
Moqui
Leguas Castellanas
LA BIBLIOTECA DEL SUROESTE
Cutganes
Hoabonomas
Rio Colorado Del
Althedomas
Sierra grande Devisada desde el Rio de Hila 1699
Rio Azul
APACHES
S. Dionisio 1700
Rio Hila Grande
1699
COCOMARICOPAS
YUMAS
Casa
SOBAIPURIS
Agua Escondido
S. Francisco Xavier del Bac
Medanos de Arena
La Merced
Bagiopas
Sero de S. Clara 1698
S. Eulalia
Saric
Guebabi
SOBAS
Cocospora
Tubutama
Remedios
Quiquimas
S. Ignacio
Dolores
S. Juan
Matape
MAR DE LA
PARTE DE LA CALIFORNIA
SOBAS
Ures
Tonichi
Guaimas
Hiaqui
Cocorim
Bicam
MAYO
Nabojoa
Rio de Los Frailes
Rio de S. Cristoval
Las Virgines
W. J. Holliday

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PREHISTORIC IRRIGATION IN ARIZONA

BY

F. W. HODGE

[FROM THE AMERICAN ANTHROPOLOGIST, JULY, 1893]

WASHINGTON, D. C.
JUDD & DETWEILER, PRINTERS
1893

SMITHSONIAN INSTITUTION

BUREAU OF AMERICAN ETHNOLOGY

WASHINGTON, D. C., Mch 11/94

Dear Mr. Mishkin:

I thank you very much for the "leaflet" containing your translation of Coronado's journey. These important articles so carefully rendered into plain name — in my opinion — accessibility to students — and I trust you may soon see yr. way clear to follow your Coronado leaflet with that of Castañeda.

Very truly yrs.

F. W. Hodge

PREHISTORIC IRRIGATION IN ARIZONA.*

BY F. W. HODGE.

In none of the extensive archeologic remains of southern Arizona are the industry, perseverance, and degree of advancement of a large pueblo population more faithfully illustrated than in the many works of irrigation that abound in the valleys and on the mountain slopes of this section. Prior to the prosecution of systematic archeologic investigation in this region, it was generally believed that, aside from the employment of catch-basins or rude reservoirs formed at the bases of mountain arroyos, artificial irrigation was not practiced by ancient pueblo builders, and that the existing pueblo tribes derived from the early Spanish missionaries or conquistadores their knowledge of conducting the water from the streams to their fields. In the valleys of the Salado and Gila, in southern Arizona, however, casual observation is sufficient to demonstrate that the ancient inhabitants engaged in agriculture by artificial irrigation to a vast extent.

The arable area of the valley of the Salado comprises about 450,000 acres, a tract almost equally divided by the river. No obstacle is encountered in irrigating the land lying south of the stream for a distance of ten miles, but greater difficulty attended the conducting of water to the northern area by reason of the greater slope of the land, which necessitated the establishment of headworks much farther up the river. This difficulty modern ranchmen have overcome by the construction of the Arizona canal, which traverses a distance of forty-one miles from east to west, and has a capacity of 40,000 miners' inches, sufficient to irrigate 50,000 acres, or over 27 per cent. of the 182,000 acres now reclaimed by the nine irrigating canals of the valley. This latter area is less than one-half the lands redeemable by the waters of the lower Rio Salado.

Judging from the remains of extensive ancient works of irrigation, many of which may still be seen passing through tracts cultivated

* From notes made in 1887–'88 while the author was a member of the Hemenway Archeological Expedition, operating in the Southwest under the directorship of Mr. Frank Hamilton Cushing.

to-day as well as across densely wooded stretches considerably beyond the present non-irrigated area, it is safe to say that the principal canals constructed and used by the ancient inhabitants of the Salado valley controlled the irrigation of at least 250,000 acres, even without considering the economical methods employed by a primitive people in all its undertakings.

