and leaves clustered near the ground. Vernal-aestival entomophilous-zoophilous.

Zigadenus venemosus — Death Camas
Common perennial herb from a corm. Found in all vegetation zones. Aestival, entomophilous.

Linaceae - Flax Family

Linum lewisii — Blue Flax
Occasional perennial herb from a thick semi-woody rootstock. Vernal-aestival, cleistogamous.

Loasaceae - Loasa Family

Mentzelia pumila — Blazing Star
Infrequent perennial herb in rocky habitats. Aestival, entomophilous.

Malvaleae - Mallow Family

Sphaeralcea angustifolia — Narrow Leaf Mallow
Occasional perennial herb with this stems and sparse foliage found on canyon rims and talus slopes. Aestival, entomophilous. Used medicinally by present-day Pueblo Indians.

Gossypium hirsutum — Cotton
Weedy perennial woody cultigen shrub. Aestival cleistogamous-entomophilous. Grown aboriginally.

Table 10 - Continued

Nyctaginaceae - Four O'Clock Family

Abronia fragrans — Sand Verbena
Common perennial herb found in canyon bottom alluvium. Aestival, entomomphilous.

Mirabilis multiflora — Colorado Four O'clock
Occasional perennial herb from a thick underground stem and thick rootstock. Found in canyon bottoms and arroyos. Early aestival, entomophilous. Used for various medicinal purposes by Pueblo Indians.

Oleaceae - Olive Family

Fraxinus anomala — Singleleaf-Ash
Occasional tree in canyon bottom alluvium, canyon rims and talus slopes. Vernal-aestival, anemophilous.

Onagraceae - Evening Primrose Family

Oenothera coronopifolia — Evening Primrose
Common perennial caulescent herb from a slender tap root. Vernal-aestival, entomophilous.

Plantaginaceae - Plantain Family

Plantago purshii — Woody plantain
Common small annual herb of moist habitats in all vegetation zones.

Polemoniaceae - Phlox Family

Gilia sinuata — Gilia
Common small annual herb. Aestival entomophilous.

Leptodactylon pungens — Granite Gilia
Common small woody perennial forb found on canyon rims and talus slopes. Vernal-aestival entomophilous.

Phlox longifolia — Phlox
Common perennial forb found in rock habitats such as talus slopes. Vernal-aestival, entomophilous.

Polygonaceae - Buckwheat Family

Eriogonum clensum — Wild Buckwheat
Common small annual herb in all physiographic regions of this zone. Aestival, entomophilous.

Polygonum sawatchense — Knotweed
Common small annual herb under shrubs and trees. Aestival, entomophilous.

Rumex hymenosepalus — Wild Rhubarb
Common perennial herb from a thick tap root found in canyon bottom alluvium and talus slopes. Late vernal, anemophilous.

Table 10 - Continued

Ranunculaceae - Buttercup Family

Delphinium nelsonii — Larkspur
Common perennial herb in most physiographic regions of this zone. Vernal-aestival, entomophilous.

Ranunculus testiculatus — Buttercup
Common small annual herb. Early vernal, entomophilous.

Rosaceae - Rose Family

Amelanchier utahensis — Utah Serviceberry
Common large shrub found on canyon rims and heads and talus slopes. Vernal, entomophilous.

Cowania mexicana — Cliff Rose
Common shrub found on canyon rims and talus slopes. Vernal-aestival, entomophilous.

Prunus virginiana — Choke Cherry
Occasional shrub found in arroyos, canyon bottoms and talus slopes. Vernal-aestival, entomophilous.

Salicaceae - Willow Family

Populus fremontii — Fremont Cottonwood
Occasional medium to large tree found along drainages and moist habitats. Vernal-aestival, anemophilous. This species was not found precisely within the study area, but because it was nearby and anemophilous, its pollen could be found within the study area.

Salix exigua — Sandbar Willow
Common small tree or shrub found in arroyos, canyon heads, canyon bottoms, seeps, springs and moist habitats. Vernal-aestival anemophilous. This species is similar to Populus fremontii

Santalaceae - Sandalwood Family

Commandra umbellata — Bastard Toadflax
Common to occasional annual herb. Found on arroyo banks. Aestival, entomophilous.

Saxifragaceae - Saxifrage Family

Ribes aureum — Golden Currant
Rare shrub in moist habitats such as arroyos, canyon bottoms, canyon heads, seeps, and spring. Edible fruit.

Scrophulariaceae - Figwort Family

Castilleja chromosa — Indian Paintbrush
Common perennial herb from a woody base. Vernal-aestival entomophilous

Penstemon angustifolius — Penstemon
Occasional-common perennial herb. Aestival, entomophilous.

Table 10 - Continued

Solonaceae - Potato Family

Datura meteloides — Jimson Weed
Rare perennial large herb from woody base in isolated locales as exotics near Navaho fields, arroyos, and canyon bottoms. Vernal-autumnal entomophilous. Used for religious purposes in past by Pueblo Indians.

Lycium pallidum — Wolfberry
Occasional small woody shrubs only in disturbed areas. Frequently occurs on prehistoric sites. Vernal-aestival, enotomophilous. Edible fruit eaten by Pueblo Indians today.

Physalis fendleri — Ground Cherry
Rare perennial herb of disturbed habitats. Grown in experimental garden. Aestival, entomophilous. Solanum triflorum — Wild Tomato
Rare annual herb only in the experimental garden. Aestival, entomophilous possibly cleistogamius.

Tamaricaceae - Tamarix Family

Tamarix pentandra — Tamarix
Common shrub or small tree along arroyos and canyon bottoms. Early aestival, anemophilous introduced from southeastern Europe.

Typhaceae - Cattail Family

Typha latifolia — Common Cattail
Common perennial aquatic. Found also in the alluvial zone, reservoirs, seeps and springs. Aestival, anemophilous.

Ulmaceae - Elm Family

Celtis occidentalis — Hackberry
Occasional shrub or small tree in moist areas such as canyon heads, seeps and springs. Vernal-aestival, anemophilous.

Umbelliferae - Carrot Family

Cymopterus bulbosus
Common perennial forb with short underground stems and taproots. Found in rock habitats. Vernal, entomophilous.

Lomatium grayii
Occasional perennial herb from a thick taproot. Vernal, entomophilous.

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AN INTRA-REGIONAL STUDY OF HOVENWEEP MAIZE

by Dorothy Reaves-Haas

Introduction

The evolution of corn (Zea mays) has long been studied (Nickerson, 1953; Galinat and Gunnerson, 1963; Magelsdorf, 1974). Many people have spent years debating and writing about its progression from a wild plant to one of the most important domestic crop plants. The main questions for the southwestern archeologist have been: 1) where corn was orginally intensively manipulated by human populations; and 2)how different varieties of maize arrived in the southwestern region of the United States. The eight-rowed cob has been of specific interest because it was commonly cultivated in the Southwest during a period of rapid population growth during Pueblo II times (Galinat and Gunnerson, 1963).

This paper is concerned with what information the corn cob can provide in connecting the archeological past at Hovenweep with the ethnographic information about contemporary Pueblo societies. I have planned and completed testing aimed at finding Anasazi corn cobs and, together with Gayl del Pero, devised computer programs to analyze such remains. I propose to explain my procedure for obtaining the material recovered from Hovenweep, the nature of the data themselves, and my results in the next few pages.

The chronology of specific sites must be considered at this point. It is important to know length of occupation of rooms from which maize was recovered because the Anasazi clearly abandoned and revisited sites. Such was the case at Hovenweep 520, for instance, where the remodeling of walls and various floor levels through time was evident. The documentation of maize by C-14 dates is necessary to extablish the chronological sequence of occupations.

Based on past excavations the presence of corn was predicted at Hovenweep sites 597 and 47. After testing many rooms in each site, only one additional burned room containing maize was found at Hovenweep 597. After testing over 50 percent of the rooms at Hovenweep 520, no burned rooms with significant quantities of corn were revealed; only three cobs were recovered from a fire pit. Therefore, out of all the testing conducted during the summer of 1977, there is only one room to add to the previous data from 1976 (Reaves, 1977) making a total of three rooms with corn to analyze. None of the previous statistics, however, had been studied from an intra-regional perspective. Consequently, corn recovered from the combined 1976 and 1977 seasons comprised the sample size on which this study is based.

The Problem

The successful outcome of this study depended upon the recovery of corn cobs from a prescribed number of rooms at the sites tested. The sites were selected for testing on the basis of data gathered during excavation in 1976 (Winter 1977). In that season Hovenweep sites 597 and 47 provided large

quantities of carbonized corn cobs from a single room at each site. Testing of one of the rooms in the roomblock at Hov 47 revealed two possible hearths containing hundreds of charred corn cobs and kernels. At Hov 597 the test pits in the room block yielded several liters of charred corn cobs and kernels and the remains of a smashed Mancos corrugated vessel (Winter, 1977). It was projected that further testing would locate other nearby rooms which would also contain more caches of carbonized corn. Additionally, the two sites were chosen because of their geographic location. They are both mesa top sites with elevations between 1600 and 1650 meters above sea level. Slope is minimal and both sites are in the sagebrush vegetation zone which is characteristically deep soiled (Litzinger, 1976). Deep soil is essential to maize growth (Mangelsdorf, 1974).

The roomblocks at both sites are built in an L-shaped design with tower, kiva, and midden elements. Roomblocks contain at least 6 to 8 rooms each. Dates from these sites have been determined through ceramics and by Carbon-14 analysis of carbonized cobs. Hovenweep site 597 was dated to A.D. 1190 $\pm$ 100 and Hovenweep 47 to A.D. 1615 $\pm$ 120 (Winter, 1977). The latter date may be unrealistically late (ibid.).

Hovenweep site 520 was also included in the 1977 testing program because it is the nearest neighbor to Hovenweep site 597 (aproximately 100 meters to the west). Because of their geographic proximity, these sites may have been closely related in terms of community sharing for example. Hov 520 is also physiographically similar to both Hov 597 and Hov 47.

The basic goal of this study was to compare intrasite and intersite variation of corn cob morphology from the rooms in each of these three sites. If the corn in the rooms displayed distinctive morphological differences, then it might be assumed that diverse varieties were represented. Perhaps the seed corn was kept separate from the food corn by the people planting and harvesting them. If no distinctive characteristics could be observed, cob varieties would probably have been mixed indiscriminately.

Contemporary Pueblo peoples consider corn seeds the property of matrilineal clans. Seeds are passed through the generations along the female line and great care is taken to preserve the integrity of specific maize varieties (Hargrave, 1932; Whiting, 1937). Seeds are shared on specific occasions only or to assume/negate social obligations (Miksicek, 1974; Winter, 1976). Ethnographic information concerning the matrilineal household control of specific varieties of corn may form the basis for understanding Anasazi grown maize and, more importantly, some social implications associated with corn during prehistoric times.

Methods

The tangible corn cob is the basis for determining morphological differences among varieties of maize. Several morphological variables are selected: row number, diameter, cupule width, rachis diameter, glum width, and glum thichness. Calipers with an accuracy of 0.5 millimeters are used for measuring these characteristics. Measurement points, drawings, and descriptions of all characteristics are described (Fig. 37). For example, glum width and thickness, depicted in Fig. 37, is a measurement of the lower section of the corn kernel or seed (Miksicek, 1974) and is important in establishing corn cob type (Cutler, 1966).

There are few difficulties in the retrieval of the corn cob fragments. Cobs thus far recovered as caches have been completely burned and fused with room material adhering to the cobs. Cobs and other carbonizing materials were excavated in the clumps in which they were found. All of the dirt around the material was then sifted, working toward a 100% sample of the cobs and kernels. In order to expose the cobs and kernels it was necessary to laboriously pick and pry the pieces apart with dental tools. Final cleaning was done with fine paint brushes and picks. The cobs and kernels were then wrapped and labeled. Next comes the task of measuring each cob fragment. A fragment had to be three quarters to full diameter to be included in the analysis. Angles of partial cobs have been used to compute cob size (Miksieck, 1974), however I have tried this method but met little success.

Other problems in conducting the analysis included the comparison of charred cobs to uncarbonized cobs. Cutler (1966) stated that carbonized cobs shrink twenty percent from original size, but he does not qualify this statement. Information about shrinkage is needed to compare data from carbonized cobs at Hovenweep with neighboring areas. Dry caves frequently preserve uncarbonized cobs which cannot be directly compared with the carbonized material; degree of shrinkage must be estimated.

It is difficult to recreate the situation that occurred during carbonization because the following variables are not known: the temperature of the fire, the moisture content of the cob (whether it had been dried or was fresh), duration of the fire, or how the fire was extinguished. Each of these variables could cause differential shrinkage of cobs.

Another problem with cob fragments is that they are frequently broken and the precise number of cobs is unknown. If all partial cobs are measured and added into the total number of cobs, then the sample may not be representative and the data are consequently distorted. One must determine the percentage of fragmented material when conducting the analysis.

