Agriculture Among the Paiute of Owens Valley

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. . . To search for the 'first domestic plant' is to search for an event. It is poor strategy, it encourages bitter rivalry rather than cooperation, and it is probably fruitless. We should search instead for the processes by which agriculture began.

—Kent V. Flannery (1973)

IN 1973, Kent V. Flannery in a masterly review article asserted that no aspect of prehistory had received so much attention from archaeologists, botanists, geographers, and anthropologists over the preceding 15 years as the origins of agriculture. "Surely at this stage," Flannery observed wryly, "we could declare the origins of agriculture a bandwagon." Indeed, one can scarcely keep abreast of new literature on agricultural origins. Yet throughout the voluminous writings on this subject over the past few decades there are only fleeting references to the practice of irrigation of wild plants among the Paiute of Owens Valley.

Almost a half century has passed since Julian Steward (1930) first brought to scholarly attention ditch irrigation of wild plants by these Great Basin people of east central California. Steward (1930:156) suggested this anomalous subsistence practice might have arisen as "simply an artificial reproduction of natural conditions" existing in the swampy lowlands of Owens Valley. One reason little attention has been given since to Paiute irrigation of wild plants appears to lie in Steward's belief that these people were "on the verge of agriculture without achieving it." In fact, Steward (1930) titled his first paper on the subject "Irrigation Without Agriculture." Almost no one who has written on the subject has taken Steward's discovery very seriously or challenged his conclusions. In part, this may be because there was some wavering by Steward over the years as to whether irrigation was truly aboriginal with the Owens Valley Paiute or acquired from contact with the Spanish or later American settlers who penetrated the region after 1850 (Steward 1930:248-249; 1938:53). Also, Treganza (1956) argued that irrigation reached Owens Valley through Caucasian contact after 1850, although he presented no data adequately defending this hypothesis. Eventually, Steward (1970:123) reconsidered the problem and somewhat cautiously returned to his original position that irrigation of wild plants in Owens Valley was probably of aboriginal origin. A third factor standing in the way of more intensive scrutiny of Owens Valley irrigation has been semantic confusion over the concept of "incipient agriculture" as opposed to true agriculture. That problem will be discussed later in this paper.

Undoubtedly, the importance of Steward's pioneer research on irrigation in Owens Valley has been obscured by his own coining of the

phrase "irrigation without agriculture." Apparently researchers have taken Steward's phrase literally, since no one has added significant new insights on Paiute irrigation, and no one seems to have considered the possibility that true agriculture could have existed in Owens Valley. For this reason, recent summaries of agricultural origins (e.g., Harlan 1975) have been unable to adequately evaluate its significance. Recent archaeological work in Owens Valley (Bettinger 1975) has been directed at other problems.[1]

FRAMEWORK OF INVESTIGATION

Bean and Blackburn (1976:6) called attention to a "renaissance of sorts" that has occurred in recent years in the study of California Indians. They noted a dramatic increase in papers reflecting a commitment to the development of theory applicable to a wider arena than California or providing "significant reinterpretations or syntheses of older data that greatly alter previously accepted views on aboriginal life." Kearney (1974:5) linked this renaissance to a growing recognition that aboriginal California was probably "more representative of the non-urban stage of human prehistory than the 'band-level' societies of contemporary hunters and gatherers in marginal environments which are relatively over-represented in the literature."

In particular, there has been a focus in the past few years on the technological processes associated with subsistence patterns of California hunters and gatherers. Heizer's (1958:23) hypothesis that the peoples of California were in a "Preformative Stage" defined as "semi-agricultural" at the time of Spanish contact has had a stimulating influence on a body of researchers who have fanned out looking for supporting data among various Indian groups. Much of their research has concentrated on southeastern California, where an increasing array of circumstantial evidence indicates that aboriginal agriculture diffused west of the Colorado River prior to European contact and was adopted by the Cahuilla, Kamia, interior groups of Southern Diegueño, certain groups in Baja California, and quite possibly some Indian groups on the Mohave Desert (e.g., Forbes 1963; Lawton 1968; Lawton and Bean 1968). Another area of primary concern has been the extent to which California Indians engaged in environmental manipulations such as burning of woodland-grass, chaparral, and coniferous forest zones to enhance plant and animal food resources (Lewis 1973). In this latter field of study, scattered data have also been assembled indicating the presence of incipient agriculture among many Indian groups (Bean and Lawton 1973). Fairly comprehensive reviews of the literature on such research may be found in Bean and Lawton (1973)[2] and Lawton (1974). Winter (1975) provided a bibliography covering aboriginal agriculture within the broader contexts of the Southwest and the Great Basin. More recent research touching upon the problem of aboriginal agriculture in southeastern California is reported by Wilke and Lawton (1975), Wilke, King, and Hammond (1975), and Wilke (1976).

Such research has made it necessary to reconsider Spinden's (1917) hypothesis that the acorn economy of California prevented the westward dispersal of agriculture from the Colorado River, where it was practiced in the pre-hispanic era. Similarly, hypotheses developed by Kroeber (1925, 1939), Sauer (1936), and other investigators that certain specific cultural or environmental factors constituted barriers to the spread of agriculture across California have been shown to be invalid or not sufficiently comprehensive in resolving this problem (Bean and Lawton 1973:viii-xvii). In a recent review of Lewis (1973), David R. Harris commented as follows on the new research data coming out of California:

> . . . What emerges most forcefully . . . is confirmation from California for the view that 'primitive' man's ability to manipulate his environment was much greater than

> conventional opinion supposes. It reinforces my belief that it is high time we rejected the simple-minded opposition between 'farmer' and 'hunter-gatherer' and sought instead to devise new and more ecologically and socially sophisticated categories in our investigations of aboriginal subsistence [Harris 1975:686].

Eventually, new directions in California research may make it possible to satisfy the demand of O'Connell (1974:120) that a clearer understanding be provided of the complex processual relationships of California hunters and gatherers to their environment and those grey areas of phenomena that shade from hunting and gathering into the domains of "semi-agriculture" or agriculture.

It was within the framework of the research outlined above that the authors determined to conduct a serious re-examination of the problem of irrigation among the Owens Valley Paiute. Our research over the past three years has brought to light previously overlooked or unpublished documentary materials indicating that irrigation was of far greater importance to Owens Valley subsistence than heretofore recognized. We will show that the Owens Valley Indians developed a complex system of irrigated vegeculture unique to North America. Some evidence will be presented that ditch irrigation of wild plants may have extended over a broader area of the Great Basin than simply Owens Valley. Field research combined with our literature survey has made it possible also to identify with considerable certainty the primary plants irrigated by the Owens Valley Paiute and to correct some misconceptions held by Steward. We will suggest that the practice of irrigation among these Indian people was almost certainly of indigenous origin and that they were engaged in *agriculture* by definition. Finally, we will present our conclusion that "wild" plant irrigation by the Paiute of Owens Valley offers a more exemplary model of the origins of agriculture than any yet revealed by archaeological studies of early deposits containing already domesticated plants.

NATURAL AND CULTURAL SETTING

Owens Valley is a deep structural trough in east central California (Fig. 1). The valley is over 75 miles long, averages 6-10 miles in width, has an average elevation of about 4000 feet, and runs generally southeast to the Mojave Desert. High mountains rise like vertical walls within a few miles on either side of the valley. The Sierra Nevada to the west and the White Mountains to the east exceed 14,000 feet in elevation, making it the deepest valley in the United States. The valley is watered by the Owens River and its numerous tributaries which take their snowy origin high in the Sierra Nevada (Fig. 2). Precipitation on the valley floor averages only 5-6 inches yearly due to its position in the rainshadow of the mountains. Annual snowfall averages about 12 inches. Summers are hot, and winters are moderately cold. The average growing season is 144 days (Felton 1965:120).

Although formerly classified as Eastern Mono, the Indians of Owens Valley are now recognized as the southernmost division of Northern Paiute. A definitive ethnography has been published by Steward (1933; see also Steward 1938). There were probably at least thirty permanent villages clustered into a lesser number of land-owning districts between Round Valley to the north and Owens Lake to the south, making Owens Valley one of the most densely settled regions of the entire Great Basin. The aboriginal population of Owens Valley was probably at least 2000 (Wilke and Lawton 1976:46). Many plant foods were collected in season in recognized territories, including a section of the valley floor and the adjoining mountain slopes. Especially important were pine nuts (*Pinus monophylla*) and the seeds of Indian rice-grass (*Oryzopsis hymenoides*), wild-rye (*Elymus cinereus*, *E. triticoides*), love grass (*Eragrostis*, probably *E. orcuttiana*), and many others (see Steward

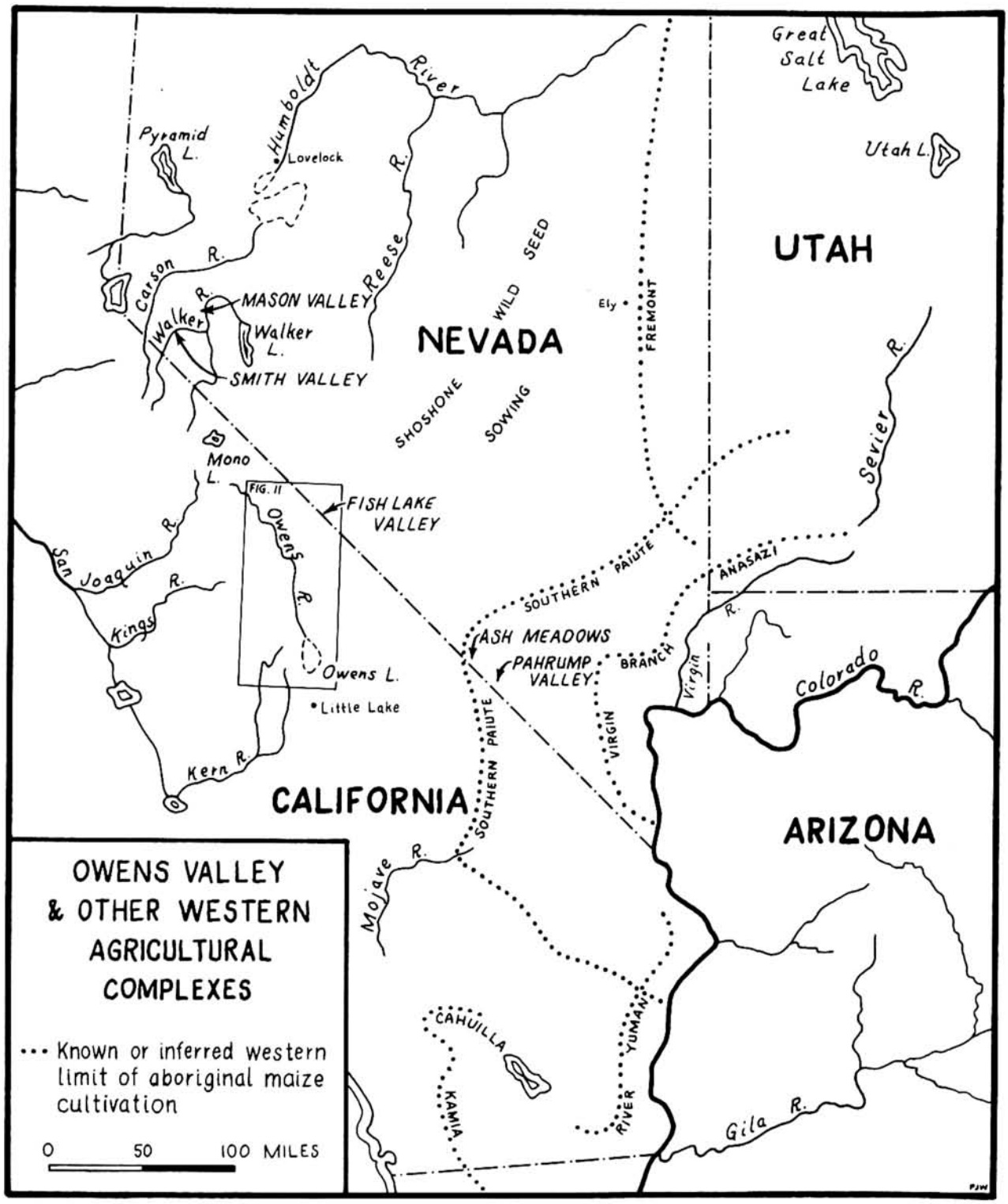

Fig. 1. Location of Owens Valley and other western aboriginal agricultural complexes.

