CONTRIBUTIONS TO
TULARE LAKE ARCHAEOLOGY VII

UNIQUE TOOLS AND WIDESTEM POINTS FROM THE TULARE LAKE REGION

Jerry N. Hopkins and Alan P. Garfinkel, Editors

Contributions by

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Alan P. Garfinkel
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THE TULARE LAKE ARCHAEOLOGICAL RESEARCH GROUP

2016

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Preface

This is the seventh publication in the contributions series resulting from the Tulare Lake Archaeology Research Group (TULARG). The present publication consists of three manuscripts (Chapters One through Chapter Three). Chapter One focuses on a recently identified atlatl dart point that closely resembles the Borax Lake Widestem Points first recognized by Harrington (1948) in the Clear Lake region of Lake County in Northern California. Specimens were chemically characterized to source by Northwest Research Obsidian Studies Laboratory using x-ray fluorescence analysis and analyzed by ArchaeoMetrics Inc. for obsidian hydration measurements. Alexander (Sandy) Rogers then determined ages for the Tulare Lake Widestem Points employing source-specific temperature-adjusted dating equations. His analysis suggests ages of about 7,000 – 9,000 years old calibrated ages before present for a majority of the obsidian sample.

Chapter Two addresses the *limace* shaped uniface scraper, a flaked stone tool-form thought to be rooted in the Old World Paleolithic period. This tool-form occurs in most large-sized Folsom, Clovis and other fluted point Paleoindian assemblages. *Limaces* clearly formed part of the assemblages from several of the well-documented Paleoindian sites elsewhere in North America.

Chapter Three focuses on a wooden artifact recovered by Hopkins in 2009 at the Witt Archaeological Locality (CA-KIN-32). To our knowledge, this is the only complete Native American wooden digging stick ever recovered from Tulare Lake's natural environment. Radiocarbon dating results indicate that the artifact supports a historic or protohistoric age for the implement. Digging stick stone weight components are also discussed in this chapter.

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Chapter 1

FURTHER STUDIES OF ANCIENT BLACK GLASS: OBSIDIAN TRACING AND HYDRATION DATING TULARE LAKE WIDESTEM POINTS

Jerry N. Hopkins, Alan P. Garfinkel,
Alexander K. Rogers, Tim R. Carpenter and Craig E. Skinner

Abstract: *Widestem points are to some degree common at the Witt Site (Ca-Kin-32) locality of Tulare Lake. Within the Hopkins collection, there are 101 examples of widestem points that were complete enough to allow classification. These artifacts were manufactured from a variety of toolstone materials. Most of these points were fashioned from locally available chert (cryptocrystalline silicate = ccs) and other materials (fine grained volcanic = fgv) including basalt, fine grained igneous (aka rhyolite), quartz (crystal, milk white and rose) and quartzite (n = 65) along with (n = 36) specimens made of obsidian (obs).*

Virtually identical point forms to the Tulare Lake Widestems are recognized from Northern California and are identified at the Borax Lake Site (CA-LAK-36) and in the larger vicinity of the Clear Lake region. Those North Coast Range projectile point forms (known as Borax Lake Widestem Points) appear to overlap in age with both fluted points and crescents, but continue to be employed until a more recent era discontinuing at a time estimated to be 6,000 years cal b.p.

In the present study, we formally classify Tulare Lake Widestem Point forms from Tulare Lake found within the Witt locality and determine whether they are of comparable age to other early Holocene artifacts recovered from Borax Lake. The entire sample of formally classifiable Tulare Lake Widestem Points manufactured from obsidian was analyzed to both chemically characterize these artifacts as to provenience (geographic source) and to determine their obsidian hydration measurements.

Obsidian studies appear to date the Tulare Lake Widestem Points to an average age of 8,250 calibrated years before present. Applying a single standard deviation added to that mean or average provides a time range for the bulk of the Tulare Lake Widestem assemblage from ca. 7,500 to 9,000 years ago.

Source determinations for Tulare Lake Widestem show that a brisk trade was taking place with imported obsidian coming from Fish Springs, Coso, Annadel and Casa Diablo obsidian sources. Most of the obsidian Widestems at Tulare Lake came from the Casa Diablo suite of obsidian sources. This obsidian toolstone contributes a significant portion to the Widestem assemblage and testifies to long range movement and the value of the imported toolstone to the indigenous people who occupied Tulare Lake.

INTRODUCTION

Proveniences for Tulare Lake Widestem Points

Jerry Hopkins was the first to identify and describe the Tulare Lake Widestem Points, all of which were found in surficial contexts recovered mostly within boundaries of the Witt Site locality. These points have not previously been formally defined as a specific type of projectile point for the Tulare Lake region. Loci numbers (1 - 15) of the Witt locality were assigned by Hopkins to identify specific sub-locality collection zones where Paleoindian artifacts were found on Tulare Lake's fossil shorelines (Township 23 South, Range 20 East) at elevations between 190 and 195 feet amsl (above mean sea level), a contour interval that marks the level at which Lake Tulare stood during late Pleistocene/early Holocene times. These eroded shorelines were well below the 210 foot shoreline of more recent high-stands that placed these artifacts under water for several millennia.

Raw Material Selection

Most of the Tulare Lake Widestem Points were fashioned from local toolstone materials consisting of chert (ccs) and fine grained volcanic materials (fgv) available within the nearby Jacilitos Creek drainage (about 15 miles [24 km.] southwest of Coalinga [two days walking distance from Tulare Lake]. See Figure 1.1 for raw material selection. Also, obsidian (obs) toolstone material that originated from five different California volcanic glass source locations were imported and most likely traded into the Tulare Lake region and used for both projectile points and other tool forms. These volcanic glass sources will be the subject of some discussion later on in this report.

Two widestem points (DL2JH44 and DL2JH48) were initially misidentified as being made of obsidian. They were fashioned from grey or black glassy material which is similar in appearance to obsidian artifacts recovered from Tulare Lake as well as other California locations. They were ruled as *not obsidian* by Craig Skinner. Upon close examination, we later identified the points as being fashioned from fused shale originating from Monterey Formation shale deposited throughout the Pacific Rim during the Miocene.

There are at least three sources of fused shale in California. The primary sources are located in Grimes Canyon (Ventura County), a little south of Fillmore and Happy Camp Canyon (Santa Ynez Valley, Santa Barbara County). The Chumash exploited fused shale toolstone for weapons and tools for 8,000 years or more.

TULARE LAKE WIDESTEM POINT IMAGES

One hundred-one (101) Tulare Lake Widestem Points from the Jerry Hopkins Collection were sorted and photographed for this study (see Figures 1.2 – 1.11).

OBSIDIAN GLASSY ROCKS

Obsidian is a compact natural volcanic glass that occurs as crusts on lava flows or as the outer layer of swollen volcanic domes. It develops because of the rapid cooling of melts that are usually gas-rich. When its composition is silica-rich, obsidian belongs to the rhyolite family. There are also trachytic, andesitic and phonolitic obsidians. Once cooled, obsidian can be shattered like glass into sharp, conchoidal (curved) fractured fragments. It is typically jet black and sometimes colored by titanium oxide and other materials. Streaks and swirls of oxide can make broken surfaces look like color-flowed marbles, i.e., brown and black-streaked “mahogany” obsidian.

Obsidian, together with flint, was considered a much valued raw material for flaked stone tools because of its sharp-edged fracture and its great hardness (Mohs’ hardness 5-5 ½) (Schumann 1993:238). Because obsidian fractures with a beautifully curved glass-sharp edge, it can easily be fashioned to make tools and weapons such as knifes, blades and projectile points even better than flint. Consequently, it was much-admired among early cultures of Native Americans.

Because obsidian absorbs water once it is broken, ancient obsidians can be accurately dated by measuring their hydration rind thicknesses. Just how much water their surface layers have absorbed has allowed modern-day scientists to determine ages of specimens by using contemporary, source-specific, temperature-dependent obsidian hydration dating methods and equations.

Exotic Colored Obsidian

Obsidian is natural glass that was originally molten *magma* associated with a volcano. It is most often black in color, but may be about any color ranging from clear to opaque. Glass Buttes, Oregon has produced a variety of exotic gem-quality obsidian including mahogany, red, flame, midnight lace, jet black, pumpkin, brown, rainbow, gold sheen, silver sheen, and green, lizard skin, snowflake and more (Bakken 1977).

So far with the exception of black, only mahogany brown or red obsidian "streaked" with different layers or colors has been found at Tulare Lake by Hopkins. However, Hopkins has seen several mahogany obsidian points in other collections from Tulare Lake. These colors generally result from tiny crystals or inclusions of hematite or limonite (iron oxide). Only one source for this type of colored obsidian toolstone material found at Tulare Lake has so far been identified. The material has been chemically characterized as originating from Buck Mountain in Modoc County. No doubt, our stone-age ancestors living in the Tulare Lake Region placed great value on colored obsidian since they imported this very special obsidian that originated from such great distances.

ANALYSIS OF TULARE LAKE WIDESTEM POINTS

X-Ray Fluorescence Analysis

With permission from Northwest Research Obsidian Studies Laboratory (personal communication with Craig Skinner 2008), TULARG borrowed a portion of his introduction to obsidian characterization studies as follows:

> Although a variety of physical, optical, petrographic and chemical attributes are used to characterize volcanic glass; certain trace element abundances have been demonstrated as the most useful to "fingerprint" obsidian sources and artifacts. The use of X-ray fluorescence analytical methods has shown the greatest overall success for raw material sourcing. X-ray fluorescence has ability to nondestructively and accurately measure trace element concentrations in obsidian and has been widely adopted for this purpose.