The mode of canal construction employed by these pueblo builders was another indication of their patience and industry. Their canals are models for the modern farmer to imitate; yet they could have been dug in no conceivable manner save by the laborious process of hand excavation with stone or wooden implements, the earth being borne away by means of blankets, baskets, or rude litters. Notwithstanding this, the outlines of at least a hundred and fifty miles of ancient main irrigating ditches may be readily traced, some of which meander southward from the river a distance of fourteen miles.

In following the courses of these canals their depressions may more readily be seen in the dense mesquite forests, where protection is afforded against the drifting sand. On more open ground their routes are generally entirely effaced, lines of stones alone remaining to mark their sites. These stones were the implements once used, broken, and cast aside upon the banks, as well as concretions grotesquely eroded by the river stream and deposited by the natives along the banks as "tamers of the waters." Similar concretions or huacas, according to the description by Mr. Cushing in his article on "Zuñi Breadstuffs," are placed by the Zuñis along the courses of hill-streams near their main pueblo and along the ditches of Pescado and Ojo Caliente, in order, presumably, to direct the waters of the rainy season from the hillsides to the thirsty fields, and to prevent the overflow of their acequias. It is interesting to note that in no instance were these concretions found to have been used as implements, although many of them are admirably adapted to such purposes; a fact further attesting their sacred character.

In the progress of the investigations of the Hemenway Expedition in the Salado valley, under the directorship of Mr. Cushing, excavation was undertaken at a point along the course of one of the principal supply canals of the ancient Pueblo de Los Muertos, near one of the thirty-six large communal structures which formed this now ruined city, and extended for a distance of about thirty feet. The depth of the bed beneath the original banks was found

to be about seven feet. Unlike ordinary irrigation ditches, these were constructed in such a manner as to control to some extent the depth of the current as well as to prevent waste through seepage. The bed of the canal was about four feet wide, but the sides broadened in their ascent to within about four feet of the bank, where a "bench" three feet in width on each side of the canal had been made. From these benches the banks continued, broadening until they reached the brinks, which were about thirty feet wide. Thus a main ditch consisted, so to speak, of one water-course within another; so that if at any time a small current of water only could be supplied at the headgate, owing, perhaps, to drouth, the lower and narrower ditch was doubtless always filled sufficiently to supply the towns beyond, while during the rainy season the upper and much broader portion of the great canal would readily accommodate all surplus waters.

The bottom and sides of the irrigating ditch which was opened, as well as those of a branch of it excavated to the southwest of the ruined-house cluster alluded to, were found to be exceedingly hard, evidently having been tamped while moist, and then, perhaps, roughly plastered with adobe clay. The extreme hardness of the canal lining may be accounted for by the supposition that, instead of burning the dense underbrush for the sole purpose of destroying it, the natives gathered it into their moist canal beds, where it was burned to harden the newly plastered lining. Very little silt was found in the beds of the irrigating ditches, a fact exhibiting either the care taken of them or showing that a current of considerable strength was flowing at the time of the abandonment of the pueblo.

A few rods south of the canal excavation referred to, the canal was observed, from the course of the chipping stones and concretions or "water-tamers" along its banks, to decrease in width and branch off into two canals, each at an angle of about 45° from the trunk acequia. Excavation at this point showed a number of post-holes on the outer banks of the two branches, as well as at the angle formed by their juncture, attesting the former existence of a head-gate for cutting off or supplying at pleasure the farm lands and house groups to the southward.

The only specimens collected from the canal excavation were a few potsherds, quite a large quantity of cottonwood pollen comparatively well preserved, a few small fresh-water univalves, and the remains of a bundle of fagots or reeds that had apparently floated

down with the current. The finding of these last-mentioned remains suggested the possibility of the irrigating canals having also been used in conducting a rude system of navigation by means of *balsas* or cane rafts, in transporting bowlders and other material from the river to be manufactured into cutting and chipping tools, etc. It was also observed that all the unfinished stone implements found at Los Muertos (except the lamelliform tools of shale or slate, such as knives and hoes), whether of diorite, granite, or sandstone, were smoothly water-worn, and consequently the products of the river-bed nine or ten miles distant, and were not conveyed from the Maricopa mountains, situated only about five miles to the westward.