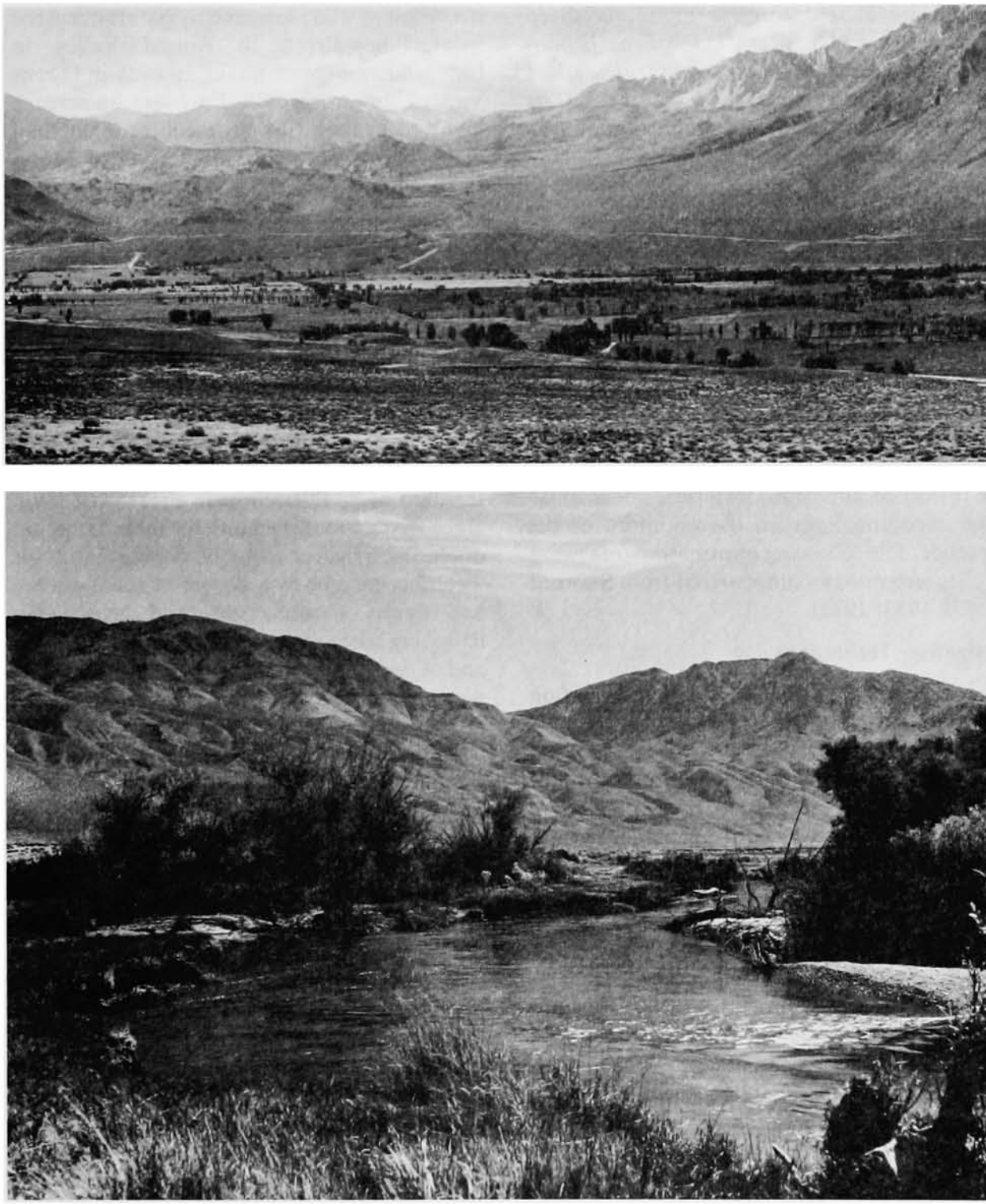

Fig. 2. Environment of Owens Valley. Above: View to the southwest across Round Valley. Horton Creek in center background. Irrigation was reported by Von Schmidt just below the center of photograph. Photo by P. J. Wilke. Below: Owens River just southwest of Bishop. View to the southeast with the Inyo Mountains in the background. Photo by P. J. Wilke, October, 1975, and Copyright © 1976 by the Ballena Press. Used by permission of Ballena Press.

1933:242-246). Hunting for mountain sheep (*Ovis canadensis*), deer (*Odocoileus hemionus*), and jackrabbits (*Lepus californicus*), and fishing in both the Owens River and its tributaries were also very important subsistence activities.

STEWARD'S FINDINGS ON OWENS VALLEY IRRIGATION

Before presenting the results of our research, it is necessary for purposes of further discussion to review Steward's findings on irrigation among the Owens Valley Paiute. Steward (1930:149-156; 1933:247-249) fully accepted his informants' statements that the practice began in aboriginal times. Steward's data were entirely ethnographic, however, and he furnished almost no historical documentation shedding light on the antiquity of the practice. The following information on Owens Valley irrigation is summarized from Steward (1930, 1933, 1938).

Irrigation Technology

Steward (1930:15) reported ditch irrigation had been undertaken "upon a considerable scale" in Owens Valley with its greatest development occurring at the northern end of the valley near the present town of Bishop, where population was most dense and "natural facilities were greatest." On each side of Bishop Creek at *pitana patü* was an irrigated plot, a northern one measuring 4 by 1 to 1-1/2 miles, and a southern plot approximately two miles square. The irrigation system for these fields consisted of a dam on Bishop Creek about a mile below the Sierra Nevada Mountains and a main ditch leading to each plot. The northern ditch was over two miles long and the southern more than three miles long, both immense earthworks the size of modern canals (Fig. 3) (Steward 1930:151, 157). According to Steward (1933:247), dam and ditch construction "involved no problems but entailed considerable labor." Elsewhere, Steward reported, Freeman and Baker creeks were dammed for irrigation of wild plots, and irrigation occurred from Pine Creek in Round Valley to Independence Creek about midway in Owens Valley. Steward provided no data on acreage involved in irrigation at localities other than *pitana patü*. The Northern Paiute of Mono Lake, about forty miles to the northwest of Owens Valley, did not irrigate.

The position of head irrigator (*tuvaijü*^{nu}) was honorary at *pitana patü*, and he was elected every spring by popular assembly. The district head man announced the time to begin irrigation, and it was approved by the people.[3] South of Bishop at Big Pine, the head man also served as head irrigator, but he had an assistant. Irrigation was communal at *pitana patü*, and all men might assist in constructing the dam of boulders, brush, sticks, and mud. Once water was turned into the main irrigation ditch, the irrigator had sole responsibility for watering the plot by a system of small ditches and dams of mud, sod, and brush. His irrigating tool (*pavodo*) was a pole, 8 feet long and 4 inches in diameter. After water was turned into the ditch, fish were recovered from the dry stream bed. The overflow water from irrigation was permitted to take its course and wander on to the Owens River. In the fall, before harvesting of the wild plants, the dam was destroyed and the water allowed to flow once more down its main channel. Again fish were gathered, but this time from the irrigation ditch.

An interesting feature of Owens Valley irrigation was that the northern and southern plots at *pitana patü* were alternated for irrigation annually. Water was turned into one plot in the spring, and the next year the other plot was irrigated. This is a form of fallowing. Steward (1933:247) was told by one informant that alternate irrigation was employed to "prevent soil exhaustion," but suggested a more likely explanation might be that it "enabled the plots to reseed themselves." We shall discuss below why neither explanation seems acceptable. Whether alternate irrigation

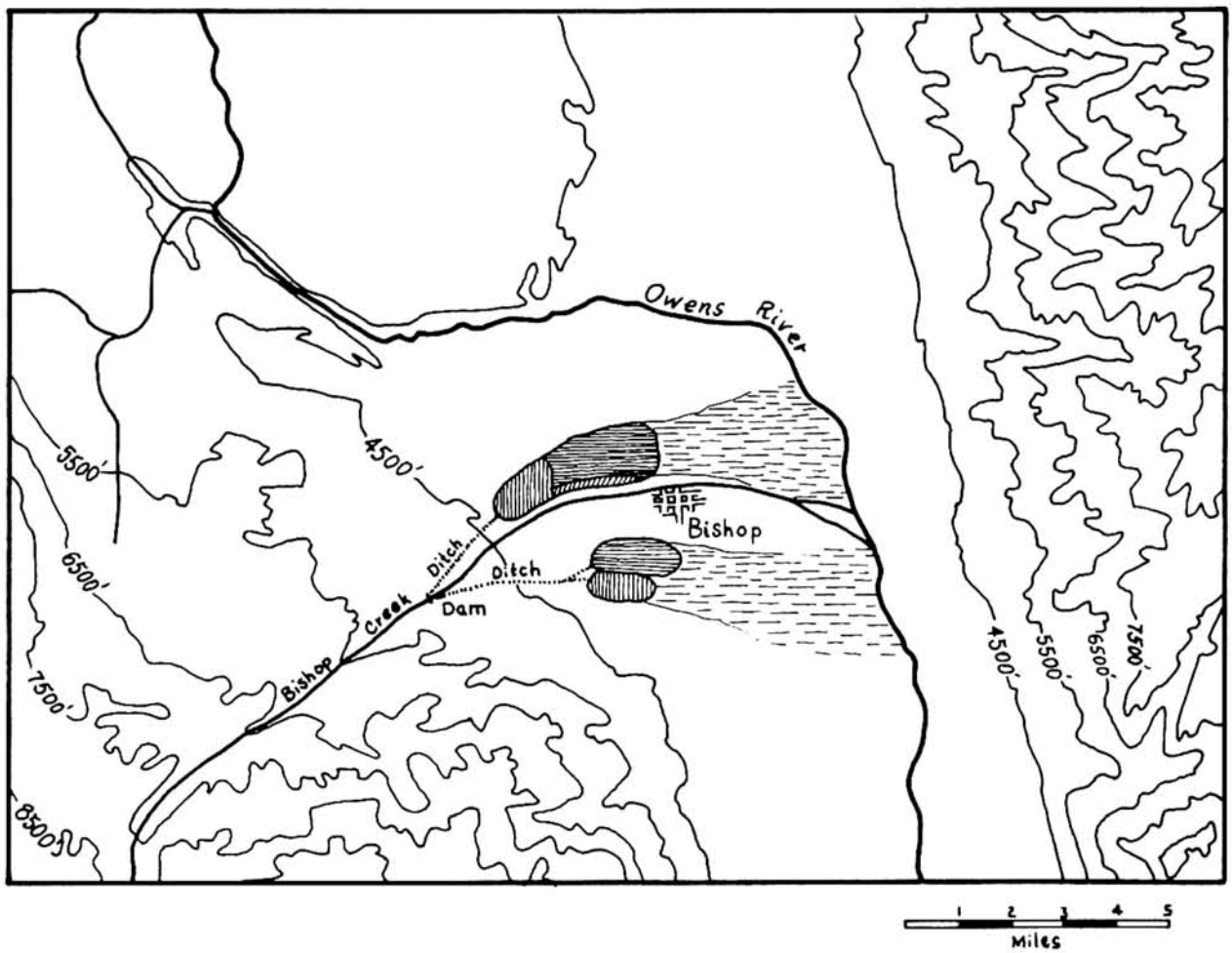

Fig. 3. Steward's map of the irrigation system at *pitana patü*, near present Bishop, Owens Valley, California. Based on informant memory recorded about 1927. Compare this with Fig. 4, which shows observations recorded 75 years earlier. Redrawn from Steward (1930:150).

was practiced at settlements other than *pitana patü* was not recorded by Steward.

Wild Crop Plants Harvested

An important aspect of early Owens Valley irrigation is that it was applied to plants other than those known to have been cultivated by aboriginal farmers in the American Southwest. Steward (1933:247) implied that the two plots at *pitana patü* were irrigated to increase the "natural yield" of two primary plants: *tüpüsi*^{n} and *nahavita* (see also Steward 1930:150).[4] He reported that the western half of the northern plot at *pitana patü* abounded in *tüpüsi*^{n}, and the eastern half in *nahavita*. The southern plot had a large stand of *nahavita* and a smaller one of *tüpüsi*^{n}. While Steward (1930:150) noted that other "wild seeds and tubers" existed in the plots, he emphasized (1930:152; 1933:247) that the overflow water below the plots irrigated land bearing *mono*, *sünü*^{ü}, *pauponiva*, *waiya*, *pak*^{ü}, and *tsikava*, which were also harvested as food plants. The principal purpose of irrigation, however, appears to have been directed at two chief plants in the irrigated plots, *tüpüsi*^{n} and *nahavita*.

Steward (1930:150) identified the plant known as *tüpüsi*^{n} as a "small bulb of the lily family." Later, he suggested (1933:245) that it was "probably *Brodiaea capitata* Benth.,

grassnut or blue dicks," the species currently classified as *Dichelostemma pulchella* (Salisb.) Heller. The second primary wild crop plant was *nahavita*, which he believed to be a member of the genus *Eleocharis* (spikerush). We will suggest below that Steward's identification of these plants was in error.

The seed-bearing wild plants primarily associated with the irrigation overflow below the plots are identified as follows: *mono* (also called *tsikava*, love grass, *Eragrostis*, probably *E. orcuttiana*); *sünü*^{ü} (wheat grass, *Agropyron*, probably *A. trachycaulum*); *paupo-niva* (?); *waiya* (Great Basin wild-rye, *Elymus*, probably *E. cinereus* or *E. triticoides*); and *pak*^{ü} (sunflower, *Helianthus*, probably *H. nuttallii*) (based on Steward 1933:242-245, unpublished ethnobotanical notes of Mark Kerr, and floristic notes of DeDecker). Steward's (1933:242-245) ethnography also lists several other plants which grew on the irrigated plots or on the overflowed land. These are *atsa* (western yellow cress, *Rorippa curvisiliqua*), *sigüv*^{ü} (an unidentified grass), *wocava* (another unidentified grass), *pawai* (water grass, *Echinochloa crusgalli*),[5] and *wata* (white pigweed, *Chenopodium berlandieri*).

Harvesting of the irrigated plots was communal, and all women might assist in the effort. The intensity with which the fields were harvested is not known, but total harvesting would have required a tremendous amount of communal labor with such extensive plots.[6] Steward does not say whether harvesting of certain plants occurred in various stages between spring and fall (when the dam at *pitana patü* was destroyed). He does say that *tüpüsi*^{ii} and *pak*^{ü} were harvested in the fall.

Digging sticks of mountain mahogany or buckbrush were employed in digging up *nahavita* and *tüpüsi*^{ii} during the harvest. A ladle-shaped basketry seed-beater was employed with seed plants, which were collected in a conical carrying basket. It has been shown elsewhere that harvesting with seed-beaters militated against genetic modification, which, through planting (which some Great Basin groups engaged in), would have resulted in increased yields and consequently a tendency toward increased sedentism and other cultural complexities (Wilke *et al.* 1972).

Theoretical Discussion

Steward (1933:248) firmly emphasized that the Owens Valley Paiute were "on the verge of horticulture but did not quite achieve it, for planting, tilling, and cultivating were unknown." Earlier, Steward (1930:149) used the word "agriculture" instead of "horticulture." The term "horticulture" as used by Steward is misleading, since irrigation as practiced in Owens Valley was on the agronomic scale of field crops, which is the chief business of agriculture (e.g., Taylor 1961). Part of the misunderstanding that exists here is the result of a disagreement over terms and concepts and of conceptual changes since Steward's research appeared.