Figure 1.12 in this study provides a map of obsidian source locations in California and western Nevada that includes the sources we identified for the Tulare Lake Widestem assemblage (Tables 7 – 12 are located at the end of the manuscript). Table 7 identifies the specific source determinations and hydration measurements for the Tulare Lake Widestem obsidian artifact sample - Table 8 the distribution of artifacts by geochemical source along with estimates of straight-line and topographically sensitive walking distances from these sources to

Tulare Lake - Table 9 source-specific hydration measurements - Table 10 attributes and metrical data for TLWS points - Table 11 attributes and metrical data for the OBS points and Table 12 lists miscellaneous artifacts for the Tulare Lake obsidian points.

Obsidian Hydration Analysis - Analytical Methods

Obsidian hydration measurements and hydration results were obtained through the services of the ArchaeoMetrics Obsidian Hydration Laboratory on Tulare Lake Widestem Points that were submitted for analysis. General procedures for determining metric rim (or rind) thicknesses for these specimens were followed. Initially, it was established that the best area in which to cut a portion of the obsidian specimens was determined. Two parallel cuts were made on the appropriate portion of the specimen using a lapidary saw mounted with two four-inch diameter diamond-impregnated .004-inch blades. The base or notches of projectile points were then cut. Weathered specimens were addressed in the same manner. On average, the majority of thin section cuts yielded samples averaging 0.35 millimeters in thickness. Samples were mounted with "Lakeside" thermoplastic cement onto sequentially numbered microscope slides. Generally, five specimens were mounted on each slide. The samples were then manually ground to reduce thickness, allowing specimens to be read under the microscope. First, slurry of water containing six-hundred silicon-abrasive grit was mixed on a glass plate. Grinding was accomplished in two steps. The initial grinding rendered the surface flat and removed the saw cut marks from one side of the specimen. The specimen was then flipped, remounted and the second side was ground to proper thickness for viewing under the microscope. Ultimate thicknesses of the specimens measured between 30-50 microns, depending on opacity or unique source-specific quantities such as hardness of obsidian vs. softer obsidians.

The prepared slides were then measured using a "Meiji" petrographic microscope fitted with a "Lasico" digital filar eyepiece. Once a defined hydration rim was observed on a color monitor screen, the hydration rim was centered in the middle of the monitor to reduce parallax and measured using a micrometer. Typically, ten measurements are taken from each specimen. However, due to imperfections in the stone, weathering or damage to the surface from the saw or grinding as few as three measurements were recorded. Surfaces exhibiting cortex were also recorded and identified as such. Hydration values were recorded to the 0.01um (nearest 1/10 [tenth] of a micron) and both the mean and standard deviation for each specimen were computed.

Tim (personal communication 2009) submitted the following report regarding an analysis of obsidian Widestem specimens from Tulare Lake:

> In all, 48 obsidian Tulare Lake Widestem Points were submitted to ArchaeoMetrics Inc. for analysis. These artifacts exhibited signs of surface abrasion and moderate to severe weathering. In order to obtain the most accurate hydration rim readings, internal hydration rims were selected that were associated with areas that exhibited internal fractures and what is known as "step" fractures. Both the ventral and dorsal sides of each specimen were examined. Of the 48 artifacts, 42 were cut multiple times (re-cut) due to weathering. Four of the 48 artifacts had no visible hydration rim values (despite re-cuts), 12 artifacts had two rim values (hydration rim readings) and one artifact had three rim values. A total

of 59 individual and distinct hydration rim values were obtained from the obsidian Tulare Lake Widestem assemblage.

ATLATL DART POINT IDENTIFICATION

Arrow and Dart Point Determinations

In David Thomas' key for the Great Basin, he indicated that a basal width of less than 10.0 mm was used for an arrow and if the projectile point exceeded a basal width of 10.0 mm it should be classified as a dart point. Thomas based his assessments working with a very large projectile point sample throughout the larger Great Basin. However, Robert Yohe's efforts (Yohe 1992; 1998) based on the more regionally restricted assessments resulted in a slightly different set of determinations for identifying and separating dart points from arrow points.

Yohe determined that arrow point basal width was about 15.0 mm. Measurements greater than this were assigned to the dart point category. Dart points varied from about 8.0 to 15.0 mm. The mean for the Tulare Lake Widestem Point assemblage in this study was 17.6 mm. Hence, according to both Yohe' and Thomas' assessments, the Tulare Lake Widestem Points are all dart points.

Dart point lengths overlapped with arrows; but arrows measured from 12 mm to 41 mm in length and darts were from 35 mm to 65 mm. During Van Buren's (1975:31) testing experiments, it was determined that a 6 to 7-foot long dart performed best and was the most consistent.

Hafting - Slot or Socket

The most commonly used method for hafting (cf. Van Buren 1974:19-20) was that which was accomplished by sawing or abrading a notch in the forward end of an arrow shaft. The notch usually varied from 1/8-inch to 3/16-inch in width and extended from 3/8-inch to 5/8-inch *in depth into the shaft (dart shafts were considerably wider than arrow shafts and they would therefore require a wider notch width to accommodate the wider dart point stem). The base or stem of an arrowhead or dart point was inserted in the slot and was then bound securely with rawhide, sinew or fiber cord.*

Some foreshafts were smaller than the main shaft and designed to fit into a recess in the forward end of the shaft. Most foreshafts, however were fitted over the end of the main shaft because lightweight sections of reed or cane could be slipped over the forward ends of shafts without appreciably affecting aerodynamics of the shaft. The stem of the projectile point was usually seated in the foreshaft against a natural joint and held in place by use of pitch, asphaltum or resin-glue combinations. The stem of the projectile point was seated, as in a socket, thus stayed with the foreshaft and the foreshaft usually remained with the game in which the projectile point was embedded. The main body of the shaft could easily be removed and reused or, if the game escaped, the loosely attached main shaft could fall free from the foreshaft, thereby making the main shaft reusable and the foreshaft disposable.

THE TULARE LAKE ATLATL DART POINT

The introduction of the atlatl and dart weapon-delivery system that provided greater propulsive force to the missile is poorly understood at Tulare Lake since it's not known when the spear-thrower was first introduced. However, we do suspect that spear throwing devices were present among New World Paleoindian hunters (Dixon 1999). The spear or dart thrower served as the principal hunting weapon in the Tulare lake-marsh country perhaps as early as 10,000 to 11,000 years ago (Hopkins 1993:49) and may well have endured into the historic period overlapping the bow and arrow beginning about A.D. 500 (1,500 B.P.) (cf. Wallace (1988:97).

The bow and arrow was a late development in the evolution of weapons and hunting equipment. It was introduced at different times in different places and it appears that the atlatl and dart in the Tulare Lake region, employing a Widestem type missile tip as well as other type projectile points, persisted for a substantial amount of time subsequent to its eventual replacement by the bow and arrow. Van Buren suggests that the throwing stick and dart did not replace the thrusting spear, but instead was employed together with it. Likewise, his suggestion applies to the atlatl and the bow and arrow as well. The first spears may have been a staff of considerable length with a sharpened or fire-hardened wooden tip later being replaced by chipped stone points. Such a weapon could be used to fend off attacking wild animals or to pierce the hide of large game that had become disabled or mired in swampy areas (Van Buren 1974:35).

During its initial occupation, the Tulare Lake region, no doubt, consisted of lakeside hunting camps with lush hunting grounds close by. During early periods, the atlatl clearly served as the weapon system of choice. Some researchers estimate that atlatls register an impact over 150 times as intense as that of hand-thrown spears. A variety of forms of projectile points, i.e., robust Lake Mohave, Pinto, Elko and various other types of dart points collected from Tulare Lake shorelines were affixed to spears or dart-shafts that were thrown by the atlatl.

Most researchers agree that big game hunting demanded heavy-duty weaponry to bring down mega-fauna. But, as big-game hunting decreased probably resulting from overkill that may have contributed to the extinction of mega-fauna, the development of smaller more efficient projectiles that were more suitable for taking smaller prey animals likely became more important. It is postulated by the authors that the smaller variants of Western Fluted (aka Clovis-like) points found at Tulare Lake were tips for fore-shafted spears and possibly atlatl darts. Both spears and darts could be thrown on flat trajectories at close-range targets and likely would penetrate deep enough to embed the point and a portion of the shaft in the target.

One of the specimens in this sample (DRL1W6164) made of Coso obsidian was fluted on one face and exhibited *channel scratching*, suggesting that it is of ancient age. Early Widestem points with thick cross-sections (common on dart points) could have easily been further reduced in thickness and this reduction in point morphology might have improved accuracy considerably. As suspected, obsidian hydration rim measurement readings used in establishing the chronological placement of obsidian missile tips has postulating ages that place the Tulare Lake Widestem Point in the chronological range of the atlatl, many years prior to the introduction of the bow and arrow in the region.

X-RAY FLUORESENCE ANALYSIS

Attributes and Metric Data

In order to formally define the precise configuration and morphology of the Tulare Lake Widestems, we followed the standardized attribute measurements (see Table 10 and 11) often applied to California and Great Basin projectile points (after Thomas 1970, 1981; Justice 2002). These metrics were employed here to facilitate a comparison of the Tulare Lake Widestem assemblage with the Borax Lake specimens. Mean results for Tulare Lake Widestem Points were compared with Borax Lake Widestem Points following Justice 2002:421, Appendix: Projectile Point Measurements.

Key (attribute measurements in millimeters):

ML	Maximum Length	
MW	Maximum Width	
MT	Maximum Thickness	
NW	Neck Width	Measurement at the narrowest portion of the necks of notched points.
PSA	Proximal Shoulder Angle	Measurement on the side with the lowest angle and most notch closure (employing a polar-coordinate-grid) with zero placed to the left and readings taken moving to the right when reading notch angles).
DSA	Distal Shoulder Angle	Measurement on the side with the lowest angle and most notch closure (employing a polar coordinate-grid) with zero placed to the left and readings taken moving to the right when reading notch angles.
MWP	Maximum Width Position	Measurement from the basal edge to the position of maximum width that can fall anywhere from the base to the tip.
SHW	Shoulder Width	Measurement at the maximum width of the shoulder.
WG	Weight in Grams	

It should be pointed out that some difficulty was experienced in measuring PSA and DSA, resulting from section saw cuts removed from notch openings of several Tulare Lake specimens. Geographic sources and specific hydration measurements for the Tulare Lake Widestem Points are reported in (Table 9 and 12).