Programed Data

Through the SPSS (Statistical Package for the Social Sciences) computer programing method, the statistician, Gayl Del Pero, and I worked on a partial correlation coefficient program. This provides a measure of association describing a relationship between an independent and a dependent variable while adjusting for the effects of one or more control variables. The goal was to determine if a spurious relationship existed between two

Figure 37

Corn Cob Morphology

1. Row number - count number of rows of grains around cob or count the rows of cupules and multiply by 2.

2. Diameter - measure across outside of glums on both axis then take the average (this takes into account lopsided cobs).

3. Rachis - measure both axis of the central core of the cob and take the average.

4. Cupule width - measure from tip to tip, the pocket holding one pair of grains.

5. Glum width - measure parallel to cupule width, the lower portion of the grain left on the cob.

6. Glum thickness - measure perpendicular from cupules, the lower portion of the grain left on the cob.

*All cobs should be measured as close to the center of the cob as possible. (after Nickerson, 1953)

variables (Blalock, 1972:433-450). First we ran a program called Pearson's Product which measures the strength of a relationship in a linear manner between two interval-level variables (Blalock, 1972:376-393). By comparing the coefficient obtained while controlling for each of the variables with Pearson's r (Table 11) it could be ascertained if any one variable appeared to be having an influence of the other variables. After controlling for each variable of the corn cob being studied, it was determined that the diameter carried the greatest effect on the other variables (Table 12). These findings help to establish a causal theory (Fig. 38) and explain the relationship indicated above by the Pearson's r coefficients:

1. As the diameter increases the number of rows is likely to increase.
2. As the diameter increases the size of the rachis is likely to increaase.
3. As the rachis increases the cupule width is like to increase.
4. As the cupule witdth increases the glum thickness is likely to increase.

Diameter was not expected to be the controlling variable as row number is the characteristic most studied by botanists as the controlling factor in the genetic make-up of the corn cob. Even after controlling for row number and diameter together and then separately, row number did not affect the size of the other characteristics to any measurable degree. This is not to suggest that row number is not genetically controlled. It does not, however, seem to have direct bearing on the size of the other variables, but rather seems to work independently.

What this information indicates is that there are other variables besides row number that should be considered in the cob typology by region. So far,

Figure 38

Causal Theory Diagram

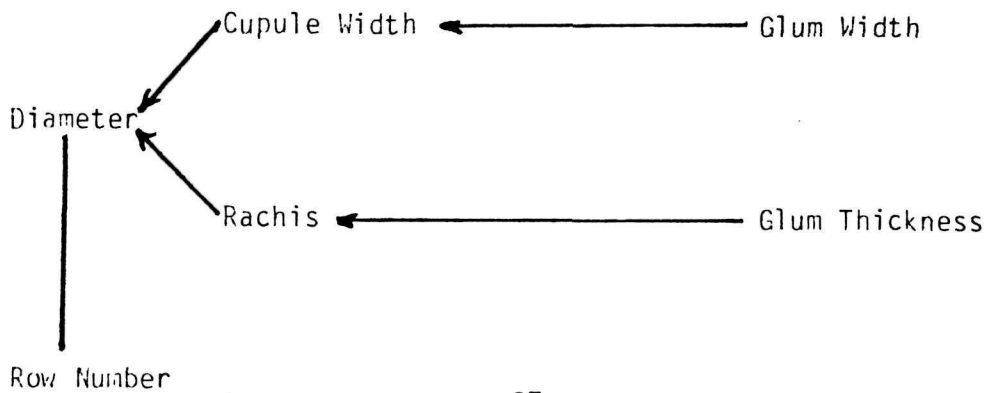

Table 11:Pearson Correlation Coefficients*
for Three Corn Cob Morhpological Attributes

Diameter	Rachis	Cupule Width	Glum Width	Glum Thickness	
Row	0.4376	0.3276	-0.2095	0.0739	-0.0792
Diameter		0.5414	0.3898	0.3751	0.3409
Rachis			0.1854	0.5138	-0.0464
Cupule Width				0.1416	0.4636
Glum Width					-0.0440

*The coefficient values indicate a measure of goodness of fit of variable values about a straight line with a value of zero indicating random distribution while a value of +1.0 or -1.0 (depending on positive or negative correlation) indicates all points lie exactly on a straight line. The better the fit to the straight line the larger the value.

Table 12:Partial Correlation Coefficients* Controlling for Diameter

	Rachis	Cupule Width	Glum Width	Glum Thickness
Row	0.1200	-0.4591	-0.1083	-0.2701
Rachis		-0.0331	0.3987	-0.2922
Cupule Width			0.0054	0.3820
Glum Width				-0.1973

*All coefficients show a decrease or movement to the left when compared to Table 11 indicating diameter is having an effect on all variables (spurious relationship).

most regional studies indicate the percentage of row numbers and then type the cob. But row number is not completely dependent on genetics and can fluctuate due to the environment (Cutler, 1966). Diameter may also be controlling the cob genetically. Also grain width and thickness as shown in the glum are sometimes characteristic of definite varieties of corn (Cutler, 1966). The computer program revealed that these variables are controlled to a certain extent by cupule width and rachis. Therefore, the latter may also define varieties of corn. Cutler (1966) states that the rachis has already been of central importance in the comparison of cobs from many areas.

Over 50 percent of the rooms at Hov 597 and 47 were tested for corn remains but only three rooms revealed corn. See the site maps for placement of the test pits and the numbered sequence of rooms (in Section I). Rooms were numbered for computer designations and to correlate room placement between sites. Had corn been found in more rooms and sites, the nearest neighbor analysis would be applicable (Washburn, 1974). This prodecure would study intrasite and intersite similarity with variables such as distances between rooms, sites and size of room. The theory is that sites closer together will exhibit more homogeneity than those farther away for intersite analysis while intrasite analysis centers of cativity within a site may be located. It would also compare the sites as complete entities and determine if similarities existed in rooms across the sites.

The data accumulated from the computer programs are reproduced in Table 13. In order to standardize the sample to avoid misleading result size percentages were used in place of frequency counts. By comparing the three rooms in each category, trends are evident. In this sample, Room 2 of Hov 597 appears to exhibit a higher percentage of cobs of smaller glum width, smaller rachis and larger slum thichness as compared to Room 6 of the same room block. Room 6 of Hov 47 appears to more closely correspond to Room 6 of Hov 597. These trends seem to indicate that as glum width increases, glum thickness decreases and as rachis increases, glum thickness decreases. Cupule width and row number seem to carry no trends. It is possible that these data may be indicating similarity in cob variety in Room 6 of the two sites and dissimilarity between them and Room 2 of Hov 597. Rooms 6 in both sites are also in the smae placement in each roomblock which could indicate that varieties were not only kept separate, but also were designated to particular rooms.

All these results can only be outlined as trends because the sample size of rooms and sites is too small for statistic validation. The trends coincide with the above hypothesis indicating that corn varieties within rooms, and even within paired rooms between sites, might be distinctive due to matrilineal households and thereby control of specific varieties.

Table 13: Percentages of Occurrence of Corn Cob Attributes

Millimeters	Glum Width			Glum Thickness			Rachis		
	Site 597		Site 47	Site 597		Site 47	Site 597		Site 47
	Rooms		Room	Rooms		Room	Rooms		Room
	2	6	6	2	6	6	2	6	6
1.5	5.9	1.0	0.0				2.3	0.0	0.0
2.0	46.8	4.9	15.0	9.0	39.8	36.0	16.2	9.7	6.0
2.5	40.1	16.5	28.0	17.6	36.9	36.0	28.8	7.8	6.0
3.0	7.2	41.7	48.0	47.3	22.3	24.0	40.5	43.7	33.0
3.5	0.0	29.1	5.0	21.2	1.0	3.0	9.0	11.7	14.0
4.0	0.0	6.8	2.2	5.0	0.0	1.0	2.7	17.5	21.0
4.5							0.5	4.9	8.0
5.0							0.0	2.9	5.0
5.5							(Averaged		with 6.0)
6.0							0.0	1.9	7.0

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HOVENWEEP ROCK ART: ANASAZI AGRICULTURAL ICONOGRAPHY

by Nancy H. Olsen

This study presents a new perspective of Anasazi rock art, demonstrating categories of social use historically and suggesting a continuity of those categories from prehistoric times.

This perspective is developed from two sources. First, Southwestern systems theory (Longacre 1970; Binford 1972; Hill 1970a, 1970b) permits reassessment of early ethnographic data concerning rock art, making it now possible to place it in a cultural context. Further, anthropological interest in art as a communication system (Conkey 1978; Munn 1971; Geertz 1970; Charbonnier 1969), Cognitive symboling strategies (Colby 1975; Fischer 1971; Voeglin and Voeglin 1961) and symbol structure (Munn 1973; Washburn 1977) furnish methods for understanding social purposes and functions of iconography. Second, three summers of archeological research at Hovenweep National Monument (Winter 1975, 1976, 1977) provide context information for the symbols. Comparison of site type with the kinds of symbols found appear to indicate patterns of use as part of the Anasazi farming adaptation to Cajon Mesa.

ROCK ART ETHNOGRAPHY AT HOPI AND ZUNI

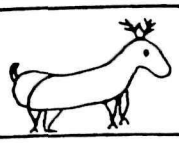
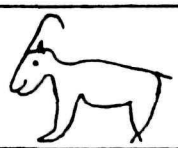
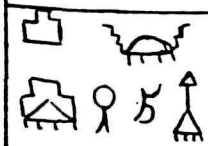
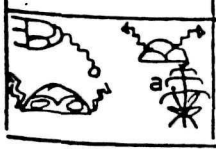
Intentional use of rock art by the Hopi and Zuni goes beyond speculation. Ethnographers noted in their journals and reports between 1880 and 1960, various uses of rock art representing four interconnected cultural categories: social, economic, political and religious (Fewkes 1892, 1896, 1897, 1900, 1973; Colton and Colton 1931; Colton 1960; Titiev 1937, 1944; Beaglehole 1937; Forde 1931; Parsons 1936; Stevenson 1905; Roberts 1932; Cushing 1920).

Unlike other cultural groups such as those in the Great Basin who no longer had a tradition or memory of a tradition of rock art manufacture when Steward was there (1927), the Hopi and Zuni, in the 1880s and 1890s, continued to make and use rock art images within the pueblo environs, on the talus slopes, along trails, at springs and in agricultural fields. Fewkes (1892) observed that rock art symbols also appeared on dance rattles, kachina masks, sand paintings, in ceremonial bowls, and on plaques. Hence it appears that Western Pueblo rock art motifs are part of a larger visual code which uses graphic signs to articulate adaptive information within the society and between the culture and the environment.

Clan Symbols

Comparing information from Fewkes (1892, 1897, 1900, 1906), Forde (1931, 1949), Titiev (1937, 1944), and Colton and Colton (1931), clan symbols can be found in a great variety of places with no change in meaning diachronically or synchronically (see Table 14). Shrines, ceremonial prayer sticks, U.S. government vouchers, and farm fields all carried clan symbols identified by informants between 1880 and 1960.