Steward (1933:248-249) presented three possible hypotheses for the occurrence of "irrigation without agriculture" in Owens Valley, which he recognized as having "an important bearing on the origins of agriculture in America." The three hypotheses may be summarized as follows:

(1) An ancient practice of irrigation may have preceded the diffusion of cultivated plants in the Southwest and survived in eastern California. Steward considered this hypothesis highly improbable, with no known evidence to support it.[7]

(2) Irrigation may have diffused from a horticultural complex of the near or remote past in the Southwest. Steward considered it unlikely that such a borrowing had occurred in recent times, since none of the crop plants grown among peoples to the east and southeast of Owens Valley had entered the Paiute irrigation complex. If diffusion from the Southwest explained Paiute irrigation, Steward (1933:249) stated, then it did not "operate in the conventional manner, for there was a

differential borrowing in which a close-knit horticultural complex was broken down and the seemingly dependent or secondary element, irrigation, diffused without the carrier or *raison d'être* of the complex—the nucleus of cultivated plants."

(3) Paiute irrigation may have been of local and independent origin. Steward considered this explanation a distinct possibility. He hypothesized that the original idea for irrigation might have come from the "swampy lowlands of Owens Valley where it is obvious that moist soil—a natural irrigation—produces a very prolific plant growth" (Steward 1933:249). Irrigation would then represent "simply an artificial reproduction of natural conditions." Kowta (1965) and Appleton and Kowta (1969), in a reappraisal of Steward's data, concluded that Owens Valley irrigation may have been of independent origin.

As mentioned earlier, Steward (1938:53) several years later admitted the possibility that irrigation was introduced by the Spanish or Americans who penetrated the valley after 1850.[8] Finally, Steward (1970:123) returned to his original view that irrigation was probably of aboriginal origin. With the above summary in mind, we can begin our reexamination of the problem of irrigation among the Owens Valley Paiute.

SURVEY OF HISTORICAL AND ETHNOGRAPHIC LITERATURE

Early Expeditions

The earliest known expeditions into Owens Valley were those of Joseph Reddeford Walker, who traversed the valley four or five times, first, we believe, in 1834. Walker's party was on a beaver-trapping expedition to California for Captain Benjamin Bonneville. The route west from the Humboldt Sink region of Nevada over the Sierras is not known precisely, but the return route was over Walker Pass and north through Owens Valley, and is documented in the narrative of Zenas Leonard (Ewers 1959). In the fall of 1843, Walker guided the J. B. Childs (Chiles) emigrant party to California by way of Humboldt Sink, Walker Lake, Owens Valley, and Walker Pass. In the fall and winter of 1845, the route was used again when Walker joined Theodore Talbot on Frémont's so-called third exploring expedition. This passage to California was documented in Edward M. Kern's diary (1876), which unfortunately has little to say of Owens Valley. In the spring of 1846, Walker left the Frémont expedition and retraced his route. He later explored the country around Mono Lake, and may have once more passed through Owens Valley (Watson 1934). Leonard provided no description of Owens Valley, and Walker appears to have kept no diaries (Ewers 1959). Due to its position, well removed from emigrant routes into California, Owens Valley escaped the devastating effects of the Gold Rush of 1849.

The Von Schmidt Survey

The oldest documentary records on Owens Valley irrigation that we have been able to locate are those compiled by A. W. Von Schmidt, who surveyed and mapped the region under contract with the U.S. Government from 1855-1856. The survey consisted of laying out township and section lines, establishing corner markers, noting the character of the terrain and quality of the soil, and recording the work accomplished on plat sheets and in accompanying notes. Since the surveyors worked their way around each section (1 square mile) of the valley floor, the plats and notes give some idea of the distribution and nature of irrigation in Owens Valley. Careful study of the record indicates that irrigation was described from Rock Creek, at the north end of Round Valley, to Independence Creek, midway down Owens Valley.

Figure 4 shows the data on irrigation in the vicinity of Bishop and in Round Valley as recorded by Von Schmidt largely in late

October and early November, 1856. In Round Valley, irrigation was observed on Rock Creek, Pine Creek (also reported by Steward), and Horton Creek, although these streams did not have their present names in 1856. Near Bishop (at *pitana patü*) the irrigation system is indicated to be of at least the extent described by Steward, as can be seen by comparing Figs. 3 and 4, which are shown to the same scale. If anything, the Von Schmidt notes indicate that irrigation was more extensive at *pitana patü* than reported by Steward.

There is little information in Von Schmidt's notes on the plants irrigated except that "fine grass" and "roots" are frequently mentioned, and "sabouse" (taboose, *tüpüsi"*) is identified as the "principal article" of food in Round Valley. Seeds are not mentioned, but all of these data on irrigation are incidental to the problems addressed by the surveyors, and we must base our conclusions on that limited information they recorded in passing. Acreage of irrigated land is not given, but distances across it were recorded in chains. In this system of linear measurement, 1 link = 7.92 inches, 100 links = 1 chain (66 feet), and there are 80 chains to the mile. Just north and east of present Bishop, irrigated lands crossed on the section line were thus 1584 feet (1/3 mile) and 1972 feet (nearly 2/5 mile) across, respectively. The Indians in the vicinity of Bishop and Round Valley were clearly involved in large-scale food production.

Steward reported irrigation in the vicinity of Freeman Creek and Keough Hot Springs (*ütü'ütü witü* 'hot place'), but no information was recorded on it by Von Schmidt. He did unknowingly record irrigation in some detail near present Big Pine (*tovowah matü* 'small natural hill place'), where Steward indicated that a major development occurred on Baker Creek. Figure 5 shows many small "creeks" recorded by Von Schmidt at the spot Steward stated irrigation was practiced. It is apparent from the size and spacing of these "creeks" that they are irrigation ditches or canals representing the much-divided stream of Baker Creek. Also indicated on Von Schmidt's map are some "dry ravines," one of which is apparently the dry channel of Baker Creek. Von Schmidt recorded these "creeks" only where they crossed the section lines he was surveying. He clearly indicates them entering the northwest corner of S. 18, T. 9S, R. 34E M.D.M. and exiting the southeast quarter of the section a mile away. The irrigation system here was apparently so large that he did not recognize it for what it was. These are not natural stream channels; it is not the pattern of braided stream channels to be so evenly spaced or so uniform in size as Von Schmidt indicates (Table 1). Besides, they are shown carrying water across the natural slope of the land, not down it (Fig. 6). There is no question that the channels are man-made ditches or canals and that Von Schmidt mapped and recorded portions of the irrigation system at *tovowah matü*. The notes are dated October 18, 1856, indicating that the dam was still intact and irrigation still being carried out that late in the fall. Apparently the harvest had not yet occurred.

Figure 7 shows the irrigated area near Big Pine as recorded by Steward on the basis of informant knowledge. The figure is based on Steward's "Ethnogeographical map of Owens Valley" (1933:Map 2), and is in close agreement with the map of Von Schmidt drawn 75 years earlier. Figure 8 is most informative since it clearly shows the irrigation system west of Big Pine as drawn by Steward's informant Jack Stewart (Steward 1933:326). Clearly indicated in Stewart's map is a vast irrigation system along a north tributary of Big Pine Creek (Baker Creek) involving main canals and many small laterals. The significance of this map has remained unrecognized for more than 40 years, but it provides some of the best information on the distribution of water by means of small ditches or canals in irrigated plots in Owens Valley.

The next reference to irrigation in the Von Schmidt survey records is at *panatü* 'water

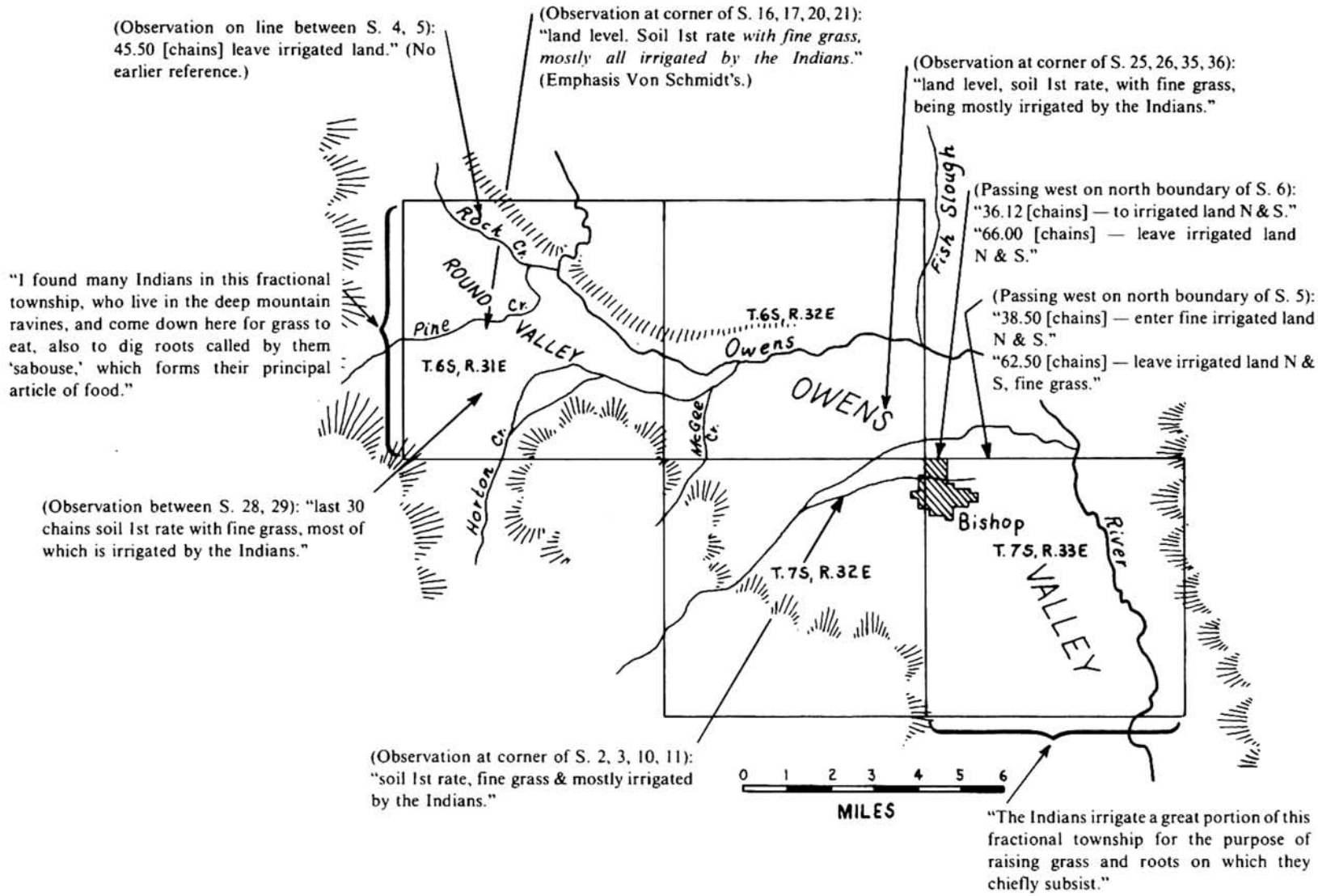

Fig. 4. Observations made by A. W. Von Schmidt in upper Owens Valley, from the northern end of Round Valley to the vicinity of present Bishop. Mostly late October and early November, 1856. Compare this with Fig. 3, which is drawn to the same scale. The main channel of Bishop Creek, as indicated here based on present maps, appears to flow in the northern main ditch. The former main channel ends in modern canals which are not shown.

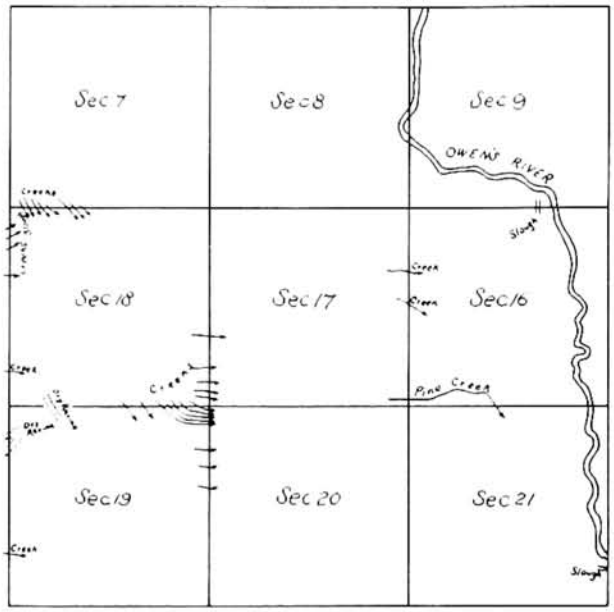

Fig. 5. Paiute irrigation system at *tovowaha matü*, on Baker Creek near present Big Pine, Owens Valley, California. Unknowingly mapped by A. W. Von Schmidt, 1856. Compare this with Figs. 6 and 7. Note that canals or ditches ("creeks") are carrying water approximately along the contours, rather than across them.

place' (?), just west of Owens River in the vicinity of Fish Springs and Tinnemaha Creek, about eight miles south of Big Pine. Steward did not specifically report irrigation there, but he did indicate (see Fig. 7) that *nahavita* and *tüpüsi*" were abundant. We believe from examination of the records that irrigation was carried out with water from Tinnemaha Creek. Figure 9 shows "creeks" recorded by Von Schmidt in the area to the south of Fish Springs and just west of Owens River. The field notes contained no information specifically describing ditches, but, as in the case of Baker Creek, the creeks are probably irrigation ditches. Table 2 gives the widths of the ditches and the distances between them. Here, then, would appear to be the record of another irrigation system of sizeable proportions. Moreover, there appears to be a clear understanding on the part of the aboriginal engineers of the proper size of the irrigation ditches, since many of them are about 40 inches