OFSIDIAN TRACING AND DATING TULARE LAKE WIDESTEM POINTS

Thirty (30) of the 48 Tulare Lake Widestem (TLWS) projectile points from Tulare Lake were amenable to hydration dating. This sub-sample of the obsidian TLWS Points was chemically characterized to source. Four geographical-specific obsidian sources were identified in this subsample: Coso West Sugarloaf (WSL, n = 3), Casa Diablo Lookout Mountain (LM, n = 6), Casa Diablo Sawmill Ridge (SR, n = 16) and Fish Springs (FS, n = 5).

The analysis is based on obsidian hydration dating (OHD), using modern temperature-dependent diffusion theory (Rogers 2007) and flow-specific hydration rates (Rogers 2011, 2012). Site temperature parameters were computed from data from Hanford, California (Rogers 2012). The age calculation includes a correction for paleo climatic changes in the temperature regime (Rogers 2010).

Ages were computed for each obsidian specimen individually, using a computer code in MatLab 7.01. The hydration rims were corrected to an effective hydration temperature (EHT) of 20 degrees C; all artifacts were assumed to be surface collected, so no correction for burial depth was made. All age computations assume the hydration rim growth to be proportional to the square root of time, per classic diffusion theory. The ages are given in calibrated years before 2,000 (cyb2k), with probable error.

The analysis employs flow-specific hydration rates. The rate for Coso West Sugarloaf was previously available (Rogers 2011) and the rates for the other three sources were computed as described in Rogers 2012. The rate parameters used here are summarized in Table 1.

Table 1 – Hydration Rates in μ/1000 Years, at 20°C

Source	Subsource	Rate
Coso	West Sugarloaf	17.21
Casa Diablo	Lookout Mountain	12.37
Casa Diablo	Sawmill Ridge	12.05
Fish Springs	(none defined)	11.26

Temperature parameters for the site were derived from data for Hanford, California, station 51, number 034747, downloaded from the website of the Western Regional Climate Center. The data are for a 30-year period, 1981 – 2010. The resulting parameters are as shown in Table 2, with details in Rogers 2012.

Table 2 – Temperature Parameters for Tulare Lake, in °C

Parameter	Value
Average annual	17.00
Annual Variation	15.56
Mean diurnal variation	14.53
Effective Hydration Temperature	19.98

Prior to chronological analysis, the hydration rim data were analyzed for outliers and two data points were removed by Chauvenet's criterion. Two more were removed judgmentally, since they seem too small and may represent surfaces that were reworked. Table 3 presents the input data and Table 4 the resulting ages.

Table 3 – Input Data

Casa Diablo LM Cat. No.	Mean, µ	Casa Diablo SR Cat. No.	Mean,µ	Fish Springs Cat. No.	Mean,µ	Coso WS Cat. No.	Mean,µ
DRL2JH5	10.45	DRL2JH4	10.05	DRL2JH2	9.59	DRL4JH22-1	11.89
DRL4JH20	10.63	DRL2JH7-1	7.92**	DRL2JH-1	9.68	DRL4JH22-2	12.63
DRL4JH21-1	9.52	DRL2JH-2	10.17	DRL2JH3-2	10.00	DRL3JH33	11.93
DRL4JH21-2	10.50	DRL2JH8-1	9.29	DRL4JH23	10.00	DRL1W6164	12.01
DRL3JH36	10.59	DRL2JH8-2	10.02	DRL3JH34-1	9.55		
DRL4JH38-1	12.44*	DRL2JH11	10.01	DRL3JH34-2	10.02		
DRL4JH38-2	14.04*	DRL4JH13	6.17*	DRL4JH37	9.59		
DRL3JH39-1	8.98	DRL4JH14-1	9.32				
DRL3JH39-2	9.54	DRL4JH14-2	9.99				
DRL3JH39-3	9.89	DRL4JH15	10.50				
		DRL4JH18	9.99				
		DRL4JH19	9.28				
		DRL4JH24-1	10.52				
		DRL4JH24-1	11.47				
		DRL2JH26-1	9.00				
		DRL2JH26-2	10.53				
		DRL2JH27	10.53				
		DRL2JH29	10.30				
		DRL4JH30	10.50				
		DRl4JH31	8.01**				
		DRL3JH35	9.95				

* Removed by Chauvenet's criterion
** Removed judgmentally
Note – hyphenated numbers indicate successive cuts on the same specimen

Table 4 – Ages for Obsidian TLWS Points from Tulare Lake

Cat. No.	Rim, µ	Source	Age, cyb2k	P.E, cyb2k
DRL2JH5	10.45	CDLM	8,626	2,195
DRL4JH20	10.63	CDLM	8,924	2,271
DRL4JH21	10.01	CDLM	7,873	1,417
DRL3JH36	10.59	CDLM	8,859	2,254
DRL3JH39	9.47	CDLM	6,989	1,028
DRL2JH4	10.05	CDLM	7,945	2,023
DRL2JH7	10.17	CDSR	8,380	1,508
DRL2JH8	9.66	CDSR	7,500	1,350
DRL2JH11	10.01	CDSR	8,100	2,062
DRL4JH14	9.66	CDSR	7,500	1,350
DRL4JH15	10.50	CDSR	8,939	2,275
DRL4JH18	9.99	CDSR	8,068	2,054
DRL4JH19	9.28	CDSR	6,886	1,754

DRL4JH24	11.00	CDSR	9,871	1,776
DRL2JH26	9.77	CDSR	7,681	1,383
DRL2JH27	10.53	CDSR	8,990	2,288
DRL2JH29	10.30	CDSR	8,602	2,189
DRL4JH30	10.50	CDSR	8,939	2,275
DRL3JH35	9.95	CDSR	7,995	2,035
DRL2JH2	9.59	FS	7,948	2,024
DRL2JH3	9.84	FS	8,396	1,511
DRL4JH23	10.00	FS	8,678	2,209
DRL3JH34	9.79	FS	8,305	1,495
DRL4JH37	9.59	FS	7,948	2,024
DRL4JH22	12.26	CWSL	8,543	1,534
DRL3JH33	11.93	CWSL	8,056	2,049
DRL1W6164	12.01	CWSL	8,172	2,078

Statistics on the ages are given below in Table 5. Note that the mean ages are indistinguishable statistically; this occurs because of the technique used in Rogers 2012 to compute hydration rates for Casa Diablo and Fish Springs and may not represent archaeological reality.

Table 5 – TLWS Point Age Statistics, Tulare Lake

Source	Subsource	Mean Age, cyb2k	S.D. Age, cyb2k	CV	N
Coso	West Sugarloaf	8,253	203	0.02	3
Casa Diablo	Lookout Mtn.	8,203	681	0.08	6
Casa Diablo	Sawmill Ridge	8,265	769	0.09	13
Fish Springs	n/a	8,255	279	0.03	5
Aggregated Data		8,248	638	0.08	27

Five data points were excluded from the analysis of central tendency of age. These five points may, however, represent interesting archaeological phenomena, so their ages are reported in Table 6.

Table 6 – Tulare Lake Anomalous Data Points on TLWS Points

Cat. No.	Rim mean, μ	Source	Age, cyb2k	Age P.P., cyb2k
DRL4JH38-1	12.44	CDLM	12,762	3,245
DRL4JH38-2	14.04	CDLM	17,292	4,395
DRL2JH7-1	7.92	CDSR	3,249	831
DRL4JH13	6.17	CDSR	5,148	1,313
DRL4JH41	8.01	CDSR	5,251	1,339

Cat. No. DRL4JH38-1 and -2 represent a single specimen with two obsidian hydration cuts. Both yield dates that are too old to be archaeologically reasonable (12,762 ± 3245 ± 4,395 cyb2k). Either this specimen has unusually high water content or else, more likely, it was exposed to fire at some time in its use life.

Cat. No. DRL2JH7-1 represents one cut out of two on a single specimen. The other cut (-2) on this specimen yielded an age of 8,380 ± 1,508 cyb2k, which is reasonable; however, the -1 cut gives an age of only 3,249 ± 831 cyb2k, possibly indicating a point which has been curated and then reworked sometime in the early Newberry Period (2,000 BC – AD 600).

As a final caveat on the entire analysis, the single independent data point is represented by the three Coso West Sugarloaf points. These suggest a central data point with an age of about 8,200 – 8,300 cal BP, or the Mid-Lake Mohave Period (7,000 to 11,000 years before present). Typically when one estimates the suite of readings, one includes a single standard deviation added to that mean or average. With the latter in mind, the bulk of the assemblage would appear to fall within time range from ca. 7,500 to 9,000 years ago (calibrated before present, see Table 5 above).

The ages computed for the other sources are not independent, because the rates for these sources were computed based on the CWSL rate by assuming that the projectile points were manufactured at approximately the same time, irrespective of obsidian source; that they experienced similar temperature histories; and that the growth of the hydration rim is proportional to the square-root of time. This methodology yields valid rates as long as the assumptions are valid, but not otherwise. Thus, the ages shown here must be regarded as tentative pending independent verification of the Casa Diablo and Fish Spring's obsidian hydration rates.

TULARE LAKE AND BORAX LAKE WIDESTEM POINT COMPARISONS

The Tulare Lake Widestem Dart Point is morphologically similar to the Borax Lake Widestem series, recognized at the Borax Lake Site and nearby vicinity of the Clear Lake region by Harrington (1948). Justice (2002:101-105) illustrated and described 14 specimens of Borax Lake Widestem Points; three were fashioned from ignimbrite/obsalt from Lake County, two of basalt from Plumas County, one of chert from Calaveras County, two of Franciscan chert from Lake County and six obsidian specimens from Lake and Sonoma Counties.