TABLE 14: Clan Symbols 1886 - 1937

	DEER CLAN	FEWKES 1897
	HORN CLAN	COLTON 1960
	HORN CLAN	COLTON 1960
	MOUNTAIN SHEEP CLAN	MALLORY 1886 COLTON 1960
	MOUNTAIN SHEEP CLAN ANTELOPE KIVA	FEWKES 1897 STEPHEN 1936
	DEER CLAN (TRACKS)	MALLORY 1886
	TADPOLE CLAN	FEWKES 1897
	RAINCLOUD CLAN CLOUD CLAN	FEWKES 1897 COLTON 1960
	RAINCLOUD CLAN CLOUD CLAN	COLTON 1960
	RAINCLOUD CLAN	FEWKES 1897 a.Sun Priest Chief

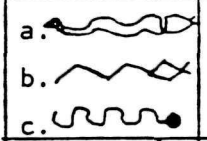
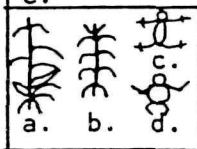
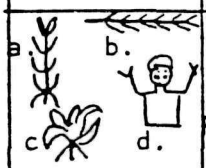
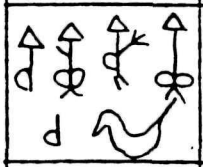
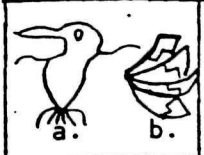
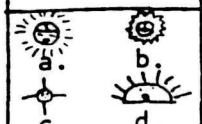
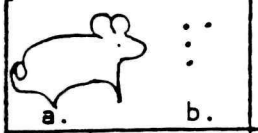
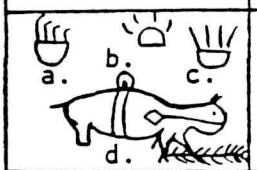
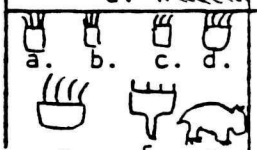
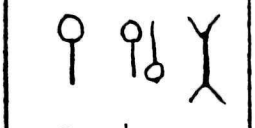
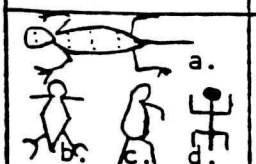
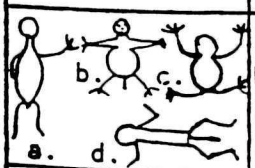
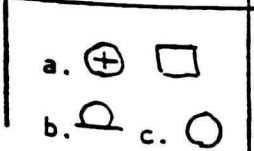
	CACTUS CLAN	FEWKES 1897 ANTELOPE CHIEF PRIEST
	DOVE CLAN	FEWKES 1897
	SNAKE CLAN	MALLORY 1886 FEWKES 1897 COLTON 1960
	CORN CLAN	a.FEWKES1897 b.COLTON1960 c.COLTON1960 d.variations
	REED PHRATRY/CLAN	FEWKES 1897 a.,b.,c., different plant species
	REED CLAN	COLTON 1960
	EAGLE CLAN	FEWKES 1897
	EAGLE CLAN	COLTON 1960
	EAGLE CLAN	MALLORY 1886 b.Eagle tail
	SUN CLAN	FEWKES 1897 a.b.c. d.COLTON 1960

Table 14 - Continued

 a. b.	RABBIT CLAN	FEWKES 1897 b. Rabbit track
a. b.	RABBIT CLAN	COLTON 1960
 a. b. c. d.	BADGER CLAN	a. FEWKES 1897 b,c COLTON 1960 d. FEWKES 1897
 a. b. c. d. e. f. g.	BEAR CLAN	a,b,g MALLORY 1886 c. FEWKES 1897 d,e,f, COLTON 1960
 a. b. c.	BEAR-STRAP CLAN	a. FEWKES 1897 b. COLTON 1960 c. FEWKES 1897
 a. b. c. d.	LIZARD CLAN	a. FEWKES 1897 b,c, MALLORY 1886 d. COLTON 1960
 a. b. c. d.	HORNED TOAD CLAN	a,b,c, MALLORY 1886 d. FEWKES 1897
	PUMA CLAN	COLTON 1960
 a. b. c.	SAND CLAN EARTH CLAN	a. COLTON 1960 b. TITIEV 1937 c. FEWKES 1897

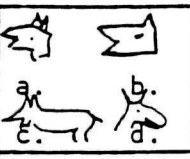
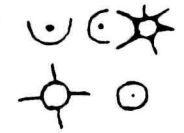
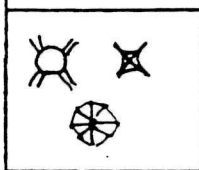
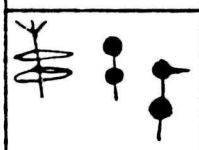
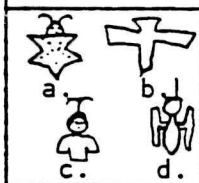
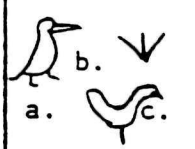
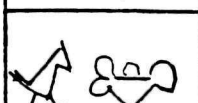
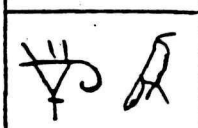
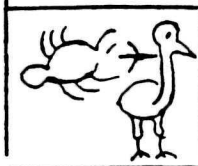
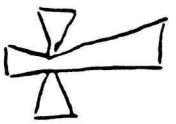
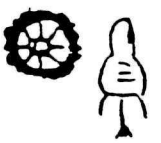
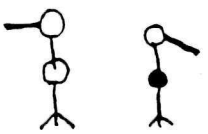
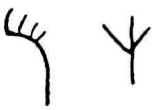
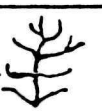
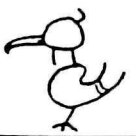
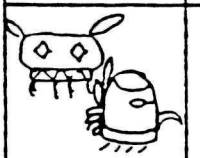
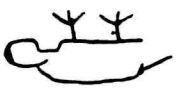
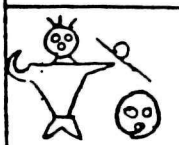
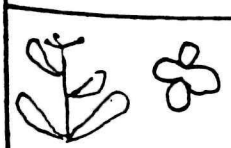
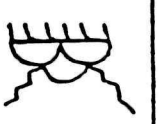
 a. b. c. d.	COYOTE CLAN	a,b, MALLORY 1886 c,d, COLTON 1960
	MOON CLAN (extinct)	COLTON 1960
	SPIDER CLAN	COLTON 1960
	RED ANT CLAN	COLTON 1960
 a. b. c. d.	BUTTERFLY CLAN	a. MALLORY 1886 b,c. COLTON 1960 d. FEWKES 1897
 a. b. c.	CROW CLAN	a,b,c COLTON 1960 b. MALLORY 1886
	BLUEBIRD CLAN	a,b COLTON 1960
	PARROT CLAN	COLTON 1960
	CRANE/HERON CLAN	FEWKES 1897

Table 14 - Continued

	TURKEY CLAN	MALLORY 1886 turkey tail		SQUASH FLOWER CLAN	FEWKES 1897
	BITTERNS (wading birds)	MALLORY 1886		CORN CLAN	FEWKES 1897 Hano
	Unidentified bird tracks	MALLORY 1886		GREASEWOOD CLAN	FEWKES1897
	PIGEION-HAWK CLAN	FEWKES 1897		KACHINA CLAN	FEWKES 1897
	GOPHER CLAN	FEWKES 1897		KACHINA CLAN	FEWKES 1897 Mudhead
a. b.	BOW CLAN	a.COLTON1960 b.FEWKES1897	a. b. c.	KACHINA CLAN	COLTON 1960 a,b,c MALLORY 1886
	RABBIT-STICK CLAN	FEWKES1897		MASAWUH CLAN (Firewood)	FEWKES 1897
	RABBIT BUSH CLAN	COLTON1960		SNOW CLAN	COLTON 1960
 a. b.	TOBACCO CLAN	FEWKES1897 a. Hano b.Oraibi		SNOW CLAN	FEWKES1897 Hano

If clans are the basic economic unit of the Western Pueblos, as Beaglehole (1937) asserts, then the use of the clan symbol is concerned with the economic rights to access, heredity ownership, identification, and fulfillment of obligations to the community, one's clan, and one's own lineage.

In an agricultural context, Forde (1931) and Titiev (1944) observed clan symbols incised into boulders at farm fields, but not in any regular order. Beaglehole (1937) and Titiev (1944) observed that boundary lines ran between clan fields along sight lines and were learned through oral tradition. Titiev (ibid.) documented that clan symbols were used in farm fields only when a boundary dispute was settled. He further notes that the Bear Clan on Third Mesa has a traditional position of Village Chief and is the final land authority for Oraibi. The Bear Clan mark is found on the outermost limits of Oraibi land designating those boundaries.

Other abstract marks and images were used to define boundaries between mesas. Forde (1931) noted that Hopis used:

> Boulders . . . incised with a horizontal T, whose leg pointed towards First Mesa . . .

in order to define limits between First and Second Mesa. In 1893 Stephen (Parsons 1936) notes a stone figure acting as a boundary marker on the trail between Oraibi and Shungo-povi, placed there to resolve an argument over land limits. Thus the use of graphic signs in Hopi agriculture is a visual document validating change and/or resolution of land stress.

Clan symbols tabulated by Colton and Colton (1931) and witnessed by Titiev (1937), on the other hand, are identification signatures when used by initiates and guides of the Horn-Antelope Society on the Salt Gathering pilgrimage to Salt Canyon. Both left their clan marks on a shrine rock along the presecribed route. Titiev observed that rows of clan symbols were made by adding one's mark to the left of the last mark made by one's clan (1937:245). Colton (1960) corroborates this tradition and was given identification by a Hopi, of many symbols both prehistoric and historic. Identical symbols on ceremonial paraphernalia may serve to identify clan ownership and/or participation in a religious event.

Religious Symbols

In 1906 Fewkes recorded the shrines near First Mesa. No anthropomorphic figures are found in shrines, nor do all shrines have images. Oral tradition supplies information about all shrines found along the trails, in boulder cracks, at cardinal points of the compass, on talus boulders of the mesas' slopes and base, and in the village plazas. A Toho (or mountain lion) Shrine used for curing and Kwataka (a bird monster) Shrine are incised with respective images since they play an active role in the ceremonies. Offerings of meal to Toho and medicine to Kwataka are placed in depressions representing their hearts during Winter Solstice ceremonies (Fewkes 1906). Snake shrines at cardinal compass points are visited during Flute and Snake

Ceremonies, two shrines have snake images. (See Table 15 for a listing of graphic elements.)

Stevenson accompanied members of a society from Zuni in February 1896 to a seep shrine outside the village. The visit was part of a minor ceremony of Salako. There she photographed negative hand prints and anthropomorphic figures on the rock above the spring.

Clan Origins and History

Zuni clan origin myths are associated with a small valley several miles from the village. Stevenson recorded a trip to that site and reports that the canyon walls were covered with petroglyphs. She describes in detail a hidden area with a very difficult access. Once inside, she reports seeing many "clan totems," and photographed a counter-clockwise spiral identified as a "Zuni seal," a radiating sun, pecked human footprints, an "ancestor figure" and a composite rendering of geometric symbols with a deer. Zig-zag lines were recognised by the Rain Priest as the altar outline of the Shi'wannakwe Society (1905:42-43).

Stevenson also photographed a group of petroglyphs related to the Wood Fraternity's migration myth (1905:444). Stevenson's informant explained that the hand and meandering lines are a map or route taken while looking for the "middle of the world." Each section of image grouping recalls some particular incident en route. Dots in various combinations represent snow, Ursa Minor, years spent in travel and mountains. The use of the same symbol (the dot) for several different concepts attests to the mnemonic character of the rock art and the wholly contextual dependence of the images to amplify oral traditon.

Stephen also recorded images shown to him at Walpi in 1893 which recorded Hopi mythology (Parsons 1936:146), tallies of slain Apache (Parsons 1936:132) and Ute and Apache shields. Each grouping documented historic conflicts with those groupings embedded in the oral tradition of that village.

Political Symbols

Titiev's discussion of secular authority contained information about a stone in the Bear Clan's possession at Oraibi (1944:60). Titiev was told that it was given to the Bear Clan by Matcito, founder of Oraibi. On it are images recording the clan migrations and others which validate the clan's secular authority. Symbols concerning Soyal are consulted each year by the Soyal priests to reaffirm their rights to hold office.

We have seen that Hopi and Zuni rock art occupy heterogeneus types of social categories: religious activities, economic access, ownership and identification, social boundaries, political statuses and clan histories. Context separation is apparant between public, restricted, and personal use of images. Spatial separation can be seen in the scattering of clan symbols at various activity locations, while others cluster together because there is a syntactic dependence among them and with their location. Each graphic sign has semantic intent which is learned through oral tradition, the visual image acting as a mnemonic device for the viewer. While individual remembrances

Table 15: Single Elements in Western Pueblo Art

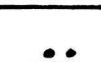
Symbol Group	Interpretation	Location	Ethnography	Symbol Group	Interpretation	Location	Ethnography
I	Body paint mark	Snake Priest	Vroman 1901	IV	Star Effigy - Little Dipper	War Chief's Altar. Winter Solstice Ceremony	Stephen 1936
	Tally or count		Stephen/ Parsons 1936			eyebrow position Crow Fox and Lizard Kachina	Wright 1973
	Eyes	kachina masks	Wright 1973			Fox Kachina Spots on Forearms and Lower Legs	Wright 1973
		Borders Sand Painting multicolored	Stephen 1936		Orion (?) (see Group XXV)	Mastop Kachina/ cheek	Wright 1973
	Eyes	Kachina Masks	Stephen 1936	V	Earth Clan Sun House Full Moon	Prayer Stick Rock Art	Stephen 1936
II	"Warrior marks"	woven into belt of ceremonial kilt	Stephen/ Parsons 1936		Spots Spots in red, blue, yellow	Ahul Mask Spotted Corn Kachina	Wright 1973
	Frog tracks/ Rabbit eyes/	whistle gourds Throwing stick	Stephen /Parsons 1936	VI	Eyes Moon Clan	KachinaMasks	Colton 1960
		Bottom of Kachina Kilt	Wright 1973		BodyPaint design	Stone-eating Kachina	Wright 1973
	Boundary Markers	Edge of Pahos Farm Fields	Stephen1936 Forde 1931	VII	prayer sticks Body Paint encircling arms legs	Flute Ceremony Wuwuchim initiates,	Stephen 1936
III	All Hopi Farm land	Bear Clan Stone Tablet	Titiev 1944		Eyes Eyes	Somaikoli Shields Navaio Kachina Mask	Stephen 1936
	Eyes Teeth	Kachina masks Broadfaced Kachina	Stephen/ Parsons 1936	VIII	Moon		Colton 1960
	Eyes	woven into belt	Stephen/ Parsons 1936		Friendship Alliance	Ute Shield Sio Hemis Kachina Palülükon Serpent, Zuni	Stephen 1936 Stevenson 1905
	Shrine	Sityatki Ceramics	Fewkes 1973		Eyes	Ahöani Kachina	Wright 1973
IV	Snow Rain Star Mountains Year Count		Stevenson 1905		Moon	Chief Kiva NW corner of SW wall	Stephen 1936
	Rabbit track Rabbit Clan		Fewkes 1897	IX	Morning Star Star	Chief Kiva wall Inside concentric circles	Stepehn 1936