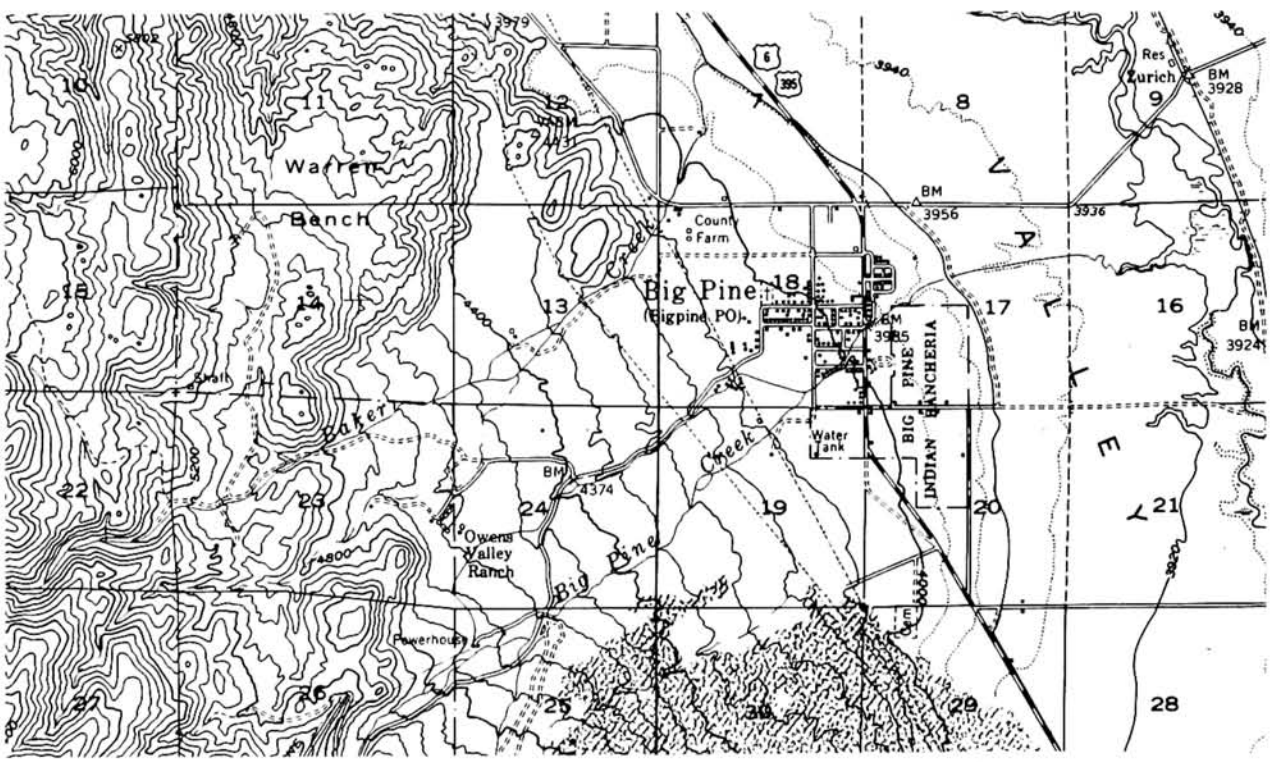

Fig. 6. Big Pine locality as depicted on U.S.G.S. Big Pine 15' quadrangle, 1950. Note direction of the contours and compare with direction of flow of irrigation ditches shown in Fig. 5.

Table 1

EXTRACTS FROM THE NOTES OF A. W. VON SCHMIDT DESCRIBING IRRIGATION DITCHES OR CANALS ON BAKER CREEK, NEAR BIG PINE, OWENS VALLEY, CALIFORNIA, OCTOBER, 1856

(1 chain=66 feet; 1 link=7.92 inches)

Chains	Notation					
		(West on boundary between S. 7, 18, T. 9S, R. 34E)				
52.00	creek	5	links	wide,	course	SE
54.50	"	10	"	"	"	S by E
56.25	slough	20	"	"	"	"
64.70	creek	5	"	"	"	"
67.00	"	3	"	"	"	"
69.00	"	2	"	"	"	"
72.30	"	5	"	"	"	"
74.20	"	10	"	"	"	"
		(West on boundary between S. 18, 19, T. 9S, R. 34E)				
4.51	creek	5	links	wide,	course	S by E
10.00	"	5	"	"	"	E by S
13.70	"	12	"	"	"	"
16.80	"	5	"	"	"	"
18.71	"	8	"	"	"	"
24.71	"	20	"	"	"	SE
33.71	"	8	"	"	"	"
		(North on boundary between S. 17, 18, T. 9S, R. 34E)				
3.60	creek	15	links	wide,	course	E
5.75	"	14	"	"	"	"
9.60	"	5	"	"	"	"
15.50	"	8	"	"	"	"
28.37	"	31	"	"	"	"
		(North on boundary between S. 19, 20, T. 9S, R. 34E)				
48.10	creek	3	links	wide,	course	E
56.20	"	5	"	"	"	"
63.00	"	3	"	"	"	"
73.40	"	5	"	"	"	"
74.60	"	5	"	"	"	"
75.95	"	5	"	"	"	"
76.20	"	5	"	"	"	"
79.00	"	5	"	"	"	"

wide. There are also regularities in the spacing of ditches, as can be seen in Table 2. A dry stream channel, perhaps representing that from which the water was diverted, is also shown.

Irrigation is again described by Von Schmidt in the vicinity of Black Rock Spring. While passing east on the boundary between S. 12 and 13, T. 12S, R. 34E, on October 1, 1856, Von Schmidt commented: "Note: These

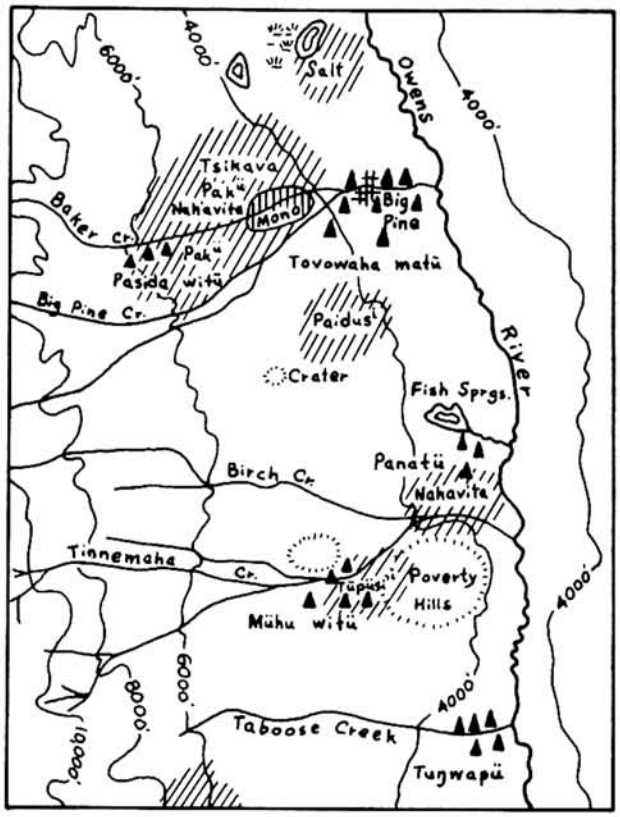

Fig. 7. Location and extent of irrigation on Baker Creek, near Big Pine, as indicated by Steward (1933:Map 2). Irrigated land indicated by vertical hachure. Redrawn from Steward (1933:Map 2).

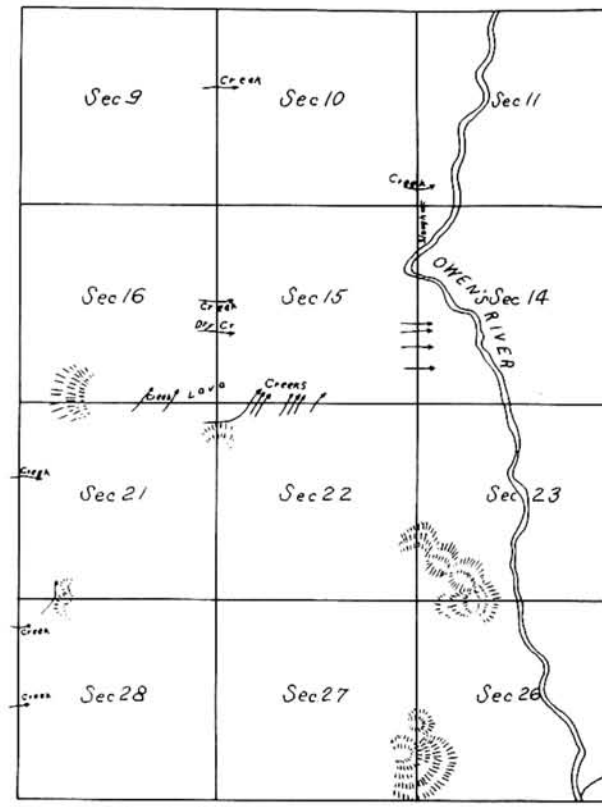

Fig. 9. Paiute irrigation system at *panatü*, near Tinnemaha Creek, Owens Valley, California. Unknowingly mapped by A. W. Von Schmidt, 1856.

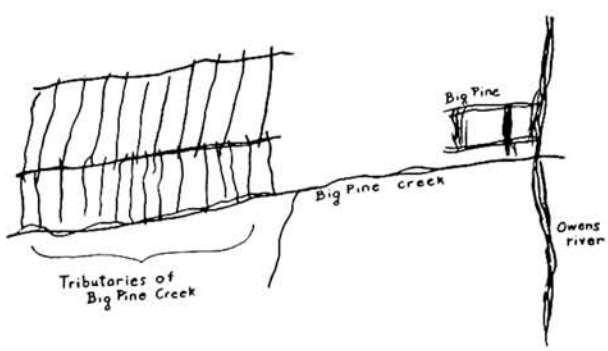

Fig. 8. "Map of Big Pine Drawn by Jack Stewart." Stewart was an informant of Julian Steward and drew this map, which clearly shows the irrigation system on Baker Creek as he remembered it about 1930. The "Tributaries of Big Pine Creek" are the irrigation ditches representing the divided channel of Baker Creek. Copyright © 1933 by The Regents of the University of California; reprinted by permission of the University of California Press.

swampy places are *coursed* by the Indians by turning the larger streams descending from the mountains into the level plains for the purpose of raising grass to eat" (emphasis ours). The mention of coursing the swampy places recalls the situation on Baker Creek, where the surveyors recorded no less than eight "creeks" (irrigation ditches) running parallel to one another and carrying water across the slope, rather than down it. It is not clear from the notes whether irrigation water was derived from Black Rock Spring or from Sawmill Creek, which reaches the floor of Owens Valley at this spot.

Proceeding down the valley another half-dozen miles to the site of Old Fort Independence, we find another apparent record of irrigation with four well-spaced streams, as well as a "dry ravine" entering the

Table 2

EXTRACTS FROM THE NOTES OF A. W. VON SCHMIDT DESCRIBING IRRIGATION DITCHES OR CANALS AT TINNEMAHA CREEK, OWENS VALLEY, CALIFORNIA, OCTOBER, 1856

(1 chain=66 feet; 1 link=7.92 inches)

Chains	Notation	
	(North on boundary between S. 14, 15, T. 10S. R. 34E)	
14.10	creek	10 links wide, course E
23.30	"	5 " " " "
29.00	"	5 " " " "
31.80	"	5 " " " "
	(East on boundary between S. 15, 22, T. 10S, R. 34E)	
13.60	creek	5 links wide, course NE
15.40	"	5 " " " "
17.60	"	5 " " " "
28.20	"	5 " " " "
31.15	"	5 " " " "
33.00	"	5 " " " "
39.20	"	5 " " " "

SW quarter of S. 6, T. 13S, R. 35E. This would seem to document irrigation on Oak Creek (*tsak:'ca witü* 'oak place'), as indicated by Steward (1938:51) (see Fig. 10).

Two miles south in the SE quarter of S. 18 of the same township, at Independence Creek (*nataká: matü* '[unidentified plant] place'), four parallel streams are indicated. Steward (1938:51) reported that irrigation was practiced at Independence Creek.

Figure 11 presents a summary of the findings of A. W. Von Schmidt as interpreted here and the additional occurrence reported by Steward in the vicinity of Freeman Creek and Keough Hot Springs. It can be seen that from Independence Creek on the south to Rock Creek on the north, a total distance of 57 miles along the axis of Owens Valley, there are 10 recorded and nicely spaced instances of irrigation from tributaries of Owens River. All of these developments occurred on the western side of the valley, where the many streams brought down abundant water from the snows of the Sierra Nevada. In elevation, the localities range from 4000 to 5000 feet. These data fully corroborate the reports of Steward on the distribution and extent of irrigation in Owens Valley. From the discussion above, it is apparent that whatever the plants irrigated ("grass," "roots," and *tüpüsi"i* are indicated), the entire Owens Valley irrigation system involved large plots totalling multiples of square miles. Dams must have been used in all instances to divert the water out of the stream beds into canals, which were further divided and carried across the plots to be watered. Where information is available, it indicates that many of the canals or ditches were about 40 inches wide, but they were often much wider, and sometimes narrower. Whether additional laterals were used to further distribute the water is not known, but the map drawn by Steward's Paiute informant, Jack Stewart, would seem to suggest that they were (Fig. 8). This would have aided in the watering of large plots.