The existence of these thousands of water-worn tool-stones and the absence of the ill-shaped fragments of basalt from the mountains, however, is not advanced as evidence that navigation existed among these people. River cobbles are much better adapted for fashioning into implements than the rough stones found on the slopes of the basaltic Maricopa range, previously mentioned as the rock deposit nearest to the Los Muertos ruins. Therefore, notwithstanding that the difference in distance from Los Muertos to the river and to these mountains is fully four miles, river bowlders would doubtless have been procured in preference to the clumsy natural chippings from the mountains, even if the facilities for a system of water transportation were lacking. It would, therefore, not necessarily be an indication of particular advancement on the part of these people if they did construct rude craft as a means of water communication from the river to their pueblos. In fact, having exercised their ingenuity to such an extent as is exhibited by their canal construction, one would expect this next step as a matter of course, particularly where the extreme necessity for such navigation, however primitive, had arisen.

It was noted that nearly all the pueblos encountered throughout the Salado valley were situated, not near the river, as would seem more likely by reason of the convenience of such a location to stone, cottonwood timber, rushes, osiers, and other river products, but nearer the ends of the canals, where the slope of the land prevented further irrigation without the necessity of overcoming obstacles beyond the skill of such a people. In each of these cases, with but a single exception, it was observed that the tracts lying between the towns and the river were devoid of vestiges of previous pueblo set-

tlement, but, as indicated by the ramifications of the lesser canals, bore evidence of having been under cultivation.

The location of the towns usually at the farthest possible distance from the river would of itself seem to demonstrate the independence of their builders toward the source of water supply and deposits of raw material. Again, countless bowlders or cobbles were unearthed at each of the pueblos excavated, which clearly exhibited faults in chipping or flaking, and had apparently been rejected as unfit for use. Had the natives been without ready means of transportation, this rough or primary chipping of the stones would most probably have been done at or near the river rather than at the places where they were to be used, ten or twelve miles away, to which point they must necessarily be conveyed by hand.

The great distance to which these ancient canals were extended in order to utilize all the available land through which their waters coursed, the depth which they were dug, and the care taken to prevent waste by seepage, are not the only evidences of the indomitable energy of these ancient agriculturists. At the group of ruins near the Mormon settlement of Mesa City, eastward from Tempe, in Maricopa county, remains of an extensive irrigation system may be seen. Here, more than at any other point in the valley, is demonstrated the degree of skill attained. In the original excavation of the canal referred to a hill of indurated tuff was encountered, beyond which a large tract of fertile land lies. This knoll or mound of concrete was partly encircled by the irrigating ditch in order to preserve the proper incline of the canal bed, and to accomplish this it was necessary to excavate through this indurated deposit with implements of stone, a work necessarily attended with inconceivable difficulty and requiring a great length of time.

Several years ago, when the Mormons first settled at Mesa City and began the irrigation and cultivation of the fertile plain about them, they utilized this ancient canal bed for a considerable distance, including that portion encircling the knoll of volcanic tuff mentioned. The writer has been informed by one of the founders of this settlement and builders of the Mesa canal, which is nine miles in length, that the saving to them by using the ancient canal was from $20,000 to $25,000. To use the words of my informant: "The old canal was utilized for fully three miles to great advantage, and from one to two miles with but little benefit." In other words, one-half the modern canal occupies the ancient bed.

A number of writers, mainly in the public press, have given expression to opinion in regard to irrigation in the Salado valley by means of water stored in catchment-basins or *represas*, constructed on the various mountain slopes, in addition to irrigation by the canal system. Great stress has been laid upon this supposed irrigation by means of reservoirs in order to give color to the theory, entertained by some, of a prehistoric population in the Salado valley much more vast than possibly could have existed. Had this means of storage of rainwater for irrigation been practiced by the natives of a region so bountifully supplied with water as the Salado valley, the fact that a teeming population dwelt upon and cultivated the lands within its limits would be undeniable; but this cannot be proved to be the case, although a very large population, as Indian populations go, doubtless did occupy the greater portion of the lower valleys of both the Salado and Gila, as is shown by the extensive irrigation operations once engaged in.