Justice (2002:101) points out, the use of the term *square stemmed* (for the Borax Lake Widestems) requires some qualification as this refers to projectile points with lateral margins exhibiting relatively straight edges with a straight to rounded base (Justice's Figure 13). Haft variation ranges from slightly contracting through parallel and slightly expanding. The haft element joins short, horizontal to downward projecting shoulders and a short triangular blade. Edge grinding of the haft element is common but not present on every specimen. Borax Lake Widestem technology is hypothesized to derive from the Great Basin Stemmed cluster, specifically the morphological changes that take place within the Silver Lake type (Justice 2002:108).

Both Tulare Lake and Borax Lake Widestem types appear to follow similar manufacturing strategies and many specimens from both locations show evidence of repeated resharpening. The Borax Lake Widestem type appears well represented at various localities in the North Coast Ranges from Clear Lake to sites in Del Norte, Mendocino and Humboldt counties (Justice 2002:110).

At Tulare Lake, although some isolates have been found nearby, the Widestem type point style occurs predominantly at the Witt Locality on the southwestern side of the lake. Source-specific hydration measurements, morphological attributes and metric data of the specimens were collected and reported in (Table 10). Measurements were taken and mean values are included in the tables for comparative purposes. We have included data for a small sample of Borax Lake Widestem Points for comparisons to Tulare Lake examples. Borax Lake data are from Justice (2002:423).

It is interesting to note, while morphology of the two types is quite similar to the projectile points from both geographic regions, there is substantial variation in sizes of the artifacts in each area. As a result of combining mean values for maximum length, width and thickness for the Borax Lake specimens, we find that the Borax Lake examples are about a third larger than the Tulare Lake Widestem Points. While basal widths for Borax Lake (19 mm) exceed the average of points from Tulare Lake (17.6 mm), both are within suggested atlatl dart criteria. Size variations of the Tulare Lake specimens may be attributed to extensive resharpening that may suggest atlatl weaponry was in use for a greater time span at Tulare Lake or the size of game within the Tulare Lake basin was considerably smaller than that of the Borax Lake region. Projectile points were often broken during use and rejuvenated for re-use that may have altered profiles of certain specimens, accounting for some of the size differences.

SUMMARY AND CONCLUSIONS

Widestem points are frequently discovered at the Witt Locality on the prehistoric shorelines of Tulare Lake. There are 101 such artifacts in the Hopkins Collection. Most (n = 63) are not fashioned from volcanic glass. Those artifacts within this assemblage are overwhelmingly chert. A few (n = 2) are fine grained volcanic and fortunately a significant complement were obsidian (50).

The metrics for both the obsidian and the non-obsidian toolstone, Tulare Lake Widestems are rather consistent and demonstrate that this form was one widely employed and was somewhat of a template for the prehistoric Tulare Lake Natives. The Borax Lake Widestem Points, although very similar in form to those discovered at Tulare Lake, were slightly larger. The Tulare Lake Widestems were about a third shorter than those from Borax Lake and they were also slightly narrower on average. We do not believe this was a function of differences in toolstone use – one being dominated by obsidian and the other with a significant complement of chert. The Tulare Lake Natives may have reworked their points to a greater degree in general. Otherwise, both forms were similar in manufacture in the objective to produce a roughly square stemmed dart point.

Obsidian studies appear to peg the Tulare Lake Widestem points to an average age of 8,250 calibrated years before present, or dating to the time span when Western Stemmed Points were popular (Lake Mohave Period, 7,000 to 11,000 calibrated years before present). Applying a single standard deviation added to that mean or average provides a time range for the bulk of the Tulare Lake Widestem assemblage from ca. 7,500 to 9,000 years ago.

Source determinations for Tulare Lake Widestems show that a brisk trade was taking place with imported obsidian coming from Fish Springs, Coso, Annadel and Casa Diablo obsidian sources. Significantly most of the obsidian Widestems at Tulare Lake came from the Casa Diablo suite of obsidian sources. The obsidian toolstone was a significant portion of the Widestem assemblage and this testifies to long range movement of obsidian and the value of this imported toolstone to the indigenous people who occupied Tulare Lake from about 7,500 to 9,000 years ago.

ENDNOTES

1. Annadel Hydration Rate

We were unable to confidently develop a source-specific, temperature-dependent hydration rate and apply it to the Annadel obsidian Tulare Lake Widestem points. We reviewed the existing literature and given the small sample from Tulare Lake we did not feel we could validly calculate a hydration dating equation with specific applicability to the assemblage of Widestem dart points from Tulare Lake as their numbers were so few and the data so minimal.

2. A Possible Obsidian Cache from Dudley Ridge (Tulare Lake)

While this report does not directly pertain to Tulare Lake Widestem Points, the authors acknowledge that obsidian caches found in the region are rare and worthy of note and discussion.

What may have once been an obsidian storage or cache pit containing three hunks of unworked obsidian material was unearthed by local collectors on the highest elevation of Dudley Ridge on the south side of Tulare Lake (once Tachi Yokuts territory). This obsidian material was likely intended to be recovered later by its owner/s for use or trade. The largest specimen was an unreduced piece weighing 23 pounds (10,160 grams). The other two pieces, 14 ounces (397 grams) and 17 ounces (485 grams) are of more common sizes of obsidian that Native American Indians (master explorers) transported via established trade routes. Thick knapped blanks of material were often reduced in size at the source and other locations along trade routes for later refinement into finished tools or weapons. Such rough-shaping of raw material removed cortex and other less desirable material for knapping finished products. It also reduced weight of the load enabling transporters to carry more of the higher quality stone for sale or exchange over impressive distances.

In North America, raw obsidian is generally only found in localized areas of the West, where the process of plate tectonics have created geologic conditions favorable to volcanism and the formation of obsidian (Bakken 1977). These obsidian specimens found at Tulare Lake were sourced by Northwest Research Obsidian Studies Laboratory as having originated from three different trans-Sierran source locations (Mono Glass Mountain, Queen and Buck Mountain - Modoc County, near the California/Oregon border). To reduce the load, the largest and heaviest specimen may have been transported by foot travel to Tulare Lake in a burden basket or a sack secured to the carrier's body. Such baskets may have been devised by Native carriers as a pack that could be strapped on the shoulders or back to lighten the load. The route of this large hunk of obsidian may have followed a southerly direction through Owens Valley on the eastern side of the Sierras, then north following the Kern River drainage to Tulare Lake. Water once flowed regularly into Tulare Lake via Kern River about seven or eight miles-from where the bulk materials were discovered.

Hopkins discussed the obsidian specimens with Craig Skinner. His comments follow:

> It's hard to know what to think about these three specimens, especially that 23 pound chunk of obsidian from Glass Mountain. Of the three items, I'd give the Queen piece the best chance of being authentic; that's a source that's not well known to modern flintnappers and is one that produces obsidian occasionally found west of the Sierras in good archaeological contexts.
>
> The 23 pound piece seems to be the least likely to be prehistoric seeing as the source is easily accessible from the highway and I've never seen bulk obsidian from Glass Mountain show up at archaeological sites very far south of the Medicine Lake area. It's possible that it may have been brought in much later by automobile; however the finders, who Hopkins find credible, strongly claim they found it together with the other obsidian specimens.
>
> *Hopkins enlightens us by pointing out that automobile transport of heavy amounts of raw obsidian, like this specimen, could have occurred during historic times after the Mission Period ended, acknowledged during times when groups of Tache Yokuts Indians returned to their native homelands seeking their former way of life.*
> *Eventually, Natives were removed from the region, influenced by pressure from an influx of trappers and farmers moving into the region. The Native Indians were forced to live on rancheros and reservations or adapt to lifestyles of the whites, working for them on cattle ranches or tending agricultural crops.*
>
> It's hard to tell about the visually quite distinctive Buck Mountain sample; though every once in a while I run across it in what appears to be good archaeological context in southern California - although it's rare. Of all the northeastern California sources, it's the one that is consistently found the farthest from the source area.

Travel routes to Tulare Lake were also discussed with Dr. Gerrit Fenenga, who is well versed on California Indian trade routes and networks:

> Dr. Fenenga was of the opinion that a westerly route from the eastern side of the Sierras was highly unlikely given the rugged topography transporters would have had to deal with during travel. It would simply have been too demanding to carry the 23 pound specimen on foot. He agrees with us that our suggested route along the eastern side of the Sierras would have been more likely.

Hopkins reports that he is not aware of any other raw obsidian or preform caches discovered in the Tulare Lake region. However, finished and broken obsidian artifacts (projectile points, crescents and other tool forms) have been found at Tulare Lake by local collectors in considerable numbers. Several of these items, originating in California and the Great Basin, were chemically characterized to source and subjected to hydration analysis (cf Garfinkel, et al. 2008).

The archaeological record affirms that Tachi Yokuts Indian tribes generally had control over lands from south and west of Tulare Lake, north to the Diablo Range (east of the San Francisco bay area) and traveled numerous trade routes throughout the state gathering materials within their networks for barter or sale, both in route and at their final destinations.

Tachi trading customs and accounts were discussed by the late Frank Latta, a natural born ethnographer/self-taught archaeologist from Kern County and Kahn-te the oldest Tache chief he interviewed. This Tachi chief was in charge of early trading activities at “Udjiu” (better known as Poso Chane village), a trading center located near the confluence of Jacilitos, Las Gatos and Warthen Creeks east of Coalinga. Annual trade events were conducted at this village with coastal Indians that periodically brought seashells and shell beads (clam, *Olivella* and abalone (*Haliotis*), salt, salt grass and various seed foods). According to Kahn-te, coastal Indians came mostly for obsidian and soapstone beads in trade for their possessions (Latta 1977:728-9).