Table 15 - Continued

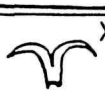
Symbol Group	Interpretation	Location	Ethnography	Symbol Group	Interpretation	Location	Ethnography
IX	Sky Symbol	War Chief's house Flute Society Altar	Stephen 1936	XIII		Kachina Mask	Wright 1973
		Pesrum Kachina figurine, Goat Kiva	Stephen	XIV	Mouth	Sun Shield Body Paint For Protection cheek marks	Stephen 1936 Wright 1973
	Star	Zuni Altar	Stevenson 1905		Turkey Feathers	Lalakon Society	Stephen 1936
X	Rabbit ears	Brood Stick	Stephen 1936		"	"	"
	Antelope prints	Praverstick Horn Kiva Winter Solstice	Stephen 1936		"	"	"
 XI	Eyebrow/nose	Masks from Horn Kiva	Stephen 1936		"	"	-
	Crow Clan Snipe track Mouth Duck Track	Morning Kachina	Colton 1960 Stephen 1936	XV	"Hook Mark"	Sash design	Bahti 1968
	Crane Track	Nata'shka father Mask	Stephen 1936		Face Design	Kachina dancers	Stephen 1936
	Crane Track	Serpent face Pülölukon	Stephen 1936	XVI	Milky Way		Stephen 1936
XII	Begun on rising of Morning Star 3AM meal	Flute Dance spring in Cave (Seep)	Stephen 1936		rainbow colors	Somakoli Masks	Stephen 1936
	Meal Altar All Corn Colors	Mamzrau Society Wuwuchim, Goat Kiva	Stephen 1936	XVII	Corn	Butterfly Tablita green	Stephen 1936
	Body Paint	Kachinas	Stephen 1936		Corn		Stephen 1936
		Rock Art on trail to Sun Spring	Stephen 1936		Corn stalk	Mask of "Tewa Navajo grandfather"	Stephen 1936
XIII	Bean Sprout	eye of Morning Kachina	Stephen 1936	X		kachina masks Powamu Horn Kiva	Wright 1973 Stephen 1936
	Plantingstick Prayer Stick Altar Crook	On "planting stick" staff Winter Solstice	Stephen 1936	XVIII		Somaikoli Shields	Stephen 1936

Table 15 - Continued

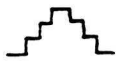
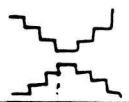
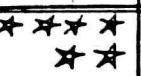
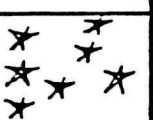
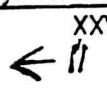
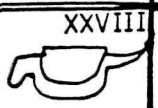
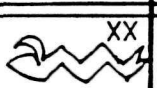
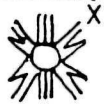
Symbol Group	Interpretation	Location	Ethnography	Symbol Group	Interpretation	Location	Ethnography
XVIII		Medicine Bowl . Zuni	Stevenson 1905	XXII	Cloud Design	Butterfly Headdress	Stephen 1936
		Water jar for Snakes, Snake Ceremony	Stephen 1936		Terrace House	Shalako, Niman Kachina	Stephen 1936
		Nāva'kchina Kacnina Mask	Stephen 1936	XXIII	Corn Ear	Chief Stick Chief Kiva	Stephen 1936
		Mask of Shumai'koli of the Zenith Zuni.	Stevenson 1905		Tiponi Corn Ear	Flute Ceremony Navajo Mask	Stephen 1936
XIX	Lightning	Hopi Zuni	Stephen 1936 Stevenson 1905	XXIV	Sex Organ	Paiyakyamū Doll	Stephen 1936
		Broad Face Kachina	Wright 1973		Phallic Emblems	Garments of initiates Wāwuchim	Stephen 1936
XX	Lightning Stick	Held by Muiyiñwa Lalakon Altar	Stephen 1936		Phallic Design	back of Zuni Chā'wimkya	Stephen 1936
	Snake	Altar Antelope Kiva Snake Ceremony	Stephen 1936		Body Paint designs	Singer Kiva	Stephen 1936
	Snake	Altar Image Horn Society Horn Kiva	Stephen 1936		Phallic designs Mother Rock	carried by Wuwuchimtu Corn Mountain	Stephen 1936 Stevenson 1905
	Lightning Sticks	Yayatū red/yellow	Stephen 1936	 XXV	Pleides	W Wall Chief Kiva	Stephen 1936
	Lightning in Rain Picture	A'vaka Shrine	Stephen 1936		Orion	South side wall Chief Kiva, Walpi 1893	Stephen 1936
XXI	Cloud	Antelope Prayer Stick Horn Kiva	Stephen 1936			Wall Chief Kiva	Stephen 1936
	Cloud		Stephen 1936	XXVI	Plant Stick	Buffalo Dance Buffalo Girl	Stephen 1936
	Cloud Clan	Body paint, Kachinas	Stephen 1936		Plant	Prayer Stick Yayatū Butterfly Shrine	Stephen 1936
	Cloud mark	1893 on ground for purification	Stephen 1936		Tree	Nashabki Kiva	Stephen 1936

Table 15 - Continued

SymbolGroup	Interpretation	Location	Ethnography	SymbolGroup	Interpretation	Location	
 XXVI		Palulakoña	Stephen 1936	XXXII	Mountain Lion	Zuñi Altar	Stevenson 1905
XXVII	Squash Blosson multicolored	Rainmaker Mask Zuni Hopi Kachina Masks	Stevenson 1905 Stephen 1936		Bear	Zuni Altar	Stevenson 1905
	Squasn Blossom	Hopi and Zuni	Stephen 1936 Stevenson 1905		Wolf	Wall Hle'wekwe Society	Stevenson 1905
 XXVIII	Bird effigy	Yayatō	Stephen 1936		Badger/Bobcat	Zuni Altars	Stevenson 1905
	Bluebird Snipe Dove	Palolokon Curtain	Stephen 1936	XXXIII	Bi'*si'si	Markings on back of Ne'wekwe	Stevenson 1905
 XX	Palolokoña	Rock Art	Stephen 1936	XXI	Reversed on Body of Flute Boy	Altar of Flute Society Headdress of Flute Maid	Stepehen 1936
XXIX		Tū'mash Kachina Mask	Stephen 1936	 XII	Body Design	Flute Society Altar Flute Maid/ Boy	Stephen 1936
XXX		Kachina Mask	Stephen 1936	VII	Multicolor, Black Red/ Yellow	Body Design on Mu'yinwû	Stephen 1936
XXXI	Calako Myth Powamu Kachina	Kachina Mask Mastop Pot-carrier Goat Kiva	Wright 1973 Fewkes 1973 Stephen1936	VI	Disc Gourds	Flute Water Rattle	Stephen 1936
XX	Tadpole	Hopi Rattles Zuni Masks	Stepehn 1936				
XII	Dragonfly	Hemishikwe Mask with Tablet Zuni	Stevenson 1905				
XXII	Life Symbol	Woven into Hopi Wedding dress	O'Kane 1950				
XXI	Cloud Design	N. Wall, Chief Kiva Nashabki Kiva	Stephen 1936				
XIII	Ice	Winter Solstice Ceremony	Stephen 1936				
XXXII	Mountain Lion	Altar of the Galaxy Fraternity	Stevenson 1905				

will vary, the basic structure of reasons why a story exists does not change. Hence each symbol does not have what we would consider a one word equivalent, or an exact translation. Rather, variations can be expected, but does not invalidate the information. Oral tradition can be understood as a "bank" for all important cultural information, the images are the words' mnemonic counterparts. They reinforce each other and may, as Eggan has suggested for clan names (1950), identify categories of experience, structuring the Hopi or Zuni world view.

Since the Hopi have direct links to Mesa Verde Anasazi through clan oral traditions (Sekaquaptewa 1969) and since Hovenweep agricultural systems closely resemble Western Pueblo farming systems (Winter 1978), it is logical that other cultural systems may also be similar.

If Anasazi social systems operated in a manner similar to present Western Pueblos, and for similar economic reasons, then we can expect to find corresponding use of visual symbols and activities in which they were used. To test the validity of this hypothesis, the following implications can be stated:

1) If rock art is part of a visual repertory of graphic signs used by the Anasazi, then we should expect to find repeated use of them, assembled in different arrangements and on other cultural objects. The same type of motif should occur in certain site classifications. For example, potential clan symbols should predominate agricultural situations, while anthropomorphic figures, hands, directional alignments should predominate ceremonial contexts;

2) if Anasazi iconography indicates categories of semantic intent, then we should be able to find indications of social rules for use. Potential clan symbols will occur in a great many different contexts while religious symbols will cluster densely in a few locations;

3)if symbols are used to bank information over time, then we should expect to find a sizeable percentage of Anasazi symbols from Hovenweep still in use by the Western Pueblos. While we anticipate that changes and new adaptations of graphic signs have taken place since the ancestors left Hovenweep, the same strategy for structuring compound images ought to remain unchanged.

ARCHEOLOGICAL DATA

Three thousand acres of Cajon Mesa were surveyed by San Jose State University in a stratified, random, nonbiased grid system of 40 acre quadrants (Winter 1978). The survey identified probable agricultural features such as flood water farm field, slope wash sites, sand dune farming, springside irrigated gardens, reservoirs and check dams as defined by Hopi and Zuni ethnography (Hack 1942; Beaglehole 1937; Forde 1931, 1949; Borher 1960; Bradfield 1971; and Titiev 1944). These sites were classified as single purpose sites and were identified by excavation, fossil pollen analysis, and contemporary floral patterning which indicated past disturbance. Habitation sites were classified as multi-purpose sites and identified by the architectural features; certain specialized features were identified by

excavation, fossil pollen analysis and material remains such as corn cobs, ceramics, manos and metates, et al.

A total of 714 sites were identified. Fourteen of those sites (or two percent) contained rock art. In 3000 acres, no rock art was found outside of a site, "in the middle of nowhere," as is sometimes suggested in the literature (Rohn 1977; Casleton 1979; Fewkes 1919). That two percent was densely clustered across the sage-juniper-grassland portion of Cajon Mesa at Pueblo II and Pueblo III complexes arranged around canyon heads and seeps. Three sites are located in the northern pinyon-juniper zone, one indicating longer occupation. Three sites located in the southern greasewood-blackbrush zone indicated two habitation sites with Pueblo I and Basketmaker III origins.

At eight multipurpose complexes, the rock art's location consistently coincided with a specialized location such as storage or potential water control use. Single use sites usually had less than ten motifs but the number of elements is not determined by the size of the rock, since they were found clustered on sizes ranging from small boulders to expanses of slickrock.

A repetition of identical symbols soon became apparant. Table 16 illustrates the single images found at all the sites. Column 1 shows the symbol, column 2 gives the distribution of images, column 3 lists contemporary ethnographic sources indicating that the sign is still present in pueblo representational repertory. Sixteen of the Hovenweep images are identical to those in use around the Hopi mesas and are identified by informants to Fewkes, Colton,and/or Titiev. Signs that appeared most often were the counter-clockwise spiral, the "sun glyph," the "bird tracks," the human footprint, the hand, the circle, mountain sheep and snakes. The "sun glyph," spirals, hand, foot, zig-zag line and interlocking stepped triangle have ethnographic use and various identifications in present ceremonial clothing, paraphernalia, oral tradition, shrines and altars.