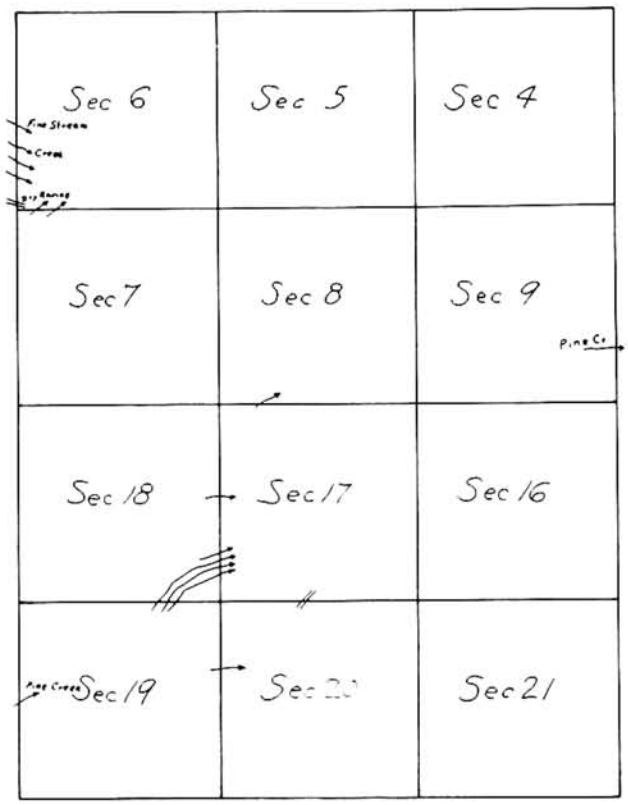

Fig. 10. Probable irrigation systems unknowingly mapped by A. W. Von Schmidt on Oak Creek (Old Fort Independence), Section 6, and Independence Creek, Section 18, T. 13S, R. 35E. Redrawn from 1856 township plat.

Later Historical Accounts

On July 5, 1858, a party of prospectors led by David McKenzie set out from Los Angeles for Owens Valley. This group learned from the Indians that gold was being mined by prospectors at Mono Lake, and several of its members pushed on into that region. These gold ventures are described in a brief article in the *Los Angeles Star* of August 21, 1858, which provides additional recorded data on irrigation in Owens Valley:

> . . . About the centre from one lake to the other [between Owens and Mono lakes], there is a tribe of fine looking Indians, tall and well made, having features quite different from the Indians on Owen's Lake. They are an active, industrious race, irrigate the lands and raise a kind of pea, which is their principal food. Farther on, the party came to another tribe of Indians, resembling them, tall stalworth [*sic*] fellows, with nose straight. They also cultivate the land, turning the river by ditches for the purposes of irrigation. Several small streams descend from the mountains on the west and empty into the river. Where these Indians live, the land is good, and in the upper part of the valley there is

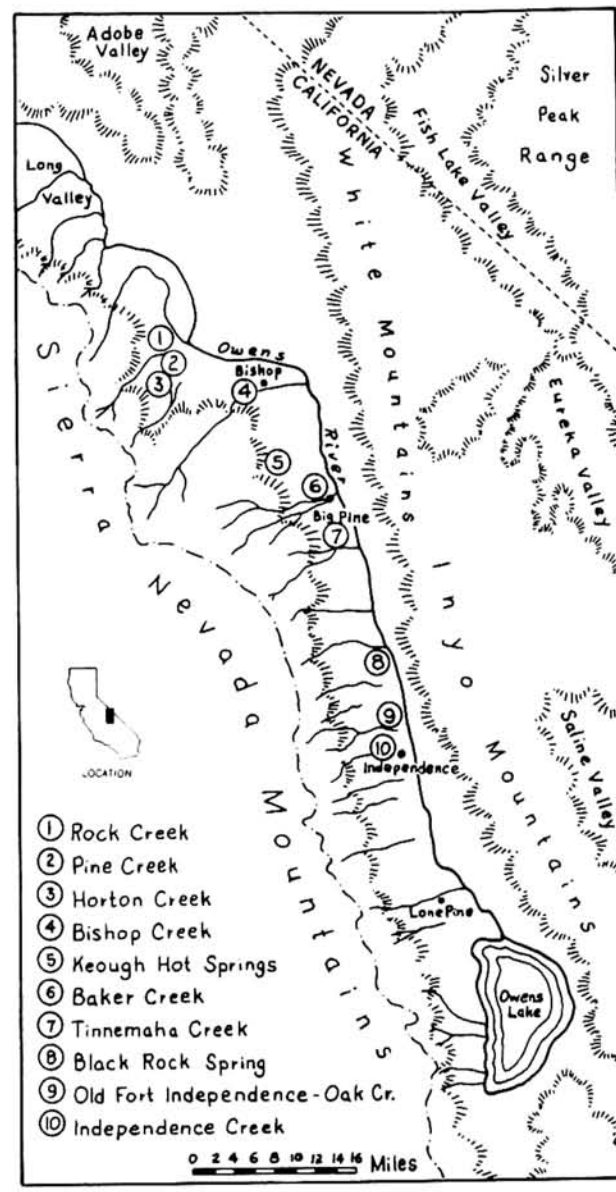

Fig. 11. Distribution of irrigation in Owens Valley, as indicated by Steward (1930, 1933, 1938) and Von Schmidt (unpublished records). Redrawn from Steward (1933: Map 1).

> plenty of clover. In this valley of Owen's River, there are probably 2,000 Indians....

The word "industrious" as applied to the Paiute of Owens Valley keeps cropping up in later accounts of these people. Throughout the nineteenth century, Anglo accounts of Indian lifeways frequently used this word to describe those tribes or groups which were engaged in agriculture.

The presence of prospecting parties in Owens Valley in the summer of 1858 may have stimulated the visit of an Owens Lake delegation of Indians to the Fort Tejon Agency. On August 20, 1858, Indian Agent J. R. Vineyard wrote to his superiors:

> A delegation of Indians from the region of Owens Lake, east of the Sierra, visited the [San Sebastian] reservation a short time since. The people of that region, so far as I can learn, number about 1500. The delegation asked assistance to put in crops next season, also someone to instruct them in agriculture, etc. I would respectfully invite your attention to the subject, as they seem to be very sincere in their solicitations [Chalfant 1933:123].

In nineteenth-century accounts, the terms Owens Lake and Owens Valley were often used synonymously. This report may therefore refer to the Indians of Owens Valley seeking to learn the culture of European crops like wheat and barley, or of native American crops like corn, which they had never grown. It would then indicate that the Owens Valley Paiute, who were themselves engaged in large-scale agronomic pursuits, felt that they would need special instruction to shift over to crops being grown by the white man. Only a people aware of the different requirements in the growing of plants would be likely to ask for specialized instruction in addition to crop seeds. Alternatively, since irrigation does not seem to have been practiced at Owens Lake, but only in the Owens Valley from Independence north, the report may indicate that the Indians of Owens Lake, who, for reasons to be suggested later, never adopted irrigation of wild crops, elected to attempt European agriculture.

Owens Valley irrigation was mentioned again in the *Los Angeles Star* of August 27, 1859, which reported that a detachment of soldiers under a Captain Davidson had marched from Fort Tejon to Owens Valley on a search for Indian horse thieves, and had vindicated the Indians of that region as not being responsible for horse raids. Instead, the *Star* correspondent, who accompanied the expedition and signed himself "Quis," reported the Paiutes to be "quiet, industrious, friendly, and altogether reliable." The *Star* account again describes the vast scope of irrigation activities in Owens Valley:

> Large tracts of land are here irrigated by the natives to secure the growth of the grass seeds and grass nuts—a small tuberous root of fine taste and nutritious qualities, which grows here in abundance. Their ditches for irrigation are in some cases carried for miles, displaying as much accuracy and judgment as if laid out by an engineer, and distributing the water with great regularity over their grounds, and this, too, without the aid of a single agricultural implement. They are totally ignorant of agriculture, and depend entirely on the natural resources of the country for food and clothing [*Los Angeles Star*, Aug. 27, 1859, p. 2].

The authors were led to the *Star* article on Captain Davidson's expedition of 1859 through an excerpt published by Guinn (1917:41-47). Further effort led to our discovery in the U.S. National Archives of the then unpublished report of Captain John W. Davidson on his military reconnaissance to Owens Valley (Wilke and Lawton 1976). Several points should be stressed about the Davidson report. First, previous expeditions through the valley had traversed it rapidly without stopping to observe its inhabitants. Davidson's party was the first to carefully study the lifeway of the Owens Valley Pai-

ute. His orders specifically instructed him to do so. Although these people apparently knew a few Spanish words, Davidson was unable to communicate with them except through an Indian interpreter. He found the people of the valley in a relatively pristine aboriginal state with almost no evidence of acculturation other than an awareness that they would have to come to terms with the outside forces moving in on them. (Recall the Von Schmidt survey three years earlier.) They possessed no horses, no firearms, and no metal tools. As yet there were no white settlers in Owens Valley. In his report, Davidson twice referred to the practice of irrigation:

> . . . They expressed a desire to have a military post among them, as well as they could understand its nature, to live under the protection of our Government, and to have seeds and some simple instruments of Agriculture furnished them. They have already some idea of tilling the ground, as the *ascequias* [*sic*] which they have made with the labor of their rude hands for miles in extent, and the care which they bestow upon their fields of grass-nuts abundantly show. Wherever the water touches this soil of disintegrated granite, it acts like the wand of an Enchanter, and it may with truth be said that these Indians have made some portions of their Country, which otherwise were Desert, to bloom and blossom as the rose [Wilke and Lawton 1976:19-20].[9]

Davidson goes on to provide a rather clear botanical description of the "grass-nuts," which Steward (1930:150) believed to be *Brodiaea capitata*. He apparently described one of the two primary wild crops grown in Owens Valley, and stated that the wild crops were planted.

> These Indians subsist upon the flesh of such game as they can kill, the Deer, Antelope, & Rabbit, upon the seeds of various grasses, the Acorn, Pinon-nut, & the Tuber of a species of nutritious grass of which our horses were very fond. Whole fields of this grass, miles in extent are irrigated with *great care* [italics ours], yielding an abundant harvest of what is one of their principal articles of food. The tuber is about the size of a large marrowfat pea, has a coarse rind or covering, & tastes something like the Chincapin. They are reproduced by *planting* [italics ours] [Wilke and Lawton 1976:29].

Another botanical description of an important wild crop plant grown in Owens Valley and a second plant of apparently lesser significance is provided by Alexander S. Taylor (1861*a*) in his *Indianology of California*. Taylor published the report of a correspondent on the *San Francisco Evening Bulletin*, who made a trip through Owens Valley in June, 1861. At this time, white stockmen were already making inroads on the valley, and white settlers were building cabins near the present Independence and in Round Valley (Chalfant 1933:147). The *Bulletin* correspondent also referred to the Indians of Round Valley as "industrious." In describing the numerous creeks coming down from the mountains on the west side of the valley, the correspondent wrote:

> . . . Some of them are large, forming branches of the river; others, mere rills, losing themselves in the dry and porous earth, irrigating a considerable patch about the place where they disappear. Most of these streams are shallow, and after leaving the mountain-ravines, have banks but a foot or two high. This admits of their being easily turned aside for irrigation, a purpose to which they are extensively applied by the Indians. These tribes cultivate a small white root of an oval shape, and the size of a cherry. It grows like an onion, sending up three blades that bear a blue lily-shaped flower. When roasted, it looks and tastes like the yam, being very palatable and nutritious. It strongly resembles the root so much in use among the Indians of Oregon and British Columbia, called the *Camass* [*sic*]. Besides this, these Indians have a species of wild onion

> (amole) with a variety of other roots which they cultivate for food. In irrigating they conduct the water some distance through ditches and little acqueducts [*sic*] made of dirt. The surplus water flowing over the land below these patches of roots has caused much grass to grow along these creeks, consisting of clover, blue-joint, and bunch grass. Cattle are very fond of these and fatten upon them rapidly [Taylor 1861*a*:8].

Taylor (1861*b*) again speaks of irrigation by the Owens Valley Paiute, but presents no new data. During the Paiute Indian War in 1862, Colonel Warren Wasson (Wassen [*sic*] 1862) stated: "The Indians are fighting to hold possession of their lands, which they have irrigated and subsisted on for many years, and are jealous of white settlers coming into their country." Elsewhere, Wasson (1862) observed: "These Indians have dug ditches and irrigated nearly all the arable land in that section of the country, and live by its products" (see also Angel 1881:166). In a bloody skirmish between the Paiutes and 60 white cattle "graziers" under a Colonel Mayfield on March 28, 1862, the white men lost the battle and retreated to an Indian irrigation ditch, employing it as a trench, until they could escape under cover of darkness (Wassen [*sic*] 1862; Angel 1881:166).

In addition to the historical accounts presented above, scattered data indicate that other Indian groups of the Great Basin practiced some irrigation of wild plants. Angel (1881) provided the following information on irrigation in Walker Valley, Nevada:

> When the first white settlers went into the Walker Valley they found the Indians irrigating portions of it to promote the growth of an edible root which formed a great portion of their living. As far as is known this was the only cultivation of the soil previous to the operations of the Mormons in Carson Valley subsequent to 1850 [Angel 1881:131].

Catherine Fowler (personal communication) reported to the authors that she has a note from a woman of Walker River, who spent some time in the Smith and Mason valleys and was told by Indians there that a plant known as *mahavitu?u* (probably Steward's *nahavita*) was watered from a natural stream to keep it "moist." It should be noted that the Northern Paiute band that inhabited the Smith and Mason valleys and the upper Walker River in southwestern Nevada were known as the *Tövusi-dökadö*, meaning "grass-nut eaters" (O. C. Stewart 1951:363).

In the cultural elements list for the Nevada Shoshone, Steward (1941:281) recorded one informant as saying that all villages in Snake and Spring Valleys near Ely, Nevada, irrigated wild plants. A second informant stated that there were still native irrigation ditches near Ely. Steward's (1941:281) informant also reported irrigation of wild plants, the building of dams and ditches, and the election of a head irrigator among the Northern Paiute of Fish Lake Valley, Nevada. Finally, Steward (1970: 123) also noted that during litigation over water rights "a few years ago" the Paiute of Pyramid Lake argued that they had irrigated with certain streams before the coming of the white man.