A fourth sample of obsidian was recently discovered and can now be included with the possible cache from Dudley Ridge. It was found by Hopkins in the same area as the original three samples discussed earlier. A fragment of material was removed from the sample and sent to Northwest Research Obsidian Studies Laboratory for XRF sourcing. Craig Skinner concluded:

> It originated from Glass Buttes (Glass Buttes, Variety 3) in Oregon. The sample I received was of transparent glass or a mottled mahogany. The initial piece contained a cortex of mahogany obsidian.

Given the large size of the original sample and the distance to the source, Skinner was very suspicious that it was a historical introduction and not a prehistoric one. The Oregon source area is very well known and accounts for a disproportionately large number of anomalous obsidian samples in the western U.S.

> *With respect to discoveries of Yokuts artifacts, clearly manufactured during historical periods and found mixed with prehistoric artifacts in the same areas in the Tulare Lake region supports the author’s suspicions that raw material and finished artifacts may have been brought in during historic periods, i.e., see A Yokuts Indian Digging Stick from the “Stick in the Mud Site,” Chapter 3 of this volume.*

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Figure 1.1 Raw Material Selection - Tulare Lake Widestem Points (Ca-Kin-32)

Lithic Material	Percent	*n* =
Cryptocrystalline Silicates (CCS)	59%	60
Fine Grained Volcanics (FGV)	5%	5
Obsidian (OBS)	36%	36
Total	100%	101

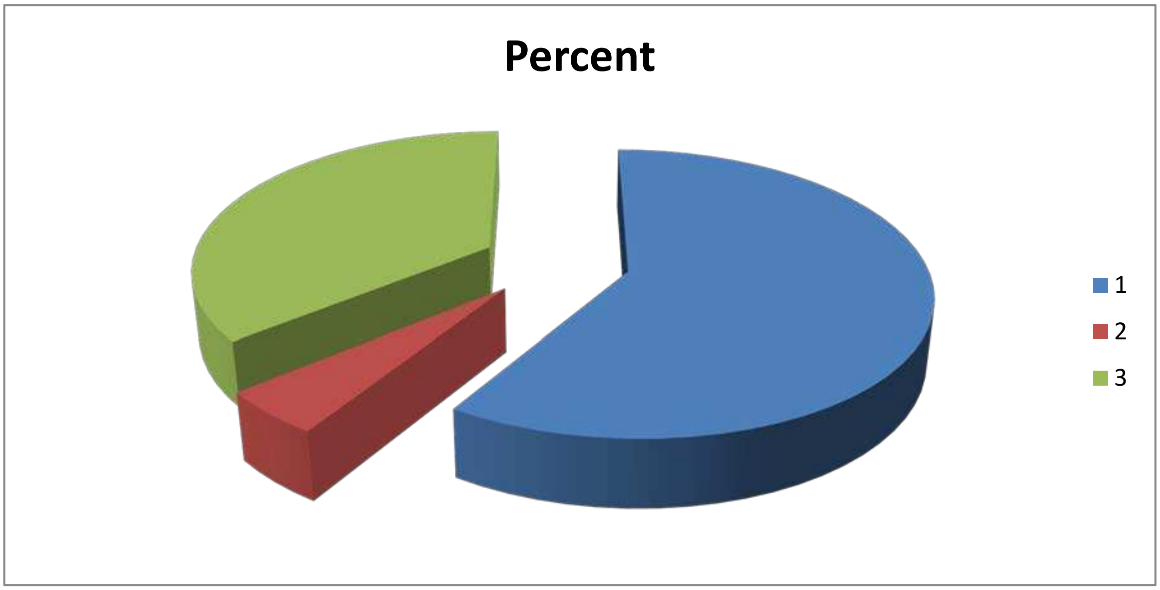

Figure 1.2 (obs) Widestem Points. (Top-bottom/left-right) DRL2JH5, DRL2JH6, DRL4JH20, DRL2JH9, DRL3JH36, DRL3JH39, DRL4JH38, DRL4JH21.
(Image 8961)

Figure 1.3. (obs) Widestem Points. (Top-bottom/left-right) DRL4JH24, DRL2JH26, DRL2JH27, DRL4JH19, DRL4JH31, DRL4JH30, DRL3JH35, DRL4JH16, DRL4JH18.
(Image 8962)

Figure 1.4 (obs) Widestem Points. (Top-bottom/left-right) DRL4JH15, DRL4JH13, DRL2JH8, DRL2JH4, DRL2JH11, DRL4JH14, DRL2JH12, DRL2JH29, DRL2JH27. (Image 8963)

Figure 1.5 (obs) Widestem Points. (Top-bottom/left-right) DRL3JH34, DRL2JH23, DRL4JH37,DRL2JH3, DRL2JH2, DRL8JH32, DRL4JH17, DRL4JH22, DRL2JH33, DRL1W6164. (Image 8964)

Figure 1.6 (ccs, obs, fgv) Widestem Points. (Top-bottom/left-right) DL2JH45, DL2JH48, DL2JH51, DL2JH46, DL2JH47, DL2JH40, DL2JH41, DL2JH42, DL2JH43, DL2JH44 (Image 8967)

Figure 1.7 (ccs) Widestem Points. (Top-bottom/left-right) DL5JH65, DL3JH56, DL3JH57, DL3JH58, DL3JH59, DL4JH61, DL4JH62, DL4JH63, DL5JH67, DL5JH66. (Image 8968)

Figure 1.8 (ccs, fgv) Widestem Points. (Top-bottom/left-right) DL7JH80, DL5JH81, DL5JH82, DL5JH83, DL6JH84, DL5JH75, DL5JH76, DL5JH77, DL5JH78, DL5JH79.
(Image 8970)

Figure 1.9 (ccs, fgv) Widestem Points. (Top-bottom/left-right) DL3JH87, DL3JH101, DL5JH89, DL5JH97, DL3JH102, DL5JH92, DL5JH95, DL5JH93, DL5JH94, DL7JH99.
(Image 8971)

Figure 1.10 (ccs) Widestem Points. (Top-bottom/left-right) DL2JH54, DL4JH60, DL4JH64, DL9JH74, DL7JH73, DL7JH72, DL2JH53, DL2JH52, DL2JH49. DL3JH55, DL2JH50, DL5JH70, DL5JH68, DL5JH69, DL6JH71. (Image 8969)

Figure 1.11 (ccs, fgv) Widestem Points. (Top-bottom/left-right) DL3JH100, DL5JH88, DL3JH91, DL7JH104, DL6JH90, DL5JH86, DL4JH96, DL7JH98, DL5JH85, DL5JH103. (Image 8972)

CALIFORNIA and WESTERN NEVADA OBSIDIAN SOURCE LOCATIONS

Chapter 2

THE *LIMACE* SHAPED UNIFACE SCRAPER: A FLAKED STONE TOOL-FORM FROM TULARE LAKE, CALIFORNIA

Jerry N. Hopkins

Abstract: *Stone artifacts are a significant and often the only available record of prehistoric hunter-fisher-gatherers. One such artifact form, the* limace*, weighs heavily in local collections from Tulare Lake. This type of ancient unifacial stone tool, thought to be of Paleoindian age, occurs in surface sites within the boundaries of the Witt Archaeological Locality (CA-KIN-32). These tools, part of a remarkable early assemblage from the region, represent a treasure trove of superbly crafted artifacts. This manuscript focuses on* limaces *in the Hopkins Collection, recovered over a 30 year time-span from erosional shoreline exposures. Before later stages of transgression, Tulare Lake's shorelines at the 190-195 foot contour, where these artifacts were collected were bounded by wide-shallow marshes. Accompanying data, resulting from surface archaeology of the Witt Locality, provides a critical supplement to our understanding of late Pleistocene and early Holocene settlement patterns and paleolandscape utilization in the Tulare Lake basin.*

INTRODUCTION

Limaces (Figures 2.1 and 2.2) discussed within this paper were recovered from prehistoric shorelines of Tulare Lake. To my knowledge, *limaces* have not been found in non-Paleo Tulare Lake sites. They are but one class of the scraper family found in the region and other Paleo sites, continent wide from Alaska to southern Florida. This type of tool-form is thought to be rooted in the Old World Paleolithic period. They were believed to be projectile points or convergent scrapers. French prehistorians first used the word *limace,* which translates to "(garden) slug" or "snail", to morphologically classify this implement. Old World *limaces* were made on blades, whereas most similar tools from American Paleoindian assemblages were produced on flakes (bifacial and cores). At Tulare Lake, some examples were clearly made on blades and some were not (personal communication with Gerrit Fenenga 2012). Tulare Lake artifacts exhibiting blade technology such as Clovis (prismatic blades) occur on common shorelines (Hopkins 2008:34, Figure 47; 2009:4). Such tools are unknown in the region after early Paleoindian periods. Examples are generally bi-pointed, but the "working end" often exhibits variation depending on its intended use, breakage, resharpening, etc. and similar to "classic" European tool-forms.

Gramly, described the *limace* as a narrow, slug-shape, unifacial, flaked stone tool having steep edge angles and a high dorsal surface that is often rounded. They are a rare form, but present in most large-sized Folsom, Clovis and other fluted point Paleoindian assemblages; its presence in later Paleoindian phases needs clarification (Gramly 1992:37).

Three examples of *limaces* were illustrated by Valerie Waldorf (Gramly 1992): Vail Site, Maine; Potts fluted point site, New York and the Ledford site, Kentucky – where a variety of *limaces* or awls were discovered that were made on prismatic blades. Other researchers surmise that these tools were used as chisels on hard substances which caused breakage and required frequent resharpening (Grimes and Grimes 1985); (Hopkins 2008:26:29).