Potential clan symbols appeared in all categories of site type. In the habitation complexes they appeared at granaries, possible shrine, ceremonial or public locations. In single use sites, they appeared at a reservoir (Hov. 665), terrace field (Hov. 612) and a possible "fieldhouse" (Hov. 480) location. At four Colorado sites they all clustered on talus boulders with anthropomorphic figures. Site 5Mt294 contains similar arrangements of clan symbols as are found on the Signature Rock of the Salt Gathering trail. The negative hand print appeared consistently at multi-purpose sites imprinted on the wall just under a round tower. Positive white hand prints appeared at two seeps under the canyon head. Three symbols which are familiar motifs on ceramics of the late Pueblo periods were found in a number of contexts. The interlocked step triangle and zig-zag line were found together at a potential granary (Hov. 51-52) and also appear together on kiva jars excavated at Twin Towers (Hov. 12). Basketry from Mesa Verde (Morris and Burgh 1941), pottery from Alkali Ridge (Brew 1946), Lowry Ruin (Martin 1936), and Mesa Verde (Rohn 1977) carry the same motifs and other Hovenweep symbols. Concentric circles and spirals were found on building stones at the Dominguez and Escalante Ruins (Reed et al. 1979).

Table 16: Single Form Distritution

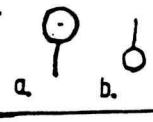
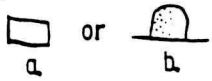
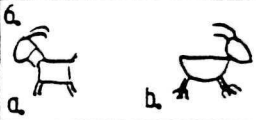
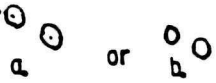
SYMBOL	LOCATION	SITE TYPE	ETHNOGRAPHY
1.  a. b.	5Mt294 a. (4 times) Hov. 480	Possible shrine a. Possible "fieldhouse" b.	Rope Clan Colton 1960
2. a. b.	Hov. 15	Probable kiva/ granary/ storage	Mountain Sheep Clan (a.) Antelope Clan (b) Fewkes 1897
3.	Hov. 665 MV506 5Mt309 MV1001 5Mt311	Reservoir Possible tower Storage cists	Crow Clan Colton 1960 Snipe / Frog Stephen/ Parsons 1936
4.  a. b.	Hov. 665 a. 5Mt309 b.	Reservoir Possible tower	Sand Clan Colton 1960 Sand Clan Titiev 1937
5.	5Mt312 Ceramics Piedra B/W	Possible pit house/kiva	Kachina Clan Colton 1960 Rohn 1977
6.  a. b.	5Mt309 MV1001 5Mt311 Hov. 51-52 Hov. 536	Possible tower Storage cists Storage / Granary Single habitation	Mt. Sheep Clan Fewkes 1897 a. Colton 1960 b.
7.	Hov. 612 5Mt309 5Mt311/312	Terrace Field Possible tower Storage cists/possible kiva	Snake Clan Colton 1960 Fewkes 1897
8.	Hov. 665 MV687 MV594 5Mt312	Reservoir Habitation sites Ceremonial	Bear Clan Fewkes 1897 Colton 1960
9.	5Mt 294	Ceremonial /possible shrine	Coyote Clan Titiev 1944 Colton 1960
10.	5Mt 311	Storage cists/ ceremonial	Spider Clan Colton 1960
11.	5Mt 294 MV B/W ceramics PI - PIII BIII - PI	Possible shrine	Sun Clan or Moon Clan Colton 1960 Spider Clan Wright 1980 Rohn 1977 Roberts 1930
12.	Hov. 430 5Mt294 Hov. 57-59 Hov. 64-68	Possible shrine/storage /single habitation Seep/water control	Earth Clan Fewkes 1897
13.	Hov. 665 Ceramics 5Mt 311 / 312 MV1320 5Mt 294 5Mt 309 Hov. 366 Building Stones	Reservoir Slope wash terrace Possible shrine Possible kiva/storage	Crane track Stephen/Parsons 1936 Crane Clan Fewkes 1897
14.  a. or b.	Hov. 430 5Mt294 5Mt 311	Possible shrine/ storage/habitation	Moon Clan now extinct Colton 1960
15.	Hov. 8 5Mt 294	Terrace gardens Possible shrine	Crow Clan Colton 1960

Table 16 - Continued

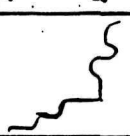
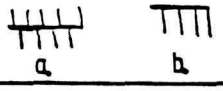
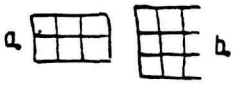
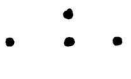
SYMBOL	LOCATION	SITE TYPE	ETHNOGRAPHY
16.	Hov. 536 5Mt294	Storage/Granary/Habitation Possible Shrine Ceremonial	Ant Clan Colton 1960
17.	Hov. 51-52 Ceramics MV/McElmo B/W Mesa Verde baskets	Probable granary/storage Ceremonial contexts	Corn Motif Hibben 1975 Life symbol O'Kane 1950 Washburn 1976 Morris - Burgh 1941
18.	Hov. 51-52 MV1227 MV1320 MV625 MV1001 B III thru Pueblo III ceramics	Probable storage/granary habitation/storage/ ceremonial	Lightning symbol Stephen/Parsons 1936 Outline of altar Stevenson 1905
19.	Hov. 430/MV27/5Mt 312 5Mt 294 (2 times) Building Stones Ceramics Chapin B/W	Possible shrine Rock tank reservoir Probable ceremonial	Sun glyph Ellis 1975 Hayes - Lancaster 1975 Equinox alignment Williamson 1978
20. Counter clockwise	Hov. 8/15/366 Hov. 430 (2 times) Hov. 664 MV1320 5Mt309/294/311	Storage/granary/habitation Water control/terrace gardens Sun shrine	Path of Masau bringing rain Beaglehole 1937 Members of Chief Kiva form Spiral at Winter Solstice Parsons 1939
21. Clockwise	5Mt294 5Mt309 5Mt311 MV1320	Possible Shrine Ceremonial/habitation Storage/granary Habitation Ceremonial	Migration Roberts 1932 Whirlwind Fewkes 1892 Zuni seal Stevenson 1905
22.	Hov. 366 Ceramics BIII PI	Slope wash terrace gardens	Warrior marks Parsons 1936 Roberts 1930 Marks made on kiva wall with corn meal Fewkes 1911
23.	Hov. 8 MV1001 Hov. 57-59 MV1341 Hov. 64-68 Hov. 600 Hov. 51-52	Rock Shelter under tower Seep Water control Seep Rock shelter Possible granary	Signature at end of prayer Ellis 1975 Powamu Kachina/Kiva renewal Stephen 1936
24.	5Mt309 5Mt311/312 Hov. 15	Ceremonial Possible granary/storage Possible granary/storage /kiva	Zuni origin myths Stevenson 1905 Exorcises Witchcraft Stephen/Parsons 1936
25.	Hov. 8 5Mt309 5Mt294 Piedra B/W Cortez B/W	Terrace gardens/Tower Possible Shrine Tower	Sumaikoli shields Stephen/Parsons 1936 Hayes-Lancaster 1975
26. a. b.	Hov. 8 a. MV Ceramics MV 687 MV1000 b. MV1001	Terrace gardens/ water control/habitation	a. Fewkes 1909 Like T-shaped doorways at Mesa Verde / Hov.
27. 	Hov 430 5Mt312	Possible Sun Shrine Habitation/Storage Ceremonial	Always occurs with "sun glyph"
28.	5Mt 309 (2 times) 5Mt 311/312	Ceremonial Ceremonial use	
29.	Hov. 430	Possible Shrine Habitation next to field w/ 3 check dams	
30.	5Mt309 (4 times) MV1001 McElmo B/W ceramics	Tower/Habitation Ceremonial use	Lowry Ruin Martin 1936

Table 16 - Continued

SYMBOL	LOCATION	SITE TYPE	ETHNOGRAPHY
31.	5Mt 311/312	Circular Depression Storage Cists	
32.	5Mt312	Cirular Depression	Puma ? Rabbit ? Bobcat ?
33.	5Mt294/5Mt311 Hov. 608 Ceramics Mesa Verde	Possible shrine Storage/Granary/Ceremonial Granary/storage/habitation	Star Parsons 1936 Rohn 1977 Chapin / Piedra Hayes - Lancaster 1975 Martin 1936 Mancos B/W
34.	5Mt309.	Possible Tower	
35.	5Mt 309	Possible Tower	
36.	5Mt 309	Possible Tower	
37.	5Mt 309	Possible Tower	
38.	5Mt309	Possible Tower	
39.  a b	Hov. 51-52 a. Hov. 608 a. b. 5Mt 312 b. Ceramics	Granary/storage/Habitation Slope wash/terrace gardens Circular Depression	Washburn 1976 Hovenweep Ceramics Rohn 1977
40.  a b	Hov. 366 a. MV1890 b. 5Mt 312 b. MV1000 a. b. Ceramics	SlopeWash Terrace Gardens Left of pour off at canyon head Habitation/ Water	Washburn 1975/1976 Hayes and Lancaster 1975 Rohn 1977 Cortez B/W
41. a b c	Hov. 480 a. Hov. 366 b. MV 1890 c. b. Ceramics	Next to farm field a. Slope wash terrace b. Placed next to Pour-off c.	Rohn 1977 MV/McElmo B/W Corn Meal Symbols in Mamzrau/Wuwuchim Parsons 1936
42.	Hov. 366	Slope wash terrace	
43.	Hov. 51-52	Granary/Storage Above slope wash terraces	Rohn 1977 Piedra / Cortez B/W
44. 	Hov. 665	Reservoir	
45.	Hov. 480	Next to a farm field	Rabbit Clan Fewkes 1897 Pleides Chief Kiva Parsons 1936

One concentric circle or "sun glyph," and two counter-clockwise spirals were made in a rock corridor next to a probable farmfield. They were tested by astronomer Williamson (1978). Inside this corridor, only a view of the eastern horizon is possible. Williamson's calculations revealed that the sun could be observed rising, from the "glyph," only 30 days before the spring equinox and 30 days after the autumn equinox. Further, the concentric circle and spirals were bisected and connected by slits of sunlight at sunrise during the Summer Solstice period. Limited access, solar alignments, and symbols together suggest that site is a shrine directly connected with clan ownership and links the adjacent farmfield directly to the planting and harvesting seasons.

Anthropomorphic figures occurred only at the four Colorado sites and one Hovenweep site. All the sites are huge talus boulders around the base of mesas near the junction of the McElmo and Yellowjacket Creeks. Sites 5Mt311 and 5Mt312 are within fifty meters of one another; 5Mt311 is a series of storage cists, 5Mt312 is a talus boulder with anthropmorphic figures and possible clan symbols incised and pecked on the flat east surface. A circular depression was recorded next to the talus rock.

Comparison of the Hovenweep figures with others at Mesa Verde, Marsh Pass, Navajo Mountain (Kidder and Guernsey 1919) and Glen Canyon (Turner 1963) revealed a number of structural combinations repeated at different locations.

Table 17 separates the torso which is arbitrarily identified as a "core" or stable (unchanging) shape (after Munn 1971). Arms, legs, heads, headdresses, sex organs, hand and feet are depicted and arranged around the "core" torso in a variety of combinations. If a number is assigned to each type of torso, and a letter is assigned to each type of rendering within the body classifications, then the figure can be abstracted to reveal the specific formula by which the figures are organized. Usually, combinations are made only once per site, but similar formula combinations can be found in the places recorded on Table 17. For example, comparison with Mesa Verde figures at Pictograph Point shows some interesting similarities and differences. While the formulas remain the same for three of the anthropomorphic figures, local preferences for torso shape can be observed. Yellow Jacket Creek figures show a larger variation in torso shapes than Mesa Verde, which can be seen to carry a strict preference for one shape. Speculation can further be made that each grouping or formula represents a specific compound idea or abstract concept. Each human figure may represent one entity or deity; the groupings may refer to specific mythological or ceremonial events, recreated at those sites. Clan symbols appearing on the same panels may signify participation, particularly in ritual food redistribution connected with the ceremonies.

One last comparison between Mesa Verde and Hovenweep concerns the type of headdresses and figure renderings. At both locations a certain formula class was present, while the anthropomorphic figures at 5Mt312 are not reproduced anywhere else in the vicinity. The closest documented figure with a bird shape in the headdress (as seen at 5Mt311) is reported at a site on the Mancos River (Fetterman 1976). Other large anthropomorphic figures

TABLE 17: COMPOSITE IMAGES AND DISTRIBUTION

Discrete Elements "Core" Torsos	Arms and Gestures a.	b.	c.	d.	e.	f.	g.	h.	Legs i.	a.	b.	c.	d.	e.	f.
1.	Hov. 536(2x) 5Mt312(6x) 5Mt311(2x)	5Mt311(5x)										5Mt 312(7x) 5Mt 311(4x)		5Mt 311 Hov. 536	
2.		Hov. 536(2x) 5Mt309	5Mt 294 MV 661 MV544		5Mt 311		5Mt311	5Mt 294 (2x) NM		MV 661	5Mt 294 Hov. 536 MV544 5Mt309(2x)	5Mt 294 5Mt 311		5Mt 294 5Mt 311 Hov. 536(2x) MP + NM	
3.	5Mt311 Hov. 536	Hov. 536 MP + NM		MP + NM						MP + NM		5Mt 311 MP + NM			
4.			MV1001 Hov. 536 5Mt 309 MV 684 MP + NM	MV1001 MV 990		Sand Canyon (R) MV684		MV 664			5 Mt 311 Hov. 536 Glen Can. Sand Can.	Hov 665 MV 661	5Mt 309	MV990	
5.					5Mt 311 Right		5Mt 311		5Mt 294					5Mt 311	
6.		5Mt 311 5Mt 309		Glen Canyon						5Mt 311	5Mt 309				Glen Canyon
7.			5Mt309					5Mt 309 MV 684 Glen Can.			Sand Canyon			5Mt 309	

KEY:

Solid pecking ■
Outline □
MarshPass and Navajo Mountain - MP + NM
Mesa Verde - MV
Hovenweep - Hov.
Colorado, Montezuma County - 5Mt etc.