Patch (1951) reported discovering what he thought to be the remains of ancient irrigation ditches leading out onto a Pleistocene lakebed in Eureka Valley, which lies in the desert to the east of Owens Valley. The authors have viewed these "ditches" and believe their archaeological examination would be fruitful. Sullivan (1974) also reported the presence of rock alignments in Hidden Valley, Nevada, which he hypothesized might have been used to retard rainfall runoff and encourage the growth of grasses on the valley floor.

On July 11, 1863, following the termination of the Indian war that occurred after the white man began taking over Owens Valley and grazing his cattle in Paiute fields, more than 900 Owens Valley Paiutes were removed to San Sebastian Reservation near Fort Tejon. Many other Indians fled into the mountains.

Gradually, over the next few years, many of the Indian people returned to Owens Valley. Most of their irrigation ditches were already being used by white settlers. Whether some of the Owens Valley people resumed their irrigation practices after their return to the valley is unknown. The authors have been unable to find any historical accounts of Indian irrigation of wild plants after 1863. Although irrigation in Owens Valley may have continued in some districts after 1863 on a lesser scale, it would appear that the system had largely broken down as a result of white settlement and the use of their fields for grazing and of the irrigation ditches for growing introduced crop plants.

TIME DEPTH INFERRED FROM HISTORICAL ACCOUNTS

Historical accounts of ditch irrigation in Owens Valley describe the practice as it existed from 1855 to 1862, during the period just prior to white takeover of the valley. Although apparently not realized by Steward, information provided in his own writings extends the practice back to probably at least thirty years earlier. In his *Two Paiute Autobiographies*, Steward (1934) stated that his informant, Sam Newland, born at *pitana patü*, was at the time of writing about one hundred years of age. In describing his boyhood, Newland related that the husband of one of his older sisters "had the job of irrigating *nahavita* above Bishop" (Steward 1934:432). He also said that during his early boyhood "when spring came, the people got together for a big feast, *tuwapa'it*, and elected the irrigator, *tuvaijü'ᵘ*, for the coming summer . . . . They took a vote and elected my brother-in-law again, and told him to start the water" (Steward 1934:434).

Irrigation was thus fully institutionalized by 1845, and probably much earlier. The miles of irrigation ditches described in the accounts dating back to 1858 could not have been built overnight by a people lacking metal tools. When Sam Newland was still a young boy, "there was a big dance ('fandango') at *nügatuhava* just below the dam on 'Paiute ditch'" (Steward 1934:433). The ditch was thus in use by about 1845. It seems reasonable to conclude that the system of ditch irrigation as practiced up and down Owens Valley was very well developed by at least 1840. Moreover, there is no reason to assume that irrigation began in the Owens Valley simultaneously at each of the settlements as the result of some massive communal construction project. More likely it started at one settlement and was gradually adopted by other districts which lent themselves to the development and use of irrigation. Even from the most conservative point of view—assuming the technology was worked out rapidly and other settlements quickly adopted irrigation also—the system would have required a minimum of twenty years to spread out over the valley. Thus irrigation in Owens Valley has to extend back to at least 1820, almost a decade and a half before secularization of the Spanish missions, when many California Indians who had learned agriculture from the padres returned to their homelands. It seems probable, however, that Owens Valley irrigation dates far back into the aboriginal period.

TIME DEPTH INFERRED THROUGH LINGUISTICS

Lawton (1968), in presenting circumstantial evidence for the aboriginal practice of domesticated plant agriculture among the Cahuilla, reported the presence of a native agricultural terminology. He noted that the Cahuilla possessed both native crop words and words relating to the technique of crop-growing (Lawton 1968:16-20). In examining other Indian groups along the California coast, who had been under Mission influence, Lawton found that native vocabularies (e.g., Gabrielino, Luiseño, Cupeño) contained only Spanish loan words or derivatives for crop plants and agricultural practices. Thus, for example, the Spanish word *elote* for "sweet or

green corn" was rendered as *looti* among the Cupeño (Hill and Nolasquez 1973:184).

In the case of the Owens Valley Paiute, Steward provides three words associated with the growing of wild plant crops: *tuvaijü'ᵘ*, head irrigator; *tüvaᵛᵃdut*, to irrigate; and *pavado*, the irrigator's pole. Catherine Fowler (personal communication) informs us that these are Paiute words and not derived from the Spanish. Possibly, a review of unpublished field notes of linguists working on the various Northern Paiute and Nevada Shoshone groups will elicit still more words related to irrigation of wild plants such as the words for "ditch," "fallowing," and "dam." We suggest, however, that the presence of these few recorded words in the Paiute vocabulary and the fact that the well-known Spanish term *zanjero* for irrigator did not enter their language provides at least some confirmation that irrigation did not diffuse from the Spanish missions. Whether future analyses of Paiute vocabularies can throw more light on dating the origins of irrigation in Owens Valley we must leave to linguists working in that area.

IDENTIFICATION OF THE TWO MAIN WILD CROPS

On the basis of material gathered in our literature survey, the authors set out to establish the identity of the two primary wild crop plants which Steward (1933:247) said the natives called *tüpüsi'ⁱ* and *nahavita*. Steward identified *tüpüsi'ⁱ* as *Brodiaea capitata* and *nahavita* as *Eleocharis* sp. How closely Steward worked with botanists on his plant identifications we don't know, but we immediately encountered problems with his identifications.

Steward's *nahavita*

Steward's (1933:245) *nahavita* was described by him as "having a number of bulbs." His identification appears to be in error, because *Eleocharis* sp. do not produce a number of tubers or bulbs. Such a description appears better suited to the wild-hyacinth or blue dicks, formerly *Brodiaea capitata* and currently classified as *Dichelostemma pulchella* (Fig. 12). This was the species Steward identified as *tüpüsi'ⁱ*, sometimes called "grass-nuts" or "nut-grass" by laymen. Steward gave no season for the harvesting of this plant. Wild-hyacinth blooms in the spring with violet flowers and probably would have been harvested in late May or early June (Munz 1965:1385). Thus the *Bulletin* correspondent who visited Owens Valley in June, 1861 might have observed the harvest of this plant. His description of a primary wild crop plant as "like an onion, sending up three blades that bear a blue lily-shaped flower" (Taylor 1861*a*:8) agrees with our identification of Steward's *nahavita* as the wild-hyacinth. Catherine Fowler (personal communication) notes that an unidentified plant used by the Indians of Mason and Smith valleys, Nevada, is referred to as *mahavitu?u* and is probably the *nahavita* of Owens Valley. She adds: "It seems to me likely that this may be your Brodiaea [*D. pulchella*] and that it is probably also Angel's 'bulb root' [Angel 1881:131]."

Steward's *tüpüsi'ⁱ*

Steward's *tüpüsi'ⁱ* or taboose grass was also clearly misidentified, since his plant list showed it as gathered in the fall after the dams were destroyed (Steward 1933:245). One of his informants, Sam Newland, also mentioned his mother going to gather *tüpüsi'ⁱ* in the fall "after my father's death" (Steward 1934:433). Since wild-hyacinth (Steward's *tüpüsi'ⁱ*) is not a fall plant, it was necessary to reconsider this identification and attempt to identify the tubers Davidson saw being gathered from a grass-like plant in August of 1859 (Wilke and Lawton 1976:29).

Donald Bell of Big Pine, descendant of a pioneer family, identified the "grass-nut" of Davidson as taboose grass or taboose,[10] common names still in wide use in Owens Valley. DeDecker identified taboose grass

Fig. 12. Wild-hyacinth (*Dichelostemma pulchella* [Salisb.] Heller), from Plate 91, Fig. F of *A Flora of Southern California*, by Philip A. Munz. Copyright © by The Regents of the University of California; reprinted by permission of the University of California Press.

as yellow nut-grass (*Cyperus esculentus* L.) (Fig. 13), also sometimes called chufa, earth almond, and Zulu nuts (Sturtevant 1919: 230).[11] Stanley Miller of the Fort Independence Indian Reservation made it possible to obtain yellow nut-grass tubers for nutrient analysis. Later, the authors discovered that Train, Henrichs, and Archer (1974:40) had identified "*too-boozie*" as the Paiute Indian name for yellow nut-grass in a report prepared many years earlier for the Works Progress Administration. Chalfant (1933:77) had also speculated that "taboose" was a member of the sedge family, but questioned its identity as yellow nut-grass. Unpublished field notes of Mark Kerr compiled by DeDecker also identified "*te-posie*" as tubers used for food and "for making milk as a beverage." Kerr's notes on Owens Valley plant names also listed "*tupu sï*" as the name for wild-hyacinth.

There thus still appears to be some linguistic confusion surrounding the terms *nahavita* and *tüpüsi"i*, although we believe we have correctly identified the two primary wild crop plants. Catherine Fowler (personal communication) stated that the *tɨb·uzi* (*tüpüsi"i*) is "really a 'food name' rather than a plant name," adding that the semantic focus among most Northern Paiute is on the product, rather than the plant.[12] Both *nahavita* and *tüpüsi"i* may therefore be names not for the plants themselves, but for the plant part which was eaten (i.e., corms and tubers, respectively).

It is significant that Steward's elderly informants, who recalled the period of Owens Valley irrigation, should have talked of plots containing two principal plants, *tüpüsi"i* and *nahavita*. Perhaps with the loss of knowledge of cultivation practices among the Owens Valley Paiute, the better-known term *tüpüsi"i*, adopted by white settlers as "taboose grass" and applied as a name to Taboose Creek and Taboose Pass, came to be synonymous among later generations of Indians for various tubers and corms, including that of *Dichelostemma pulchella*. Certainly, some collaborative linguistic and ethnobotanical research is needed here.

Although often treated in floras as an Old World plant, *C. esculentus*, a member of the sedge family, is known throughout the world. Professor L. G. Holms, an authority on weed control and the family Cyperaceae, informed us that it probably reached the New World very early (personal communication).[13] Often a noxious weed along irrigation ditches and in agricultural fields, yellow nut-grass has a range from cismontane California to Alaska. Like all weeds, which follow the disturbed habitations of man, it may have moved down across North America in early migrations of

Fig. 13. Yellow nut-grass (*Cyperus esculentus* L.), from *A Flora of the Marshes of California*, by Herbert L. Mason; plant about 1/2 to 2/3 actual size, tubers slightly reduced.

man over the Alaskan land bridge. During winter dormancy, this *Cyperus* species is cold-hardy and has no problem surviving in Owens Valley. A less cold-hardy worldwide species, *C. rotundus* L., is common throughout southern California and the San Joaquin Valley (Munz 1965:1426). The plant is widespread today as a weed in agricultural fields in Imperial Valley, although Castetter and Bell (1951) did not record its use among the Yumans of the Colorado River. They did report the use of *C. esculentus* and *C. ferax* L. C. Rich as a food plant among the Yuma, Mohave, and Maricopa, where in all likelihood these weeds were closely associated with the crop complexes of these agricultural peoples.

THE CONCEPT OF INCIPIENT AGRICULTURE

Anthropologists and others interested in the processes by which man moved from hunting and gathering to agriculture have created a semantic jungle of terms for initial stages in that evolution. One hacks through the literature, chopping desperately against such rarely defined terms as "incipient agriculture," "proto-agriculture," "quasi-agriculture," "semi-cultivation," "environmental manipulation," and even Heizer's (1958) "semi-agricultural," which at least had the virtue of being concrete and eminently understandable in the context in which he used it. Even the terms "horticulture" and "agriculture" are used interchangeably or mistakenly by scholars who would profit from sharing their ideas more frequently with agricultural scientists, who often rightfully view us with amusement.[14]

Domestication of plants is the result of agricultural practices and is always an ongoing process. Through agricultural practices, man manipulates the natural selection factors operating in plants, favoring those genetic characteristics adapted to domestication. Nor is domestication ever complete in the sense that it stops. Although many crops such as corn are cultigens (extreme domesticates, the origins of which are obscured in antiquity), and cannot survive without planting by man, they are still being further modified by agricultural scientists (farmers, if you will) to achieve improved breeding characteristics. Other crop plants have been genetically modified by man over time without becoming domesticated to such a degree. Some of our modern crop plants (lettuce, oats, potatoes, and perhaps certain varieties of grapes and berries) under the right environmental conditions would revert to the feral or "wild" state if civilization disappeared tomorrow. Both the cultigens and those plants which could continue to survive without man's efforts are "crop" plants insofar as they are products of agriculture.

The Owens Valley Indians have been viewed as practicing something called "incipient agriculture." Even Steward (1930:150) wrote that they merely "intensified by irrigation what nature had already provided." He added that they were not engaged in agriculture because they did not "till the soil, plant, or cultivate." Ignoring the problem of whether tillage is necessary to agriculture (even agricultural scientists have differing views on its value for some crops and consider tillage primarily a weed control measure), the fact is that the Owens Valley Paiute did engage in tillage. Their digging sticks were used to turn the soil over to a depth of six inches or more in harvesting the underground plant parts of their two primary crops. While they did not possess the plow, neither did any of the other agricultural peoples of the Americas.