A full complement of similar tools was discovered at Tulare Lake, resulting from extensive collection of surface artifacts by opportunistic collectors (Hopkins 2008:1:58). The existence and examination of such collections prompted Michael Sampson to publish a report on 39 (*n*=39) specimens from the Hopkins Collection and 17 (*n*=17) more from the Van den Enden Collection, all found within boundaries of the same locality. These distinctive tools from Tulare Lake (first referred to as "humpies" by Van den Enden, followed by other local collectors) were described by Sampson:

They are oblong-shape, plano-convex in cross-section and exhibit pointed ends…On most specimens the ends are acutely finished, though on some, they are more rounded…Dorsal surfaces are mostly abruptly angled resulting from multiple episodes of unifacial retouch…Some of the tools show minimal retouch and thus have thinner bodies (or lower "humps")…Many examples exhibit minimal pressure flaking at one end of the ventral or bulbar surface (perhaps performed to remove the bulb of force)…All humpies have flat ventral surfaces and this, obviously, was an important attribute (Sampson 1991:53, Figures 1 and 2).

Limaces from the Witt Locality that has produced Clovis-like points and other early artifact forms were described and illustrated over 40 years ago by Riddell and Olsen (1969:126-127, Fig. 3 a-k). It was suggested that they may have been part of an early assemblage; indeed they might be used as an important time marker for it (Sampson 1991:53). Both bi-pointed specimens, more akin to classic European Paleolithic examples, are found with fan shape end-scrapers sometimes triangular in cross section and chisel-bit tool types that show hard use damage to distal ends. In this study, all of these types are grouped under a single descriptive label (*limace)*. The quantity of *limaces* included in this sample, all from the Witt Locality, is 180 (*n*=180*)* (see Table 1). The scope of the current sample substantially expands Sampson's study and supports a revisit to this unique tool-form. One hundred thirty-eight specimens (*n*=138 or 77 percent) are complete or nearly complete.

DISCUSSION AND OBSERVATIONS

Most of what is presently known about Paleoindian periods at Tulare Lake (14,000 - 8,000 BP), must be inferred from sparse surface recoveries of lithic artifacts since datable contexts so far have not been found. With rare exceptions, stone tools are the only artifacts that have survived in the region. Perhaps they, like some other tool-forms collected, are objects that belong to later Archaic periods (10,000 - 5,500 BP) and are not as old as we originally thought. Nonetheless, the author suggests that settlement and subsistence systems in place at the beginning of the early archaic period were most likely similar to that of the late Paleoindian period. The greater diversity of tool types present in early assemblages probably existed because of activities associated with a gradually mixed foraging economy and exploitation of a wide range of local resources that continued well into archaic periods.

Descriptive Classifications

In attempts to determine their function, the *limace* tool-form has been accorded many different designations, subjecting the artifact to a plethora of terminology. They have been identified as "slug scrapers" Beck and Jones 2009:127); Davis and Panlaqui 1978); "boats" and "Hendrix scrapers" (Faught 1992), Purdy 1986:18-20), (Warren 1973:119); "awls" (Funk 1976), (MacDonald 1968); "*limaces"* (Gramly 1982:43, 1992:37); "flakeshavers" (Grimes and Grimes 1985:40-41); "keeled tools" (Haury *et al.*); "unifacially flaked drills" (McCary 1984:279); "humpies" (van den Enden, nd), (Hopkins 2009), (Sampson 1991:53); "sidescrapers" (Witthoft 1952); "turtleback scrapers" (anonymous) and a host of other unrelated names.

Geographic Distribution

Limaces and similar tools have been recovered from several Paleoindian sites throughout the continent – Sunshine Well Locality, Nevada (Beck and Jones 2009); Bull Brook, Massachusetts (Byers 1954); China Lake, California (Davis and Panlaqui 1978); J and J Hunt Submerged Archaeological Site, Florida (Faught 2004), (Purdy 1986), (To'bon and Pendleton 2002); Vaile, Maine (Gramly 1982); Atkins, Maine (Gramly 1988a); Ledford, Kentucky (Gramly 1992); Potts, New York (Gramly and Lothrop 1984); Lehner, Arizona (Haury *et al.* 1959); Tulare Lake, California (Hopkins 2008), (Sampson 1991) and Shoop, Pennsylvania (Witthoft 1952).

Ten tools (side notched unifacial beveled chisel plane-carinate scrapers and a snub-nosed end scraper) were unearthed at a construction site in St. Petersburg, Florida in 1964. One of the tools, judging from the figures and descriptions presented, closely resembles *limaces* found at Tulare Lake. Warren described the artifact in his Figures 3, 4 and 6:

Figure 3 illustrates a longitudinal crest, ridge or keel running almost the length of the tool. Instead of a convexity, a keel is present, formed by the junction of the two lateral faces at the peak, so that in cross section this object would have the outline of a nearly equilateral triangle. It is reminiscent of the modern wood worker's "parting tool" (Warren 1973:119).

What resembles a *limace* (identified as a Hendrix scraper) was recovered in 1989 during an underwater project by Florida State University, a site which produced Suwannee concave base points and Bolen notched points. This underwater location has yielded diagnostic artifacts that date from the late Paleoindian to middle archaic times. The site (8JE740) represents an early archaic occupation, probably older than 7,500 BP (Faught 1992).

Raw Material – Selection and Heat Treatment

Raw material preferences for *limaces* (*n*=180) in the Tulare Lake sample consist of cryptocrystalline silicates (ccs) - 92 percent (Figures 2.3 – 2.6) and fine-grained volcanic materials (fgv) 8 percent) (Figure 2.7). Raw material selection compares favorably to the Sunshine Locality in eastern Nevada, the second largest occurrence of *limaces* reported in the West (*n*=60), at 93 percent (ccs) and 7 percent (fgv). As statistically reported in this manuscript, neither of the two comparative regions used obsidian for *limace* tool-forms.

Apparently, obsidian was not selected for *limaces* since, none to my knowledge, have turned up in the Tulare Lake region. Several hundred specimens were also collected in the Sunshine Locality in Long Valley, Nevada (Beck and Jones 2009). However, I suspect that *Limaces* and other tool-forms made from locally, abundant obsidian may occur in eastern California, northern Nevada and southern Oregon.

A likely source for high-quality (ccs) material (mostly cobbles) used for *limaces* and other Paleoindian artifacts found at Tulare Lake is the nearby Jacilitos drainage. Following are comments from researchers familiar with this region:

A large, rich prehistoric site (Dillon Site – Temporary Number: COALARG 97) is situated on a stream terrace along the north bank of Jacilitos Creek (Betts and Foster 2001:323). It was suggested (Wallace 1998:3-4) that a likely source for the lithic materials used to manufacture fluted points, crescents and "humpies" found at nearby Tulare Lake may have been in the Coalinga area (Betts and Foster 2001:5).

A preference for high-quality lithic materials is apparent from the debitage collected from the early sites near Dudley Ridge. Varicolored cherts were most often selected. The stones are available at no great distance from the lake's western shorelines. Jacalitos Creek south of Coalinga and close to the northwestern shoreline of Tulare Lake is a suspected source of much of the raw material (Hopkins 1991:36). Another likely source of material is the hilly country surrounding Coalinga. Here good-quality chert, chalcedony and petrified wood were obtainable (Fowkes 1982); (Wallace 1998:3-4):

> Materials from which the Tulare Lake lanceolate projectile points were made are predominantly cherts and jaspers. They closely resemble materials from the Jacalitos Creek drainage 15 miles (24 km) southwest of Coalinga. Ancient inhabitants of the Tulare Lake shorelines may have obtained their raw stone in this drainage, which is within a two day walk from Tulare Lake. The lustrous nature of the finished points suggests that heat treatment of raw material to enhance flaking qualities was performed (Rick and Chappell 1983); (Wilke 1991:41). A number of the Tulare Lake (ccs) specimens display evidence (lustrous mottled colors) of thermal alteration of the toolstone used for production. Numerous studies have demonstrated that a controlled exposure to heat appreciably improves the flaking quality of cherts (Crabtree and Butler 1964); (Mandeville and Flenniken 1974:147); (Rick 1978:62); (Sampson 1991:53).

On May 30, 2009, the author led a field trip to Jacilitos Canyon in an attempt to locate and conduct archaeological investigations at the Deford Quary Site (COALARG 26) and the nearby Dillon subsite (COALARG 27), both situated on Jacilitos Creek. The Deford Site is a very large multicomponent site situated on a barren stream terrace adjacent to Jacalitos Creek. The prehistoric component can be described as an occupation site, lithic work shop and quarry consisting of an enormous, rich lithic scatter that includes thousands of chert, jasper, chalcedony and agate flakes, cores and angular chunks of tool stone. A supply of naturally occurring chert of various colors is available in the creek (Betts and Foster 2001:15-16).

In attendance were Gerrit Fenenga, Jeff Rosenthal, Mike Rondeau, Don McGeein, Gary Breschini and Trudy Haversat. Unfortunately, as a result of locked gates on the private land leading to the sites and the rugged mountain terrain, we failed to reach our destination. However, we encountered several adjacent outcrops (slabs) of Franciscan chert and serpentine. We also observed a great deal of chert chipping debris, both workshop and residential related activity and imperfect projectile points. No doubt, most of the materials (ccs), fossil wood and (fgv) used for Paleo artifacts occurring at Tulare Lake could have been easily obtained in and around the Jacilitos drainage.

Statistical Comparisons

Measurements were recorded on the Tulare Lake examples including maximum length, width, thickness, edge angle and weight (Table 1). Within this manuscript, these measurements were compared to the assemblage from the Sunshine Locality in Nevada. Tulare Lake specimens range in length from 28.81 - 85.46 mm ($\bar{x}$=46.51 mm); widths vary between 9.11 - 29.52 mm ($\bar{x}$=17.08 mm); thickness measurements provide metrics from 4.02 - 20.26 mm ($\bar{x}$=10.13 mm); edge angles are from 33º - 81º ($\bar{x}$=59º); and weight is 2.84 - 25.52 g ($\bar{x}$=7.79 g). Remarkably, Tulare Lake measurements are comparable to the slug scrapers from the Sunshine Locality (reported by Beck and Jones 2009:125-126, Tables 5.67 and 5.69). Lengths range from 16.1 - 82.0 mm ($\bar{x}$=47.74); width from 8.1 - 29.2 mm ($\bar{x}$=17.34); thickness from 3.8 - 20.7 mm ($\bar{x}$=9.55 mm); edge angles range from 51º - 90º ($\bar{x}$=not reported); and weight 1.7 - 27.5 g ($\bar{x}$=8.34 g).