TABLE 17 - Continued

Discrete Elements / "Core" Torsos	g.	h.	Hands a.	Hands b.	Hands c.	Hands d.	Hands e.	FEET a.	FEET b.	SEX ORGANS c.	SEX ORGANS a.	SEX ORGANS b.	SEX ORGANS c.	SEX ORGANS d.	SEX ORGANS e.
1.	MV 684	MV 684 (2x)	5Mt 311				5Mt 312 5Mt 311	5Mt 311 (2x)			5Mt 312				5Mt 311 (2x) 5Mt 312
2.				5Mt 311	5Mt 311	5Mt 309 (2x)		5Mt 311 (2x)	5Mt 311 (2x) 5Mt 312(5x)	5Mt 309					5Mt 309
3.						MP + NM	MP +NM							MP + NM	
4.		MV1001			MV 661	MV 990 Hov. 665 MP + NM		5Mt 311		Hov. 665 MV 990 MP + NM		5Mt 309 MV 684		MV1001	5Mt 311 MP + NM
5.			5Mt 294	5Mt 311		MV 684									
6.					Glen Canyon	Glen Canyon	5Mt 311	5Mt 311		Glen Canyon		5Mt 309			
7.												MV 684	Sand Canyon		5Mt 309

KEY:

Solid pecking ■

Outline □

Marsh Pass and Navajo Mountain - MP + NM

Mesa Verde - MV

Hovenweep - Hov.

5Mt etc. - Colorado, Montezuma county

TABLE 17 - Continued

Discrete Elements: "Core" Torsos	Heads and Headdresses a.	b.	c.	d.	e.	f.	g.	h.	i.	j.	k.	l.	m.	n.	o.
1.					5Mt 311	5Mt 311(3x) 5Mt 312(3X		5Mt 312	5Mt 312	5Mt 312	5Mt 312	5Mt 311	5Mt 311 Hov. 536		5Mt 312
2.	5Mt 294 MV544	5Mt 294 5Mt 311 (2x)		5Mt 294		Hov. 536	Hov. 536 (3x)							Hov. 536	
3.	5Mt 311		MP + NM (2x)			Hov. 536									
4.	Hov. 536 Hov. 665 MV 661 MV 684		5Mt 309 MP + NM MV 990 MV 1001			5Mt 311									
5.	MV 684														
6.				5Mt 309 Glen Canyon											
7.	5Mt 309 Sand Canyon		MV 684												

KEY:

Solidly Pecked ■
Outline □
Marsh Pass and Navajo Mountain - MP + NM
Mesa Verde - MV
Hovenweep - Hov
Colorado, Montezuma County - 5Mt etc.

photographed at Butler Wash on the San Juan River (Castleton 1979), contain the same figure formulas found at 5Mt312, but with some interesting differences. The crescent headdresses have been repositioned, some placed beside the figure instead of in the headdress, while an exact replica of an abstract symbol placed beside a figure in 5Mt311 has become incorporated into the headdress of the Butler Wash figure.

By using a limited number of single elements which can be arranged in a great many ways, a large number of concepts can be expressed (Munn 1973) visually as well as orally. Using such a formula classification system, scholars may be able to identify and outline regional and general social boundaries such as has been accomplished with ceramics (Longacre 1964).

CONCLUSIONS

Ceremonial use of human figures has disappeared from Hopi rock art, although they persist at Zuni. Both pueblo cultures continue anthropomorphic figures in other ceremonial contexts. Altars, kachinas' costumes, sand paintings, a few ceremonial bowls and plaques still carry those images. In fact, kachinas personified by the dancers' costumes show the same strategy of organization as the formulas found in the prehistoric images. Now, however, the number and size of the discrete elements, colors, feathers, plant cuttings, and paraphernalia are so densely arranged and numerous that they now can represent 266 different kachina concepts (Colton 1949).

We have answered the test implications to this extent: all single purpose or agricultural sites contained potential clan symbols, and sometimes several; repetition of graphic elements in identical contexts, and on other materials gives evidence of a visual repertory system present among Hovenweep Anasazi. Further, there is evidence that social boundaries may exist between water control/farmfield contexts and possible ceremonial/granary/storage sites that may be mutually exclusive. Recurrence of Mountain Sheep symbols dominated the later contexts across the central section of Cajon Mesa. If that image carries the same meaning of clan identification, then we can hypothesize that a Mountain Sheep/Horn kin group may have owned and held responsibility for certain ceremonial rites which required storage of special food. A shift of emphasis is apparant from present pueblo farm field contexts. Further, potential clan symbols could be located in a variety of contexts. Anthropomorphic figures, on the other hand were clustered in a very small area between Mesa Verde and Hovenweep.

Sixty-six percent of Hovenweep rock art motifs are still in use among the Western Pueblos and confirms a continuing tradition. Further, a similar strategy for organizing ceremonial figures (e.g. kachina figures) can be seen in operation from past to present. The banking technique is so efficient that the order of colors in a series on an Ana'cknina mask in 1973, for example, is only a slight variation of Stephen's record of the same mask in 1893 (Parsons 1936). Thus there is some evidence that the strategies for organizing information have not been lost or changed, but rather expanded due to other cultural contacts which make up the Hopi and Zuni cultures today.

Certainly further testing and refining research questions will develop this initial perspective into a clearer picture; a broader data base will give more reliable quantitative support for the interpretations.

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A SYMMETRY ANALYSIS OF HOVENWEEP NATIONAL MONUMENT ANASAZI CERAMIC DESIGN

by Marcia C. Jourdane

Problem Orientation

The purpose of this study is to determine the differences in design composition on the ceramics from Cajon Mesa in the Four Corners area in the Southwest. The study is based on a non-arbitrary, standardized method of systematic classification through the analysis of the universal symmetrical structural properties of design on Anasazi Black-On-White pottery. The source of data will be the collections as a result of test excavations at Hovenweep National Monument in the summer field season in 1976 and in 1977.

Archeologists generally assume that social demography and organization is reflected in the material culture of a population. The natural environment being a cultural determinant, affects human technology. Technology, in turn, affects the social organization which ultimately affects the belief systems of a culture. Variations in ceramic technology can be indicators of social grouping and quantifications of communication.

Underlying structures of human culture systems are maintained through time by systems where rules and information can be communicated. By asking questions about this communication, archeologists attempt to reconstruct the behavior of prehistoric peoples.

Current archeological research has shifted from attempts to reconstruct past social organization only to a desire to understand the processes of social organization, change and exchange in prehistoric times. In defining our parameters and limiting the scope of our questions, we must concern ourselves with behavior patterns. We must be able to measure these behavior patterns in a way that will give us statistically reliable information. What is needed, then, is a way to get information about the structural basis underlying the subsystem, which is also inherent in the subsystem under analysis, in this case, the ceramic technology of the Anasazi of the Cajon Mesa area.

Human beings, in order to coexist and communicate, establish mutually agreed on rules. As stated in the introduction, these rules are classifications; we classify phenomena to shape our reality. So to ask questions about prehistoric systems, we need a classification system "which could be used to study specific activities" (Washburn, 1977). The classification system used must be relevant to the questions being asked by the archeologist.

Potsherds, numerous on prehistoric sites in the American Southwest, have been the focus of many archeological analyses. Analsysis of sherds is usually typological. Ceramic typological classifications are based on morphological

and functional characteristics, such as similarities in shape, design, paint, etc. These arbitrary designations by the archeologist are descriptive units.

The time range for each type is derived from the dating of associated materials. A typological analysis can be used to develop a temporal-spatial history either regionally or locally.

The focus of research in the past was the development of culture histories. The use of typologies for the analysis of data was consistent with these analytical goals (Washburn, 1977). However, there are some fundamental problems with typological anlysis as discussed by Washburn (1977).

First of all, the question arises of whether or not the types created were based on the intrinsic qualities of the ceramics themselves, or based on arbitrary classifications of qualities as viewed by the archeologist. One collection of sherds typed by a researcher may be typed differently by another investgator, depending on how the typological categories are viewed from each person's own existential position. Another problem is the assumed relationship among Southwestern pottery types. A typological analysis cannot tell us the history of a ceramic piece; it can only assist us in categorizing a finished artifact.

In order to make ceramic classifications useful to us, we must analyze some aspect that will yield information which will be unaffected by human bias. Therefore, in design analysis, some general basic element must be examined that is inherent in the design itself. In this symmetry analysis, based on Washburn's method, a specific attribute has been selected; the structure of patterns. The way that designs were painted on the pottery will reflect a knowledge of information shared by interacting artisans.

This study is based on a theory of interrelationship among potters. Within the human cultural system, subsystems of communication exist. When potters interact, through a common interest, they communicate and exchange ideas either knowingly or unconsciously. Methods of instruction may often be shared or exchanged. The result of this exchange will be similarity in the finished ceramics of that particular group of potters.

While the questions to be asked about the prehistoric population in the Hovenweep area will focus on this subsystem of communication, there are considerations to be made in relation to those things which affect the similarities in design.

The first of these to consider is ceramic design as a vehicle for expression of individuality. This expression may exhibit itself in a design as an elaboration of similar designs with the same pattern structure. Although in ethnographic studies it has been recorded that Southwestern potters view their designs as original, it has also been noted that there is a discrepancy between theory and practice in the repetition of designs. Also ethnographically described are the dreams and mental images the potters explain as the source for many designs. This relates back to the unconscious

information flow as the designs come out in formalized relationships that the potter may not have been aware of constructing. These images relate also to design borrowing. Historically, while the borrowing or copying of designs is clearly unacceptable, often what is "popular" at the time limits creativity and necessitates borrowing, though it may not be conscious.

A second consideration is a kin-based exchange of information. It is possible that not only were some techniques of pottery construction taught by members of the family, but also some elements of design as well. As illustrated by the following excerpt from Ruth Bunzel's The Pueblo Potter(1929), the source of design was sometimes traditional. In response to questions about design sources, a pueblo potter explained, "I make up all my designs and never copy. I learned this design from my mother. I learned most of my designs from my mother."

However, while theoretically there are no actual limitations placed on the personal expression of design, a uniformity of style still exists. Because their existence and experiences are shared, the artists within a particular geographic locality will produce relatively homogeneous designs. Similarities in symmetry is the probable result of close contact among populations.

Through the study of structure of designs on Black-On-White sherds and vessels, along with the examination of the distribution of the components of design (motifs):

1. It must be determined if there are differences in the structural composition of design from the prehistoric sites on Cajon Mesa.

2. If differences in composition are evident, further analysis will give us an insight into what these variances are related to geographically (i.e., drainage systems).

3. It is also proposed that further data can be obtained in support of the probability of two general information exchange spheres existing on Cajon Mesa.

4. The structural designs on ceramics may also indicate that particular design patterns are associated with particular features, such as a tower or kiva. If so, we will have some indication of design being related to site function. Identifying type of refuse and location (fill vs. floor) may indicate features of latest occupation as opposed to those of earlier occupation.

Design Classes

The nomenclature used to describe each symmetry class (Figs. 39-48) is as follows:

1. To separate the three categories of design, a 1- or 2- is placed in front of the symbol for one and two dimensional designs respectively.

2. The digit in the hundreds position indicates the number of rotations around the principal axis.

3. Information concerning mirror reflection along the vertical axis is stored in the units position.

4. Information concerning mirror reflection along the horizontal axis is stored in the tens position.

5. The digit in the tens and units position will either be a 0 or a 1. The presence of mirror reflection is indicated by a 1, the absence a zero.

6. The superscript 2 above the mirror reflection and rotation digits indicates that within the figure, counterchange accompanies the indicated symmetry.

7. The subscript 2 below the mirror reflection digits indicates counterchange between figures along that axis.

8. Counterchange between the rotation units will be indicated by a subscript 1 for counterchange along the verticle axis, a subscript 2 for counterchange along the horizontal axis, and a subscript 3 for counterchange along both axes.