Steward's oldest Paiute informants were very young men at the time white settlers began moving into the valley. Soon afterwards, they became embroiled in the Indian war which led to the abandonment of the Owens Valley irrigation system. It is doubtful that these informants possessed more than a rudimentary knowledge of the system of vegeculture or root-crop cultivation practiced by their people—and vegeculture entails a very complex ecosystem (Flannery 1973:273). Neither

of the oldest informants had worked as head irrigators. They may have had only a vague knowledge of harvesting methods, which were always carried out by women. We cannot know, for example, to what extent the women harvesters may have engaged in weed control of intrusive plants while gathering the two primary crops in their field plots. Certainly, Davidson in 1859 speaks of irrigation as being practiced with "great care" (Wilke and Lawton 1976:29). Davidson also reported that the grass-nuts were reproduced by "planting," which contradicts Steward's informants (Wilke and Lawton 1976:29). We will probably never know whether the Owens Valley Indians engaged in planting, but it seems evident that something resembling planting took place. The smaller corms of wild-hyacinth were probably returned to the earth during harvesting to ensure continued reproduction. Many of the smaller tubers of yellow nut-grass would become detached from the roots of the plant and remain in the ground during digging. Others probably fell from the roots to the surface of the ground. One method of controlling *Cyperus* as a weed in agricultural fields is to till the ground and bring the tubers to the surface, where they die in the sun (Lowell Jordan, personal communication). People who exercised "great care" in the irrigation of their fields could scarcely have remained unaware of this fact. In all likelihood, the soil was tamped over detached tubers and corms after digging to ensure their continued propagation. The women harvesters may even have exercised some selectivity over the plants grown, eliminating less palatable specimens and thus transmitting improved genetic characteristics to future harvests.

The authors are unsure as to what Steward meant by the word "cultivate." Certainly he did not mean tillage, because he also noted that the Paiute lacked a knowledge of tillage (Steward 1930:150). If by cultivation he meant the nurturing or tendance of plants—one definition—then it clearly existed in the care that the Owens Valley Paiute bestowed on their fields. This was exemplified in the Paiute system of alternate irrigation between plots at *pitana patü*, which Steward hypothesized as designed to "enhance natural seeding." Walter Reuther (personal communication) has suggested that alternate irrigation of the field plots probably had two purposes. First, harvesting of fields every other year would probably have ensured a higher yield of tubers and larger tubers. At the same time, irrigation every other year may have served as a means of ecological land management. It would have decreased the possibility of unwanted vegetation invading the fields and crowding out the two principal crops, thereby reducing their productivity.

It is time to assert that the Owens Valley Paiute were engaged in the practice of agriculture. They had developed a complex farming system on an agronomic scale that required substantial communal labor. This farming system involved a tremendous amount of work both in the initial phases of construction and laying out of the vast system of ditches and canals and in the annual dam-building, irrigation, and harvest. It was a farming system fully as sophisticated as that of many societies in southeast Asia and South America that are engaged in vegeculture of manioc, yams, taro, and other root crops. Whether or not the plants irrigated underwent some genetic modifications as a result of the care they received we may never know; but domestication is a result of agriculture, not its prerequisite.[15]

YELLOW NUT-GRASS AS A CROP PLANT

For those who may still feel some reluctance in agreeing that the Owens Valley Paiute were agricultural, it can be pointed out that yellow nut-grass (*Cyperus esculentus*) is often considered a weed, but under the common name of *chufas* it has a respectable history as a crop plant grown under irrigation since ancient times (Killinger and Stokes 1951:5). Mummi-

fied bodies in upper Egypt dating to about 3500-4000 B.C. have been found to have the remains of yellow nut-grass tubers in their intestines, along with barley chaff (Netolitzky 1911:953-956). Further studies of mummified bodies yielded remains of yellow nut-grass tubers and various cereal grasses, with the researcher suggesting that some of the plants consumed may have been cultivated (Netolitzky 1912). Schweinfurth (1884:315) reported that among a variety of offerings found in a vault at Thebes dating to the twelfth dynasty (2200 to 2500 B.C.) there were grains of barley and wheat, tubers of yellow nut-grass and other vegetable products and fruits. While it is not known if yellow nut-grass was grown as a crop plant in Egypt during this period, the plant has been cultivated from very early times for use of its tubers as a food delicacy and for its oil content (Sturtevant 1919:230).

The chufa was distributed from the United States Patent Office in 1854 for culture in gardens (Sturtevant 1911:230). Cultivation of chufas has long been carried out and is still practiced today in many parts of southern Europe, Africa, the Near East, and England. Lesant (1822) noted cultivation of chufas in southern France as early as 1822. In Germany, chufa tubers were brought to the table as a dessert in the nineteenth century (Sturtevant 1911:230). In Constantinople, the tubers were eaten raw or made into a conserve. In Italy and Egypt, the fatty oil extracted from chufas was used as a food and in the manufacture of soap (Killinger and Stokes 1951:5). In Spain, chufas are grown under irrigation even today, and a sizeable industry has developed to exploit a milky-looking beverage known as *horchatas de chufas* (Walter Reuther, personal communication; Killinger and Stokes 1951:5). This beverage may be similar to the "milk" which Mark Kerr (unpublished) reported as having been made by the Owens Valley Paiute.

The authors have been unable to find any published data comparing cultivated strains of chufas as grown around the world with the common weedy races of yellow nut-grass. Nevertheless, it seems likely that chufas cultivation over many centuries has resulted in genetic modifications of the plant, and some races may be virtually domesticated. For that matter, if Owens Valley agriculture stretches back to any considerable depth in time, it is probable that some genetic modification also took place under the agricultural system employed by the Owens Valley Paiute. An interesting area of inquiry for plant geneticists would be to make a comparative study of the genetic characteristics of cultivated races of chufas with yellow nut-grass from Owens Valley and weedy races of the plant as they have developed elsewhere.

In the United States, chufas cultivation has been carried out chiefly by small growers in Georgia, Alabama, Arkansas, and Florida, who grow the tubers mostly as a food for hogs (Killinger and Stokes 1951:5). Yield is not notably high, and approximates that of soybeans. An extrapolation from Mayo (1941:97) and Piper (1924:461) indicates that chufas yield ranges from 19 to 26 bushels per acre. So far as we are aware, only Killinger and Stokes (1951) have devoted any research attention to increasing the yield of chufas in the South. In five years of field trials at the University of Florida Agricultural Station, they succeeded in demonstrating that yield could be increased by 30.2 percent through proper plant spacing (Killinger and Stokes 1951:15).

An examination of their field studies, however, shows that they were dealing with an experimental situation entirely unlike yellow nut-grass cultivation as it existed among the Owens Valley Paiute. In the first place, southern growers of chufas plant and harvest their crop in about four months. Killinger and Stokes (1951:14-15) achieved their best yield results with a "delayed harvest" of 4-1/2 months. In contrast, the Owens Valley Paiute are reported to have harvested their fields every two years under an alternate irrigation

system. No estimates are available on the effects of increased tuber size or production of a greater number of tubers under such a fallowing system. Secondly, we have no yield data on wild-hyacinth, the other major crop grown in Owens Valley. Indian groups east of the Owens Valley Paiute had acquired a partial reliance on the highly successful maize-squash-bean crop complex developed in Mesoamerica, but are not known to have engaged in cultivation of the Owens Valley crops. The combination of wild-hyacinth and yellow nut-grass may have been an ideally integrated crop complex with ramifications that could only be understood by re-establishing such a system.

A nutritional analysis of yellow nut-grass from Owens Valley was conducted for us by J. G. Waines of the University of California, Riverside. Protein content of yellow nut-grass tubers was found to be almost equivalent to rice as a staple. Plain tubers had a protein content of 6%; tubers with fiber removed (probably the state in which they were eaten by the Paiute), 7%; and tubers with rind removed, 8%. Data extrapolated from Killinger and Stokes (1951:13) showed that Florida chufas over two seasons (1944, 1945) had a protein content ranging from 4.65% to 5.24%. Killinger and Stokes (1951) also reported that chufas contained slightly more than half the oil content of peanuts.[16]

Those who may question whether the Owens Valley cultivated plants can really be considered an agricultural crop complex should recognize that one of the two primary "wild plants" has been shown here to have a long history as a "crop plant." To refuse to accept it as a crop plant in Owens Valley, or its production there as constituting agriculture, while accepting it as a crop plant elsewhere in the world is to employ a double standard of reasoning.

ORIGINS OF OWENS VALLEY AGRICULTURE

Hopefully, we have now demonstrated that by the early historic period Owens Valley Indians practiced agriculture and that the vegeculture system they originated was unlikely to have been achieved over a brief span of time. The two primary questions to be resolved are: how did a system of agriculture begin in Owens Valley, and what impelled these people to start along the path to agriculture?

As noted earlier, Steward (1933:248-249) offered three hypotheses to account for irrigation in Owens Valley:

(1) An ancient practice of irrigation may have preceded the diffusion of cultivated plants in the Southwest and survived in eastern California.

(2) Irrigation may have diffused from a horticultural complex of the near or remote past in the Southwest.

(3) Paiute irrigation may have been of local and independent origin.

A fourth hypothesis was presented by Treganza (1956:88), who argued that ditch irrigation was acquired through Caucasian contact after 1850. This hypothesis can be dismissed, however, since we have already established that Owens Valley agriculture was well developed before the beginning of the American period.

A fifth hypothesis has had currency in anthropological circles for some time with reference to early historic agricultural practices among California Indians, including the Owens Valley Paiute. We will refer to it as the "renegade neophyte hypothesis." According to this line of reasoning, a renegade neophyte (Christianized Indian) ran away from a mission—probably Mission San Jose or San Gabriel—and found shelter in Owens Valley. Having been trained in agriculture by the Spanish, the neophyte (or neophytes) applied that knowledge in Owens Valley.

Such a hypothesis presumes, however, that a non-Paiute could have persuaded an alien group to organize a vast communal effort of ditch-digging and dam construction, develop

at least a two-crop agricultural complex using indigenous plants, conceive of a cropping system to increase yields of plants, and persuade the Owens Valley Paiute to abandon part of their seasonal round of activities while an untried new system was being worked out. It also presupposes that this new system reached maximum efficiency so rapidly that it quickly spread from settlement to settlement across Owens Valley and was established by 1820. All of this is unlikely and based on the assumption that a non-Paiute could achieve prestige as a leader within the tightly-knit social organization of another Indian group. The historical record indicates that when neophytes fled the missions they also took with them the Spanish crop complex. Zenas Leonard in 1834 found such a group of neophytes west of the Sierra Nevada (probably along Kern River) growing corn, pumpkins, and melons (Ewers 1959:122). They had left Mission La Purísima after the revolt there in 1834. For that matter, there is considerable documentation showing that some California Indians acquired crop plants from the Spanish, but ignored the irrigation technology and relied on rainfall (Bean and Lawton 1973:x-xi).

A more plausible verson of the above hypothesis is that an Owens Valley Paiute might have emigrated to one of the Spanish settlements near the coast during the early Mission period and acquired some knowledge of agriculture as a worker there. Many Indians from the interior—such as the Cahuilla of the Colorado Desert—regularly visited the Spanish pueblos to obtain work during the planting and harvesting seasons from the 1780's on into the Mexican period.

Steward's (1933:248) first hypothesis, that an ancient practice of irrigation preceded the introduction of cultivated plants into the Southwest and survived in eastern California, has no evidence to support it. We therefore agree with Steward in rejecting it.

Considerable merit lies in Steward's (1933:248) second hypothesis that irrigation may have diffused from a horticultural complex of the near or remote past in the Southwest. Canal irrigation was probably underway about 2000 years ago among the Hohokam of Arizona, several hundred miles to the southeast of Owens Valley (Haury 1976). Until recently, it has been believed the northwestern extension of aboriginal horticulture in later times was probably in Pahrump Valley and Ash Meadows in southwestern Nevada, where cultivation entailed planting small fields of corn and associated crops and using a little irrigation (Steward 1938:183). Since these people were within about 150 miles of Owens Valley, it seems probable that the Owens Valley Paiute were familiar with irrigation practices in southwestern Nevada. More recently, Jensen (1976:13-16) reported finding corn cobs in dunes near Lovelock, Nevada, and the remains of a possibly man-made ditch, which may prove to be "some kind of ancient irrigation canal." Partial reliance on horticulture may be of wider distribution in the Great Basin than heretofore believed.[17]

Steward's (1933:249) criticism of the diffusionist explanation for agriculture among the Owens Valley Paiute still has merit. He observed that it called for a differential borrowing in which a "close-knit horticultural complex was broken down and the seemingly dependent or secondary element, irrigation, diffused without the carrier or *raison d'être* of the complex—the nucleus of cultivated plants."

Along these lines, Eugene Anderson (personal communication) suggests to us that consideration might also be given to the possibility that Owens Valley agriculture is ultimately derived from the Fremont Agricultural complex of Utah and extreme eastern Nevada, which declined about A.D. 1300 (Jennings and Norbeck 1955). He noted that in a situation which is marginal for a particular crop or crop complex because it is beyond the normal range or climatic conditions have deteriorated, crops might perform so poorly

and weeds so well that the crops are abandoned and weeds encouraged. This might have occurred with the decline of Fremont agriculture, and diffused across southern Nevada to survive as irrigation agriculture in Owens Valley. While no data are available to indicate that such an event occurred, the idea is not unreasonable. Oats originated as weeds of marginal wheat cultivation, rye may have also, and there are a number of other examples of this phenomenon. Perhaps the wild seed broadcasting by the Shoshone of Nevada (Steward 1941) is in some way also connected with the decline of agriculture in the eastern Great Basin. Alternatively, they may have acquired this practice on their own.

Both the "renegade neophyte" and the "emigrant Paiute" hypotheses appear to us to be untenable. Agricultural training at the missions was with domesticated crops. To bring back knowledge of irrigation to Owens Valley and then apply it to the cultivation of indigenous plants would require an individual of astonishing leadership skills and a visionary on the order of genius. Agricultural scientists with whom we have discussed this possibility say that the plant knowledge required of such an individual—particularly the invention of a system of alternate irrigation—would necessitate a 180-degree swing in perspective. We therefore reject the idea that an Indian leader of whatever origin, combining the qualities of both Johnny Appleseed and Luther Burbank, appeared suddenly among the Indians of Owens Valley during the Spanish period preaching a native "Green Revolution."