While size, form and technological aspects of manufacturing appear to be about the same from both localities, "slug scrapers" from Sunshine have steeper edge angles, 78.6 percent having angles greater than 70º (Beck and Jones 2009:127: Table 5.69). This compares with a range of 33º - 81º ($\bar{x}$=59º) for Tulare Lake. This difference is excessive and may signal a sampling error. It's unclear where angle measurements were taken on the Sunshine specimens. Cutting angles occur on both sides of *limaces* as well as tool ends. Angle measurements of specimens may not have been taken from identical locations. If they were, Tulare Lake scrapers were not employed as exhaustively as those from the Sunshine Locality. Distal end angles were even less steep ($\bar{x}$=41º), implying that the Tulare Lake tools may have been used for something other than shaving or trimming materials, perhaps functioning as chisels or gouging instruments.

Outline Morphology

Eighty-five (47%) of the Tulare Lake sample are bi-pointed, five are rounded on the distal end, 29 are rounding on proximal ends, three exhibit rounding on both ends and several are keeled (Table 2) (Figures 2.8 – 2.10). The rounded *limaces*, more than likely, were used for different tasks than the needle pointed ones. Some are "chisel-bit shaped" and suspected to have been struck with a hammerstone or mallet and used to cut or shape wood, bone or stone.

Ten specimens are combination scrapers with single graver spurs (Figure 1.11). Spurs were probably a technique of opportunity rather than design on expedient tools and used for working antler, wood and bone. Cortex is present on ten tools, probably representing unfinished or discarded tools, and remnants of striking platforms are present on three specimens.

Thirty-five *limaces* (19%) display bifacial retouch, occurring mostly on the ends. Some specimens show retouch on the flat ventral surfaces. This likely was produced in order to sharpen the tool ends or minimize crushing damage to margins of the tools.

Hafting Evidence

Proximal end thinning occurred on 15 Tulare Lake specimens. Keels of 74 specimens, usually running the length of the tool, were flattened roughly half their length, again, suggestive of hafting (Table 3, Figure 2.12). However, it should be pointed out that a trimmed or flattened keel is not necessarily absolute proof that such tools were hafted. Nevertheless, such treatment would certainly have enhanced a socketed hafting application. Or, particularly on the smaller tools, thinning may simply have been done to improve the user's grip during finger-held use of the tools. Several of the smaller *limaces* are bi-pointed with retouch flaking completely around the dorsal margin. This argues against hafting for the smallest examples.

Hafting attributes are reported in Table 3, suggesting that 74 (43%) of the Tulare Lake sample were hafted. Forty *limaces* are broken approximately in half, indicative of hafting to the point where breaks occurred (Figure 2.13). Forty (n=40) Sunshine slug scrapers (90.1 percent) are believed to have been hafted (Beck and Jones 2009:130, Table 5.70).

Use-Wear Analysis

Microscopic use-wear determinations were not attempted on the Tulare Lake sample. However, Sampson, in his examinations, reported that use-wear on the Tulare Lake specimens in his earlier study, best observed at 40x - 70x magnifications, is unlike that commonly associated with butchering tasks (Sampson 1982:69-72, 1991:56). Sampson concluded that the nature of use-wear on the margins is consistent with that noted on ethnographic light-duty wood and bone-working tools (Sampson 1991:58). Of the 59 Sunshine Locality slug scrapers, all exhibit use-wear, primarily in the form of crushing alone (Beck and Jones 2009:127).

Chronological Implications

Limaces clearly formed part of the assemblages from several of the well-documented Paleoindian sites elsewhere in North America (listed above). Lacking well-stratified contexts at Tulare Lake typological cross-dating, though not of absolute age, has become the primary means for assessing chronological interpretations of Tulare Lake artifacts (Hopkins 2009).

As mentioned earlier, *limaces* made of obsidian have not been reported in the Tulare Lake region. However, the author obtained an obsidian *limace* (Figure 2.14 and 2.15) found near Bridgeport, California, morphologically nearly identical to many of the Tulare Lake examples. This specimen was geochemically sourced as originating from Cougar Butte – Medicine Lake Highlands in Siskiyou County, California and produced a hydration rim measurement of 5.9 microns.

According to Craig Skinner of Northwest Research Obsidian Studies Lab (personal communication with Skinner 2011):

> *There has been no attempt to work out anything in the way of chronologic hydration information for the Cougar Butte source…It wasn't one of the major prehistoric sources and there are only 161 artifacts with hydration rim measurements from that source in the Northwest Research Obsidian Studies Lab database...The range of rim measurements for (n=) artifacts with hydration rim measurements from that source is from 0.9 to 10.5 microns and the measurements are pretty evenly distributed throughout this extensive range…Medium value is about 3.8 micron…Unfortunately, this doesn't give us much to go on.*

Another specimen that I am aware of (personal communication with Gerrit Fenenga 2009) was chemically characterized to the source at Buck Mountain in Modoc County. This specimen has not been dated.

Two obsidian *limaces* (Figure 2.14 – 2.15) from the Borden Site in Rose Spring Valley north of Little Lake in the Mohave Desert (Borden 1971), given its proximity to the Coso obsidian sources, aboriginal flintknappers crafted two such tools from native stone quarried nearby (personal communication with Alan Gold 2009). Trace element analysis confirms that these two artifacts were manufactured from material acquired at West Sugarloaf (Specimen Number 15) and West Cactus Peak (Specimen Number 16). Both subsources are from the Coso Volcanic Fields. These specimens are severely sandblasted and cruder than the well-crafted specimens from Tulare Lake. However, their typological and morphological attribution to the *limace* is apparent.

One specimen has an obsidian hydration rim reading of 16.3 microns and the other a measurement of 15.3 microns. Based on our recent obsidian work (Garfinkel et al. 2008), we attempted to develop a means to date ancient Coso artifacts with large obsidian hydration measurements in excess of 10 microns. We developed the following source-specific, temperature-adjusted and hydration dating equation:

$$Y = 7{,}700 + 543(x-10.0),$$

Where Y is the age in calendar years (calibrated radiocarbon age) before present (present = AD 1,950) and X is the hydration measurement in microns.

Hence, a rim reading of 15.3 microns would provide an age of 10,578 and the larger 16.3 micron rim would equate with a calendar age (calibrated radiocarbon date) of 11,121 (personal communication with Alan Gold 2009). Hydration rims of this size tend to be rather variable and we would consider both age determinations are best estimates and would give them sigmas (error ranges) in the plus or minus 1,500 year category. In view of the time range represented by both estimates and the accompanying error range, this would suggest a time range from about 9,000 to 12,600 years cal BP, close to where we expected Tulare Lake limaces to fall. To our knowledge, these are the only source-specific obsidian hydration readings that exist on limaces from California with exception of the Bridgeport specimen (above).

CONCLUDING REMARKS

The magnitude of the present sample along with other known large *limace* collections from Tulare Lake examined by the author, suggests that additional worthy data on a local level for this tool-form may be available to researchers. Local regional collectors are encouraged to make their assemblages available for scientific study. Such data is necessary before we can fully resolve the significance and functions of this widespread implement.

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Table 1 Raw Material Selection and Metric Measurements

I.D. Number	Raw Material	Maximum Length (mm)	Maximum Width (mm)	Maximum Thickness (mm)	Maximum Edge Angle (∠ ~)	Weight (g)
DR1	ccs-tan/black	36.88	17.98	14.73	62	11.34
DR2	ccs-black/blue	41.48	18.21	12.44	66	5.67
DR3	ccs-blue/gray	59.00	24.60	20.26	42	25.52
DR4	ccs-black	52.47	20.81	9.32	65	11.34
DR5	ccs-tan/yellow	28.81	14.26	9.53	63	2.84
DR6	ccs-tan	48.01	17.82	9.35	49	5.67
DR7	ccs-brown/black	47.48	19.35	12.10	46	14.18
DR8	ccs-brown	51.46	15.94	10.42	56	5.67
DL21	ccs-green/brown	39.90	20.82	15.80	58	14.18
DL22	fgv-green	51.99	17.62	9.42	50	8.51
DL23	ccs-black	49.85	15.87	12.33	49	5.67
DL24	ccs-green	47.06	19.97	13.83	63	8.51
DL25	ccs-black/brown	42.89	15.66	7.61	49	5.67
DL26	ccs-black/tan		13.81	8.32	48	
DL27	ccs-green	49.81	24.25	11.50	59	17.01
DL28	ccs-black	31.78	15.91	8.33	48	2.84
HM1	ccs-black/tan	48.17	15.59	7.97	66	5.67
HM2	ccs-brown/black	53.03	15.62	9.44	44	5.67
HM3	fgv-black	45.36	18.33	5.81	46	5.67
HM4	ccs-black/brown	47.40	16.23	7.74	44	2.84
HM5	ccs-black/blue	46.72	22.28	8.25	60	2.84
HM6	ccs-brown/black	49.42	13.91	9.35	74	5.67
HM7	ccs-brown	44.49	14.74	11.76	66	8.51
HM8	ccs-blue	40.65	14.96	10.73	63	2.84
HM9	ccs-gray	48.53	15.50	9.04	57	2.84
HM10	fgv-black	59.01	12.23	12.52	63	17.01
HM11	ccs-tan	50.98	13.54	10.02	67	2.84
HM12	ccs-blue	47.75	15.86	14.60	41	11.34
HM13	ccs-brown	39.64	12.51	9.20	81	5.67
HM14	ccs-brown	36.81	14.93	7.84	77	8.51
HM15	ccs-gray/green	35.15	13.26	7.88	63	2.84
HM16	ccs-green	38.04	12.99	10.01	57	2.84
HM17	ccs-green/tan	49.20	16.39	11.99	64	11.34
HM18	ccs-caramel		14.66	10.47	73	
DL31	ccs-brown	67.26	18.15	13.14	73	17.01
DL32	ccs-black/brown		13.53	9.70		
DL33	ccs-green	48.43	13.73	9.48	55	2.84
DL34	ccs-green/tan	37.78	14.38	8.32	66	2.84
DL35	ccs-brown	44.23	16.27	7.55	55	5.67
DL36	ccs-brown	43.62	19.61	7.67		5.67
KC1	ccs-crème/gray	49.74	22.84	18.01	70	25.52