9. The presence of an X and/or Y after the three digit number indicates the presence of slide reflection along either the Y(vertical) and/or X (horizontal) axis.

    a. a superscript 1 above the proper X or Y designator indicates the presence of slide reflection along the axis.

    b. a subscript 1 indicates the presence of slide reflection between axes.

    c. counterchange along the slide reflection axis is indicated by a superscript 2 above the X or Y indicator for counterchanged slide reflection along one axis.

    d. a subscript 2 is used to indicate counterchanged slide reflection between slide reflection axes.

Design Classes

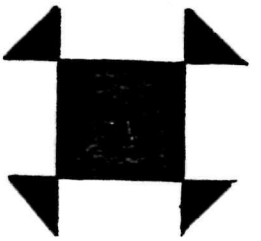


Figure 39: Finite Design with Rotations Around a Single Point Axis

One Dimensional Designs

Figure 40:
1-100 Translation
The fundamental distinction of the asymetric figure is lack of repetition. Translation is the movement of an asymmetrical figure along a straight line axis. Translation does not change the orientation of a figure.

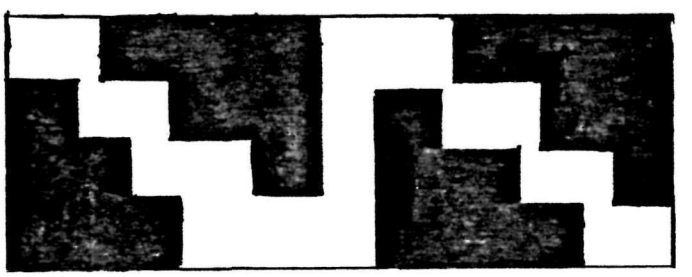


Figure 41:
1-200 Bifold Rotation
Rotation involves the movement of a figure around a point axis. Rotational figures are differentiated by the angle of rotation.

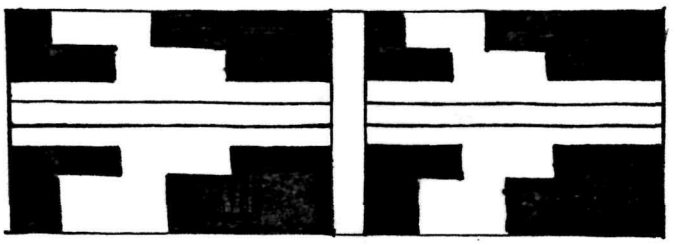


Figure 42: Mirror Reflection is the Reflection of a Figure Across a Line Axis.

Figure 43: 1-101 Vertical Mirror Reflection

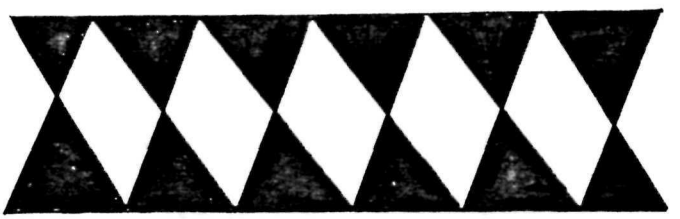


Figure 44: 1-211 Vertical and Horizontal Reflection

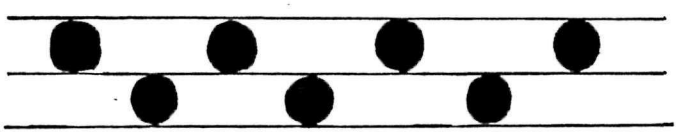


Figure 45: $1_{1-100_{X}}$ Slide Reflection

Slide reflection involves both translation and mirror reflection movements.

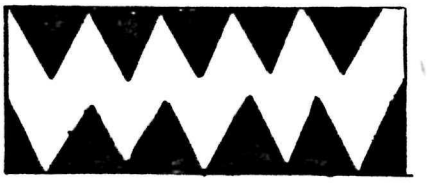


Figure 46: 1-201 Vertical Reflection and Bifold Rotation. Combines both mirror reflection and rotation around a point axis.

Two Dimensional Designs

Two dimensional designs are based on a series of horizontal and vertical axes which intersect at regular intervals forming a net.

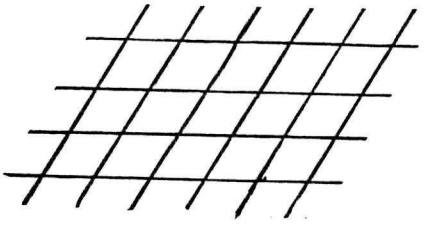


Figure 47: Open Parallelogram

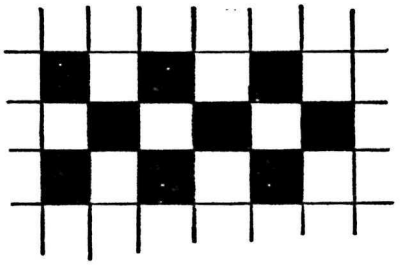


Figure 48: 2-4 1 1 Checkerboard with Counterchange
3 2 2

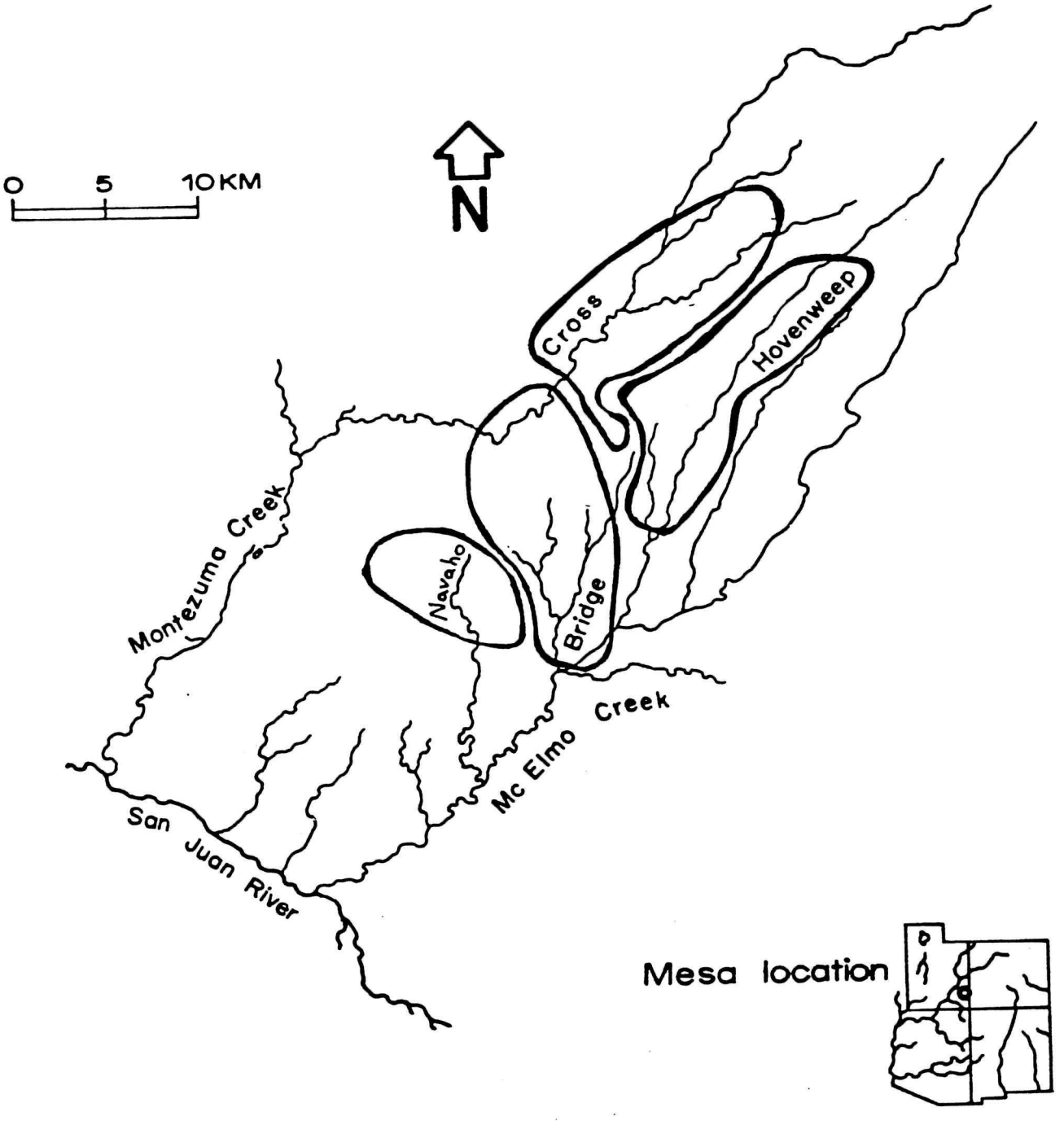


FIGURE 49 Location of Drainages in Cajon Mesa Study Area

(after Winter, 1977)

Methods

Four types of Anasazi Black-On-White painted ceramics were analyzed. Mancos Black-On-White pottery is coiled, scraped and fired in a reduced atmosphere, as are the Wetherill, McElmo and Mesa Verde types. The clay source for Mancos pottery is unknown, but may be Mancos shale. The vessels are covered with a white slip and painted with a mineral paint over an underlying organic medium. Wetherill Black-On-White is an organic paint variety of Mancos. The designs are organized into all over patterns, segmented layouts, and broad bands (Breternitz, 1974). The bands are never framed with lines. The time of manufacture and use was about A.D. 900-1150, the Pueblo II period.

The clay sources for the McElmo Black-On-White pottery were the carbonaceous shale lenses that occurred in the Mesa Verde area. The paint, primarily organic, was brushed on over a white slip. The designs are transitional between Mancos and Mesa Verde Black-On-White, with figures being made up of heavy solid lines., The time of manufacture was about A.D. 1075-1275, during the Pueblo III period.

Mesa Verde Black-On-White, produced in the Pueblo III period from about A.D.1200 to 1300, was made from the clay extracted from the carbonaceous shales. The designs, painted on with organic paint over white slip, were built by dividing the decorative field into smaller units, then filling in spaces to arrive at finished patterns. The symmetry was usually maintained within segments of the design. Framed bands were common. Most of the designs were abstract and geometric.

The sherds were analyzed in terms of the motifs (combination of elements), and the symmetry of structure of design bands. The basic subdivisions of design refers to the layout--the design structure itself. Design composition refers to how motifs are arranged within this framework.

The symmetry unit is a motif, or partial motif, that can be classified as either one dimensional or two dimensional. Since the ceramic collections at Hovenweep have been almost exclusively potsherds, the designs are largely incomplete, so that analysis of this kind is necessary.

All analyses were carried out with the assistance of a CDC 3300 and the SPSS program at the San Jose State University Computer Center. As in Washburn's study of the Hovenweep ceramics, the designs were analyzed as they occurred on sites in seven drainage areas on Cajon Mesa. Also included in this study was an analysis of designs as they were associated with particular features.

Other attributes recorded were (for each sherd and vessel) the typology, form, and condition, the diameter, and on whole vessels, the height, weight, volume, and circumference. In reference to the designs the following information was recorded: location, width, distance from the rim, the number

and width of framers, and again, for whole vessels, the number of panel repeats. Also noted is the paint type, color, the existence of counterchange, line construction in reference to the continuous line technique, the design orientation, and any irregularities which occur.

There were a number of problems encountered during the field season at Hovenweep in 1977. The first of these was the small sample size due to the type of sites excavated. As a result of the overall research design, with an emphasis on environmental reconstruction, some sites excavated were primarily water-control sites. The emphasis on water-control, as well as the number of sites tested (eleven), resulted in a small sample size. The small sample size, however, was adjusted for since 1976 and 1977 ceramic materials were analyzed. Consequently, the total number of sites represented in the study is 41, not merely 11 sites from the 1977 season.

Analysis and Results

The sample for this study consists of one hundred and eighty-eight sherds over thirty sites on Cajon Mesa. The sample is subsurface as the 1976 and 1977 field work at Hovenweep was focused on test excavation and not surface collection. The drainages studied in 1976 and 1977 were Bridge, Cross, Hovenweep and Navajo (Fig 49). A small sample was taken from Hovenweep drainage in 1977 but there were so few sherds the sample is statistically unreliable. The division of drainages across the mesa was established by Washburn (1976).

Though the results of this study were not definitive, they were suggestive enough to draw some tentative conclusions about the ceramic design output from the Hovenweep area. The designs on the painted sherds were analyzed on two levels of complexity, motifs and design pattern bands. At the outset of this study, the primary interest was in whether or not there would be differences in the frequency of occurrence of designs over Cajon Mesa, and, if these differences were detectable, what drainages they were related to. Washburn hypothesized (1976), and this study focuses on the theory that designs from any one drainage would be homogeneous.