Reservoirs at the mouths of mountain washes for holding in reserve rainwater for the irrigation of the lands which, on account of their elevation, could not be redeemed by the canals, are not found in the valley of the Salado. While most of the valley lands were once covered by a network of irrigating ditches, yet there were tracts capable of redemption over which it appears water was never conducted, and which could have been reclaimed by merely extending the canals, before *represas* were resorted to for irrigating the inferior land about the mountain bases.

Receptacles for the storage of rainwater occur in this region, their remains being found in many parts of the area of the lower Gila drainage, but it is safe to say that they were not constructed because of a lack of sufficient land irrigable by canals, as the low, level tracts in both the Salado and Gila valleys showing no evidence of former tillage will testify. The population of an agricultural tribe cannot well be estimated by the extent of its habitat, particularly in the arid region, but by the amount of land actually cultivated. For instance, the Zuñi reserve embraces a tract over thirty miles in length, and while a large portion of it is capable of redemption and cultivation by the present water-supply, only a comparatively small quantity is tilled. Were the population of this tribe estimated by the area which embraces the scattering patches of cultivated land from Nutria to Ojo Caliente, it would reach many thousands, whereas it is but 1,600. It would appear,

therefore, that the number of inhabitants of the now dead pueblos of this region has been figured on an erroneous basis.

It seems reasonable to presume that in an arid territory like our Southwest, where so many of the streams are intermittent, the valleys of the larger streams were first occupied, and, as the population increased, the lands drained by their lesser affluents were next settled upon. As the pueblos of the Gila, as shown by their ruins, were generally larger than those of the Salado or Verde, and the irrigating canals of the former more extensive than those of its tributaries, it is not improbable that these hillside reservoirs or catchment-basins were built previously to the construction of the irrigation ditches, at a time when the population was small. Should this prove to be the case, the occurrence of these hillside reservoirs may be accounted for, since their construction might be undertaken with much less expenditure of labor and skill than the building of an irrigation canal would entail, and at the same time the wants of a small population would be supplied.

In tracing the routes once pursued by many of the canals, great depressions—the sites of ancient reservoirs—are observable. The remains of one of these reservoirs, nearly a mile long by about half a mile wide, occur on the open plain at the terminus of one of the main canals that formed the source of water-supply of Los Muertos, and about three miles southwest therefrom. It is possible that this great depression was, in part at least, a natural sink, deepened by artificial means to serve more fully the purposes of a storage basin of surplus waters from the Los Muertos irrigating system. Every cluster of communal structures in Los Muertos was supplied with a reservoir on a smaller scale than the one just mentioned, a single canal forming both its inlet and outlet. Sometimes a lesser communal dwelling shared with a neighboring structure in the water supply from a single storage basin.

Doubtless the largest reservoir within the limits of Los Muertos was that lying directly west of the ruined communal dwelling designated XIV and extending almost to its walls. A trench run through the lesser diameter of this reservoir showed its original depth to have been about fifteen feet. This artificial basin was elliptical, measured about 200 feet in length by fully 100 feet in width, and, like the canals, had apparently been tamped and burned. The bed and sides of this reservoir were covered by a thick stratum of silt.

The existence of the remains of so many extensive irrigation

works scarring the broad, level valley of the Salado seems sufficient to prove the contemporaneous occupancy of the pueblos formerly within its limits, for had a village been built and for some reason abandoned by one community, it would scarcely be in keeping with the Indian's idea of economy for subsequent settlers not to utilize the enormous labor already expended in gathering building material and digging ditches and reservoirs. While the population of these pueblo settlements was undoubtedly large, it would be unreasonable to estimate the number of inhabitants of the dozen distinct ancient pueblo settlements formerly in the valley of the Rio Salado at from 200,000 to 300,000. This, however, has been done.

4/12/94