It is our conclusion, and we believe the most reasonable one given the present state of knowledge of aboriginal conditions, that agriculture was of local independent origin in Owens Valley and probably developed slowly over a long period prior to European contact.

Because of the extensive and well-organized irrigation system that apparently developed independently in Owens Valley by early historic times, entirely lacking in the usual New World cultivated plants and involving indigenous plant species, we must ask how such a development occurred and why it occurred there and nowhere else. Although there are apparently other instances of a similar nature in Fish Lake Valley and in the valleys of the Walker River drainage, these irrigation systems appear not to have been as well developed or of as great importance as in Owens Valley. It is difficult to postulate that the people of Owens Valley adopted irrigation from the Southern Paiute bands occupying such places as Ash Meadows to the east, since this suggests that they ignored corn and other traditional cultivated crop plants. In any case, such a contention requires first demonstrating that agriculture at Ash Meadows and elsewhere was of greater antiquity than the Owens Valley system, which remains unproven. For whatever reason the people of Owens Valley began irrigation, it is easiest to imagine that they were simply expanding on natural conditions that existed there. This was the position to which Steward returned shortly before his death.

Dr. L. F. Lippert (personal communication) has suggested that occasional quick thaws of the snowpack in the Sierra Nevada could cause streams descending to the floor of Owens Valley to sometimes overflow their banks, flooding the lowlands that later became the irrigated fields of the Owens Valley Paiute. The Indians would have observed that in such years of overflow there was an expansion of yellow nut-grass and other plants that were normally confined to areas of moist soil along the Owens River. Kowta (1965) also suggested this possibility. We believe that this idea has much to recommend it.

Communal labor in Owens Valley was not limited to irrigation, but was employed in driving antelope and jackrabbits and in fishing, with whole villages or districts participating in this latter activity under the direction of a district head man and all participants sharing in the catch (Steward

1933:250). Fish were also gathered from the dry creek beds when the streams were dammed and the water diverted into the irrigation ditches. Later, when the water was returned to the stream, fish were gathered from the ditches (Steward 1930:152). Daniel Lawton (personal communication) suggests that fishing by means of diverting streams might have led to the observation that economically useful plants were watered and made more productive over a wide area. Irrigation might thus have arisen inadvertently as a result of fishing activities. Perhaps the position of head irrigator is the same as the person who directed the diversion of streams for fishing.

The Owens Valley agricultural system appears to have achieved its greatest development in the northern part of the valley. It appears not to have been practiced at the southern end of the valley near Owens Lake, although streams seemingly suited for the purpose occur there. Von Schmidt does comment on the abundance of fish in the lower Owens River and indicates that it is on these that the Indians of that area chiefly subsisted. One reason irrigation may not have been practiced near Owens Lake is because of the abundance of *kutsavi*, the larvae of a small fly, *Ephydra hians* Say., which formerly occurred in the alkaline waters of Owens Lake. When J. W. Davidson visited Owens Lake in the summer of 1859, he reported that the Indians were busy collecting, drying, and packing away for winter use "hundreds of bushels of this food" (Wilke and Lawton 1976:30). Davidson was a keen observer, and there is no evidence that he exaggerated this point. The larvae were annually washed ashore in the summer by winds and collected in broad windrows from which they were scooped up in baskets. Irrigation was not practiced at Mono Lake either, according to Steward, nor was it recorded by Von Schmidt, who surveyed that region in 1857. Mono Lake is located at about 7000 feet, perhaps too high for successful irrigation of yellow nut-grass and wild-hyacinth. However, here again, the fly larvae occur in abundance (see Heizer 1950) and would have provided a reliable winter staple that involved less effort to obtain than irrigating and harvesting wild plant foods. Steward (1933:256) indicated that the larvae were also present in Walker Lake at the terminus of Walker River Valley. Thus, the Indians in all of these regions would have had a reliable winter food resource lacking in the northern and central Owens Valley.

The agricultural industry of Owens Valley can be viewed as an attempt to insure an adequate, reliable winter food supply, one not subject to the irregularities that characterized the annual crop of pine nuts, the recognized winter food resource across a large sector of the Great Basin. Winters tend to be long and moderately harsh in Owens Valley and may be severe elsewhere in the Great Basin. For the Paiutes and Shoshones of that region, winter was always a contest to see how long the supply of stored foods would last. In most years, and always in years when the pine nut harvest of the preceding autumn was poor, which was as often as not, spring found the Indians more or less in a state of starvation.[18] When spring arrived, it was necessary to break camp and start foraging for the first greens that made their appearance. The family units into which winter camps broke up were thus the basic economic units of much of the Great Basin.

Owens Valley had one of the greatest population densities of any region in the Basin.[19] It also differed from most of the rest of the Basin in that it had permanent villages. Whether population density led to development of agriculture in Owens Valley or whether it was the result of agriculture would at present be difficult and premature to speculate upon. But the combination of irrigated crops and pine nuts would have provided as stable a winter food supply as the combination of fly larvae and pine nuts did in nearby regions.

The combination of agriculture and

hunting/gathering in Owens Valley is best viewed as typical of many non-industrial societies, even though it differed in many important respects from even neighboring areas like the American Southwest. To attempt to characterize such peoples as either "hunters and gatherers" or as "agriculturists" is to attempt to jam information into rigid categories to which it is not necessarily suited (cf. Harris 1975:686). Certainly, the Owens Valley Indians were practicing agriculture when the earliest observations were made of them, but to call them agriculturists is to minimize the potentially greater importance of their hunting and gathering activities. Similarly, many California and Great Basin groups which are usually considered to be typical hunters and gatherers also involved themselves in activities related to food production rather than simply food acquisition (Downs 1966; Winter 1974). With the possible exception of the Polar Eskimo, most "hunting and gathering" societies involve themselves to some extent in forms of environmental modification, manipulation, or management. With the exception of contemporary American agribusiness, "agricultural" societies, especially non-industrial ones, likewise tend to hunt and gather to some extent. If it is necessary to classify societies on the basis of subsistence practices, then it might be more realistic to view them as having progressed to a greater or lesser degree along a continuum from strictly food acquisition to strictly food production.

CONCLUSIONS

The Paiute of Owens Valley had by early historic time progressed to a substantial extent along the path toward large-scale food production. They are perhaps the best instance in North America of a group that developed its own system of vegeculture—a system carried over to include irrigation of a variety of seed-bearing plants as well. The Owens Valley Paiute thus offer a better example of agricultural origins than any presently known archaeological cultures that already had domesticated crop plants. And this remarkable achievement of indigenous agriculture occurred in a group which, as Julian Steward (1970) concluded after nearly fifty years of study, had evolved only "proto-bands." This was a retraction of his earlier statement that they were grouped in true composite land-owning bands (Steward 1938:50). Comment on that classification we leave for a future time.

Steward (1930:153) himself deserves credit for recognizing that the Owens Valley Paiute use of irrigation could contribute knowledge within the broader framework of the "origins of agriculture." Curiously, during Steward's own time, geographer Carl O. Sauer was carrying out research on the problems of agricultural origins and dispersals. Sauer believed that vegetative propagation had preceded seed cultivation and set out to develop a theoretical basis for locating the cradle of agriculture (Harlan 1975:46). Between Sauer (1952) and Edgar Anderson (1954) a model evolved suggesting that agricultural peoples were sedentary fisherfolk living in wooded lands and bringing aggressive plants back from their riverbanks that found natural places to sprout in the kitchen middens of their homes.

Evidence since has shown that some of the presuppositions of Sauer and Anderson were simplistic or incorrect (Harlan 1975:45). Nevertheless, it seems odd that Sauer, living in California, failed to note that Steward had called attention to practices that so nearly coincided with his own model for agricultural origins. Nearly fifty years have elapsed since Steward wrote his seminal paper on irrigation in Owens Valley, but as yet no anthropologists have mustered interest in closely studying the problem. It may well be too late to acquire much of the information which still remains unknown about Owens Valley agriculture—such as the dating of its origin and the conditions under which it began. Yet research in this neglected area by archaeologists,

linguists, plant scientists, and other scholars could probably tell us as much about agricultural origins as current research on the subject being carried out elsewhere in the world.

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NOTES

1. Bettinger (1975:353-354) briefly considered the problem of Owens Valley irrigation and suggested that it may have begun around A.D. 1000. He based his suggestion on a change in artifact distribution which he believed indicated a decline in hunting of large game in upland areas and a presumed diversion of the labor force into construction and operation of irrigation facilities. This was in contradiction to Steward (1930) who reported that except for initial dam construction only one person was in charge of irrigation. Bettinger's archaeological investigations in Owens Valley are continuing, and it is hoped that further attention will be given to some of the information presented in this paper.

2. This paper also provides a general summary of most of the research which has been carried out on aboriginal agriculture in California.

3. Wittfogel (1957) argued that large-scale hydraulic works such as the digging and maintaining of canals were only possible in a hierarchically ordered society which could control the entire labor force through a central point of authority. Woodbury (1961:556) in a reappraisal of Hohokam irrigation challenged this concept. Certainly, Wittfogel's term "oriental despotism" scarcely applied to the means by which the Owens

Valley Paiute selected their head irrigator and carried out their agricultural tasks. Ho (1975:47-48) reported that the first famous irrigation network in China was completed by the Wei state between 424 and 296 B.C. in the Chang River area in northern Honan. This whole irrigation system was only 20 li in length, a little over five miles and therefore comparable to the longest irrigation ditch of the Owens Valley Paiute at *pitana patü*. In reply to the Wittfogel hypothesis, Ho (1975:48) wrote: "Insofar as ancient China is concerned the theory of the 'hydraulic' genesis of culture or of 'despotism' is completely groundless." The same may be said to apply to the Owens Valley Paiute, who chose their head irrigator in popular assembly.

4. The linguistic rendering of these terms follows Steward (1938).

5. It is possible that a variety of *E. crusgalli*, native to the Owens Valley, named *pawai* by the Paiutes, has hybridized with the introduced varieties. Hitchcock (1971:712) does not indicate that *E. crusgalli* is native only to the Old World. An indigenous New World variety would explain the presence of a Paiute term for this plant. We are reminded by Jack R. Harlan (personal communication) that a species of *Echinochloa* was cultivated in China, and species of *Chenopodium* were cultivated in various parts of both the New and Old Worlds (J. G. Waines, personal communication).

6. The plants involved are not easily dislodged from the soil, and the tubers of *tüpüsi'i*, as will be seen later, are part of an extensive root system.

7. The authors cannot completely rule out the possibility that agriculture became established among the Owens Valley Paiute before the concept of ditch irrigation had reached southwestern Nevada.

8. His reservations about aboriginal irrigation were probably prompted by the publication of Chalfant (1933), who wrote the first history of Owens Valley and reported its penetration by white settlers in the 1850's.

9. *Ascequias* (*sic*) is Davidson's term, and was employed throughout the Southwest during this period, not only by Spanish-speaking people, but by American explorers, Army engineers, and white settlers.

10. The common names of "grass-nuts," "nut-grass," "taboose grass," and "taboose" are employed interchangeably by different writers. Steward's identification of the plant as *Brodiaea capitata* can probably be ascribed to the fact that it is also sometimes called "grass-nut."

11. DeDecker had discovered many years previous that Steward's identification was in error and had considered publishing a short paper on this subject.

12. In her letter, Dr. Fowler notes that throughout Northern Paiute territory in Nevada the term *tib·uzi* or *tipuzi* is everywhere synonymous with *Cyperus esculentus*. She writes: "There does seem to be a common name confusion about 'nuts' or 'nut grass' or 'ground nuts,' however, which might be part of the same problem Steward was getting . . . " Northern Shoshone with whom she talked were unfamiliar with irrigation of the plant.

13. Holms is currently working with other scholars on the definitive work on the Cyperaceae.

14. We have found that agricultural scientists are often highly knowledgeable about anthropological concerns related to agriculture and cooperative in sharing their ideas. The authors confess that they have not always been immune to contributing to the semantic confusion surrounding "incipient agriculture" and similar terms. Sometimes it has been easier to use those terms as employed by one's predecessors than to try to clear up the confusion. Several times we have been taken to task severely by our friends the plant scientists.

15. The *Oxford English Dictionary*, the recognized authoritative work on English, defines *agriculture* first as "The science and art of cultivating the soil . . . " It has two primary definitions for *cultivation*. One is "tillage." The second definition is as follows: "The bestowing of labor and care upon a plant, so as to develop and improve its qualities . . . "

16. Content of oil (ether extract) in chufas harvested by Killinger and Stokes (1951:14) in 1944 and 1945 was 20.55% and 34.40%, respectively.

17. Steward (1933:334) reported a Mr. W. L. Skinner of Lone Pine as saying that corn cobs had been dug up a few inches deep in a cave at Little Lake. The authors have been unable to trace these corn cobs. Steward also noted: "C. D., unreliable,

said Shoshoni formerly grew 'pinto corn' and squash, but not beans."

18. Steward (1934:433) recorded a famine-like winter remembered by his informant Sam Newland: "It was a hard winter with so much snow that the sagebrush was buried and you could not even see the tops of it. We ate waiya, mono, tüpüsi", nahavita, and other seeds my mother had gathered. There had been no pinenuts that fall or we should have gone after them and spent the winter in the mountains." Newland also stated: "The fall after my father's death my mother went out to a place west of pitana patu to gather tüpüsi" for the winter" (Steward 1934:433). Elsewhere, Steward (1933:239) reported: "Pinenut expeditions of small groups wintered in the mountains in the timber when crops were good. When pinenuts failed, they wintered at valley villages, eating stored seeds gathered in summer and fall."

19. Davidson (Wilke and Lawton 1976:29) estimated the population of Owens Valley at about "1200 souls, tho' my guide & Mr. David McKenzie, a mountaineer of great experience & judgment, make them much more numerous." McKenzie's judgement was based in part on his experiences of the previous year, when he also visited Owens Valley, and provided a population estimate of about 2000 Indians.

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