From the 1977 collection, thirty-nine motifs were represented in a sample size of eighty-six sherds from the four drainage areas. The motifs did not show a tendency to occur in a nonrandom pattern over the mesa (Table 18). On Table 18 and Table 19 the percentages represent column totals. The percentage directly above each drainage heading represents the number of motifs in that drainage out of the total sample. All of the motifs were used in the same relative frequencies by groups living in the four drainage areas. However, some motifs appeared to be more popular than others.

For example, motifs 177 and 187, angled hatching (Figure 50), were the most prevalent throughout all four drainages, being 39.6 percent of the statistical sample (Table 18 and Table 20). Table 20 represents motifs with frequencies of more than one. Those with frequency of one or none are combined into the "others" category.

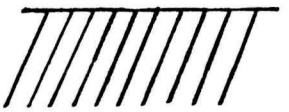
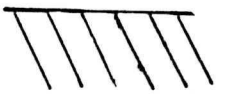
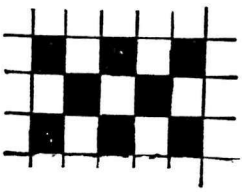


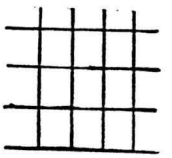
Figure 50: Motif 177



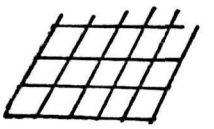
Motif 187



506



504

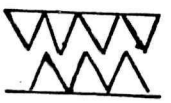


536

162

Figure 51:

414

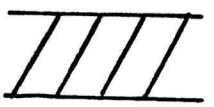


415

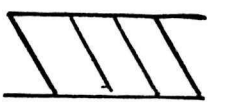
800

811

Figure 52:



401



445

Figure 53:

In contrast, the ceramic designs from 1976 yielded very few (2 out of 102 sherds) with the 177 motif. There were no sherds with the 187 angled hatching motif present (Table 19 and 21). This may be a function of site orientation and is one of the problems to be looked into in any further analysis. Table 21 represents motifs with frequencies of more than two. Those with a frequency of two, one, or none are combined into the "others" category. While the motif distribution from this season is also relatively homogeneous (Table 19), there was shift in the frequency of occurrence of motif.

Motifs 506, 504, 536, and 162 (Fig. 51) appeared most often in the represented drainages comprising 27.5 percent of the statistical sample (Table 19 and Table 21).

This information does indicate the relative homogeneity of the motif units used to construct designs, but it does not indicate the existence of smaller groups within the mesa demographic system. To distinguish one area from another then, the way that these motifs were structured was examined.

In 1977 the frequency of occurrence of motif symmetry in four drainage areas indicated a high concentration of one dimensional Translation symmetry (Table 22). In 1976, however, the design structure was more spread out over the principal symmetry classes (Table 23).

In a crosstabulation of drainages by the symmetry of structure, the 1977 ceramic output showed no significant statistical differences in symmetry structure from each drainage. Of the sherds analyzed, Translation, Vertical, Mirror Reflection, Vertical and Horaizontal Mirror Reflection, and Bifold Rotation (all one dimensional) were principal symmetry classes present and seened to be distributed relatively evenly throughout the drainages. In 1976, however, there were three symmetry classes that had a relatively high frequency of occurrence in the Cross drainage toward the northern end of the mesa. These same three symmetry classes had a low frequency of occurrence in the Bridge and Navajo drainage areas toward the southern end of Cajon Mesa (Fig. 49). Out of a sample of thirty-three sherds from Bridge, one sherd was two dimensional Translation, four were one dimensional Translation, and three were one dimensional Vertical Mirror Reflection. In the Navajo drainage area, with a sample size of fourteen sherds, one was two dimensional Translation, two were one dimensional Translation, and two were one dimensional Vertical Mirror Reflection.

In the Cross drainage area, from a sample size of fifty-five, five sherds were two dimensional Translation, fourteen sherds were one dimensional Translation, and nine were one dimensional Vertical Mirror Reflection.

It was also of interest to question whether or not particular design patterns were associated with particular features. A cross tabulation of 1976 features and design patterns was performed. Although the sample size was too small to draw definitive conclusions, some design patterns seemed to be appearing associated with kivas and towers. Design patterns 414, 415, 800, and 811 (Fig. 52), all one dimensional designs, were associated with towers.

Of the total number of sherds with design pattern 811 present, 28.6 percent were associated with towers; with design pattern 800, 25.0 percent; with design pattern 414, 50.0 percent; and with design pattern 415, 100.0 percent.

Of the total number of sherds with design pattern 401(Fig. 53) present, 25.0 percent were associated with kivas and with design pattern 445, there was a 75.0 percent association.

These features would be associated with long term living centers. There would be an expected absence of painted ware in granary and storage areas which was borne out in this study with only three painted sherds out of one hundred seven occurring in association with these food processing area features.

Also interesting to note were the results of a crosstabulation of design patterns by quad of the 1976 sample. Certain design patterns were exclusive to particular quads (Table 24). This would support the postulation that there would be locational subgroups of interacting patterns.

Conclusion

In looking at the sherds, one dimensional designs outweighed the two dimensional designs. This was to be expected because of the sherd size. Very often, only partial motifs were visible. To do a more complete symmetry analysis, semi-whole or whole vessels are needed.

The information derived from the statistical analysis of the symmetry of Anasazi design patterns is important to the understanding of cultural significances inherent in archeological remains. From this study, inferences can be made concerning the differences in the ceramic output from the Hovenweep area.

The key to the differences between 1976 and 1977 may be in site orientation. The discrepancies may be due to the functional use of sites. In 1976, more of the sites were habitation sites than in 1977. Some sites excavated in 1977 were primarily water control.

This analysis may be the basis for future ceramic studies. Such problems as similarities in design motifs indicating geographic distribution of communication lines among different populations can be addressed. Additionally the incorporation of 1974, 1975, 1976, and 1977 surface collections can help to estabblish if, in fact, surface collections reflect subsurface ceramic occurrences.

Table 18: Hovenweep 1977; Distribution of Motifs in Four Drainage Areas

Drainage Motif	41% Bridge		3.5% Hovenweep		24.4% Cross		27.9% Navajo	
	#	%	#	%	#	%	#	%
101	0		0		1	4.5	0	
121	1	2.8	0		0		0	
154	0		0		0		2	8.0
159	0		0		0		1	4.0
163	1	2.8	1	33.3	1	4.5	0	
169	0		0		0		1	4.0
176	1	2.8	1	33.3	0		1	4.0
177	12	33.3	0		5	22.7	8	32.0
187	6	16.7	0		0		3	12.0
244	0		0		0		1	4.0
249	2	5.6	0		0		0	
255	0		0		1	4.5	0	
270	0		0		0		0	
271	0		0		1	4.5	0	
272	1	2.8	0		0		0	
273	0		0		0		1	4.0
274	1	2.8	0		1	4.5	0	
275	0		0		0		1	4.0
276	0		0		0		1	4.0
277	0		0		1	4.5	0	

Table 18 - Continued

Drainage Motif	41% Bridge		3.5% Hovenweep		24.4% Cross		27.9% Navajo	
	#	%	#	%	#	%	#	%
278	1	2.8	0		1	4.5	1	4.0
279	1	2.8	0		0		0	
280	1	2.8	0		1	4.5	0	
281	0		0		0		1	4.0
282	1	2.8	0		0		0	
283	0		0		0		1	4.0
284	0		1	33.3	0		0	
285	1	2.8	0		0		0	
286	1	2.8	0		1	4.5	0	
287	0		0		1	4.5	0	
288	0		0		1	4.5	0	
289	0		0		1	4.5	0	
500	0		0		1	4.5	1	4.0
503	1	2.8	0		1	4.5	0	
504	1	2.8	0		0		0	
505	2	5.6	0		1	4.5	0	
506	1	2.8	0		0		0	
507	0		0		1	4.5	0	
536	1	2.8	0		0		0	

Table 19: Hovenweep 1976; Distribution of Motifs in Three Drainage Areas

Drainage	32.4%		55.9%		11.8%	
Motif	Bridge		Cross		Navajo	
	#	%	#	%	#	%
100	0		0		0	
101	0		1	1.8	0	
102	1	3.0	1	1.8	0	
107	0		1	1.8	0	
121	0		2	3.6	0	
134	0		1	1.8	0	
154	0		1	1.8	0	
159	0		1	1.8	0	
161	1	3.0	1	1.8	0	
162	1	3.0	4	7.3	0	
163	0		3	5.5	0	
169	0		1	1.8	0	
177	2	6.1	1	1.8	0	
188	1	3.0	1	1.8	0	
197	0		2	3.6	0	
205	0		1	1.8	0	
236	0		3	5.5	0	
241	1	3.0	0		0	
244	0		1	1.8	0	
248	0		1	1.8	0	

Table 19 - Continued

Drainage	32.4%		55.9%		11.8%	
Motif	Bridge		Cross		Navajo	
	#	%	#	%	#	%
249	0		1	1.8	0	
250	0		1	1.8	0	
251	1	3.0	0		0	
252	0		0		1	7.1
253	0		1	1.8	0	
254	1	3.0	0		0	
255	0		0		1	7.1
257	1	3.0	0		0	
258	0		0		1	7.1
259	0		1	1.8	0	
260	0		2	3.6	0	
261	1	3.0	0		0	
262	0		1	1.8	0	
263	0		1	1.8	1	7.1
264	0		0		0	
265	0		0		1	7.1
266	0		1	1.8	0	
267	0		1	1.8	0	
268	0		0		1	7.1
269	1	3.0	0		0	

Table 19 - Continued

Drainage	32.4%		55.9%		11.8%	
Motif	Bridge #	%	Cross #	%	Navajo #	%
400	0		1	1.8	0	
414	1	3.0	0		0	
450	1	3.0	0		0	
500	1	3.0	3	5.5	0	
503	0		1	1.8	1	7.1
504	2	6.1	4	7.3	0	
505	1	3.0	2	3.6	1	7.1
506	5	15.2	4	7.3	2	14.3
507	3	9.1	0		0	
536	4	12.1	1	1.8	1	7.1
537	1	3.0	0		0	
538	1	3.0	2	3.6	0	
541	0		2	3.6	1	7.1
800	1	3.0	0		0	

Table 20: Hovenweep 1977; Frequency of Occurence of Motifs in Four Drainage Areas

Motif	Number	Percentage
177	25	29.1
187	9	10.5
505	4	4.7
176	3	3.5
163	3	3.5
278	3	3.5
154	2	2.3
249	2	2.3
274	2	2.3
280	2	2.3
500	2	2.3
503	2	2.3
Others	27	31.4
	86	100.0

Table 21: Hovenweep 1976; Frequency of Occurrence of Motifs in Three Drainage Areas

Motif	#	%
162	5	4.9
236	3	2.9
500	4	3.9
504	6	5.9
505	4	3.9
506	11	10.8
507	3	2.9
536	6	5.9
538	3	2.9
541	3	2.9
Others	54	53.1
	102	100.0

Table 22: Hovenweep 1977; Frequency of Occurrence of Motif Symmetry in Four Drainages Areas

One Dimensional Motifs	Sym Structure #	Structure %	Sym Design #	Design %
Translation	48	55.8	52	60.5
Vertical Mirror Reflection	13	15.1	12	14.0
Bifold Rotation	6	7.0	6	7.0
Vertical & Horizontal Slide Reflection	5	7.8	3	3.5
Two Dimensional Motifs				
Bifold Rotation with				
Vertical & Horizontal Reflection	7	8.1	5	5.8
Others	7	8.1	8	9.2
	86	100.0	86	100.0

Table 23: Frequency of Occurrence of Motif Symmetry in Three Drainage Areas

One Dimensional Motifs	Sym #	Structure %	Sym #	Design %
Translation	20	19.6	30	29.4
Vertical Mirror Reflection	14	13.7	9	8.8
Bifold Rotation	10	9.8	8	7.8
Vertical & Horizontal Reflection	9	8.8	5	4.9
Two Dimensional Motifs				
Translation	7	6.9	7	6.9
Bifold Rotation	8	7.8	6	5.9
Vertical & Horizontal Reflection with Four Rotations	17	16.7	7	6.9
Four Rotations with Counterchange Between Rotation Units Along Both Axes, with Horizontal Mirror Reflection (counterchange between figures) and Vertical Reflection (counterchange between figures	0	0	11	10.8
Others	17	16.7	20	19.6
	102	100.0	102	100.0

Table 24: Hovenweep 1976; Crosstabulation of Design Patterns by Quad

Design Pattern	Number of Occurrences in Sample	Quad/Location	Number of Occurences in Quad/Location
Bridge Drainage			
414	4	2	4
415	2	Holly	2
820	2	Hov. 42	2
Cross Drainage			
427	3	13	3
436	3	15	3
446	3	13	3
448	2	13	2
458	2	14	2
Navajo Drainage			
401	4	45	4

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