KC2	ccs-brown	32.48	18.77	12.67	53	5.67
KC3	ccs-green	33.45	15.27	16.01	77	5.67
KC7	ccs-tan	44.64	14.98	7.34	62	5.67
KC8	ccs-tan/gray	43.93	20.61	10.73	54	11.34
KC9	ccs-brown		16.74	9.96	62	
CR2	ccs-brown/green	43.90	15.71	10.95	63	2.84
CR3	ccs-blue/green	47.40	15.75	8.69	52	5.67
CR4	fgv-black	43.12	15.90	8.93	53	5.67
CR5	ccs-tan	59.20	21.06	7.67	55	11.34
CR6	fgv-black	57.36	16.30	8.89	58	8.51
CR7	ccs-brown	54.32	18.98	12.41	60	14.18
CR8	ccs-caramel	46.01	16.56	7.89	53	8.51
CR9	fgv-black	37.86	12.01	4.02	64	2.84
CR10	ccs-brown	39.92	16.20	11.89	45	2.84
CR11	ccs-brown	49.54	16.94	11.23	63	8.51
CR12	ccs-brown	44.81	12.27	10.32	78	8.51
CR13	ccs-green	34.63	12.18	9.77	61	5.67
CR14	ccs-blue/tan	44.15	16.40	10.81	68	11.34
CR15	ccs-green	38.99	12.85	5.72	43	2.84
CR16	ccs-green	63.34	16.08	12.95	66	14.18
CR17	ccs/red/black	48.01	20.49	16.59	65	14.18
CR18	ccs-tan/gray	44.05	12.51	7.86	66	2.84
CR19	fgv-black	38.71	15.40	8.21	38	2.84
CR20	ccs-green	40.02	14.06	11.05	68	8.51
CR21	fgv-black	40.11	12.71	6.71	48	5.67
CR22	fgv-green	56.82	16.65	8.65	64	8.51
CR23	ccs-brown	42.66	16.61	8.98	68	2.84
CR26	ccs-brown	46.58	20.28	8.70	53	5.67
CR27	ccs-green/yellow	46.75	20.11	11.02	55	5.67
CR29	ccs-green	33.55	11.40	5.95	62	2.84
CR30	ccs-black/green	49.16	19.36	8.61	33	2.84
CR31	ccs-black/gray	42.86	15.72	8.76	53	5.67
CR32	ccs-brown	51.72	19.05	10.27	69	11.34
CR34	ccs-grown	52.35	18.54	12.44		11.34
CR39	ccs-green		20.02	10.26	67	
DL51	ccs-green	46.77	13.73	12.32	74	5.67
DL52	ccs-green	80.66	19.55	7.39	65	17.01
DL53	ccs-brown	85.46	25.36	9.32	65	22.68
DL84A	ccs-black		20.62	12.02	55	
DL86	ccs-brown	35.09	12.28	5.12	58	2.84
DL513	ccs-black/brown		14.80	8.93	56	
VDE1	ccs-black	47.17	21.45	11.25	68	11.34
VDE2	ccs-gray	42.83	13.56	6.40	55	2.84
VDE3	ccs-brown/black	33.76	12.42	8.24	73	2.84
VDE4	ccs-black/brown	38.91	13.21	7.77	57	2.84
VDE5	ccs-white	43.89	15.31	6.91	50	2.84
VDE6	ccs-brown	32.93	13.34	6.77	62	2.84

VDE8	ccs-red/gray	56.90	20.57	14.87	67	19.85
DL68	ccs-black	59.65	18.67	14.22	61	11.34
DL69	ccs-green	53.08	17.72	11.09	48	11.33
DL6JM	fgv-black	50.86	17.01	11.35	52	5.67
DL70	fgv-gray	53.04	18.16	8.89	62	8.51
DL71	ccs-green	47.88	17.08	8.42	66	5.67
DL78	ccs-brown	38.03	15.56	7.05	60	2.84
DL79	ccs-black/brown	42.52	12.38	8.54	70	2.84
DL8JM	ccs-brown/green	41.15	14.27	7.48	52	2.84
DL81	ccs-green		18.67	10.68	66	
DL82	fgv-black	51.50	20.60	9.33	70	2.84
DL83	ccs-black/brown	55.95	20.70	9.33	66	8.51
DL83A	ccs-tan	48.42	15.59	6.81	51	8.51
DL84	ccs-gray	57.40	26.97	11.47	45	14.18
DL84A	ccs-black		20.63	12.02	55	
DL85	ccs-black/brown	51.39	25.77	17.54	76	22.68
DL85A	ccs-black		18.82	10.16	52	
DL87	ccs-gray	39.70	15.56	6.64	65	2.84
DL88	ccs-caramel		15.29	9.53		
SC1	ccs-green/tan	44.36	14.89	9.56	60	8.51
SC2	ccs-brown/black	54.47	17.33	11.39	64	5.67
SC3	ccs-green	47.18	18.71	9.19	71	8.51
SC4	ccs-black/green	47.45	16.31	8.00	50	5.67
SC5	ccs-green	40.51	9.11	12.85		5.67
SC6	ccs-blue/tan		19.57	13.79	59	
DL92	ccs-brown	47.46	16.64	8.16	57	2.84
DL93	ccs-blue/brown	43.48	14.62	9.01	60	5.67
DL94	ccs-black/brown	47.33	18.04	10.33	68	5.67
DL95	ccs-blue/gray	42.98	16.23	7.09	51	2.84
DL96	ccs-gray/green	50.89	19.23	15.26	62	11.34
DL97	ccs-gray/brown	53.74	17.74	10.43	34	5.67
DL910	ccs-yellow/green	44.32	21.13	9.03	53	5.67
DL911	ccs-black/blue	41.19	20.28	8.25	37	2.84
DL912	ccs-blue	39.43	20.08	9.36	56	2.84
DL913	ccs-brown		13.71	7.84		
DL914	ccs-gray/tan	49.84	10.74	11.32	64	5.67
DL915	ccs-black/green	47.03	16.57	10.27	45	2.84
DL916	ccs-brown	57.22	26.43	15.35	50	19.85
DL917	ccs-gray/green	56.12	23.55	15.74	34	25.52
DL918	ccs-gray	50.56	22.42	17.02	68	19.85
DL919	ccs-brown	41.77	23.11	13.94	55	14.18
DL920	ccs-green	53.21	20.55	11.51	68	11.37
DL921	ccs-brown/black	43.47	20.07	11.44	48	11.37
DL101	ccs-blue	42.31	17.00	14.64	53	5.67
DL102	ccs-brown/black	38.20	16.93	9.26	45	2.84
DL103	ccs-black	39.12	19.88	6.58	52	5.67
L1087-55	ccs-black	35.06	13.75	7.27	55	2.84

L1087-55A	ccs-yellow/green	44.76	13.68	8.96	67	5.67

Tulare Lake Raw Material Selection for *Limace* Uniface Scrapers - includes 43 not in above - (*n*=180)

Raw Material	Specimens	Percent
CCS	165	92%
OBS	0	0%
FGV	15	8%

Tulare Lake Summary

n=	123	137	137	130	123
±	85.5 - 28.8	27.0 - 9.1	20.3 - 4.0	81 - 33	25.5 - 2.8
x̄	46.51	17.08	10.13	59	7.79

Sunshine Locality (Long Valley, Nevada) Raw Material Selection for Slug Scrapers (*n*=60)

Raw Material	Specimens	Percent
CCS	56	93%
OBS	0	0%
FGR	4	7%

Sunshine Locality Summary

n=	29	44	54	56	55
±	82.0 - 16.1	29.2 - 8.1	20.7 - 3.8	90 - 51	27.5 - 1.7
x̄	47.74	17.34	9.35	unk	8.34

Bridgeport, California *Limace* Uniface Scraper

DM1	obs-black	59.39	19.6	13.34	57	14.18

Note:

CCS = cryptocrystalline silicates
OBS = obsidian
FGV = fine-grained volcanics

Table 2 **Morphological Characteristics - Tulare Lake *Limace* Sample (*n* =180)**

Bipointed	Rounded Distal End	Rounded Proximal End	Rounded Both Ends	w/Graver Spur	Cortex Present	Platform Present	Bifacial Retouch	Percent of Sample ~
85								47%
	5							3%
		29						16%
			3					2%
				10				6%
					10			6%
						3		2%
							35	19%

Table 3 **Hafting Attributes - *Limace* Uniface Scraper - Tulare Lake Sample (*n* =174)**

Bending Break	Proximal Thinning	Flattened Keel	No Hafting Evidence	Percent of Sample ~
40				23%
	15			9%
		74		42%
			45	26%

TABLE 5a TULARE LAKE WIDESTEM OBSIDIAN POINT AGE STATISTICS

N=	Source	Subsource	Mean Age, cyb2k
3	Coso	West Sugarloaf	8,253
6	Casa Diablo	Lookout Mountain	8,208
13	Casa Diablo	Sawmill Ridge	8,265
5	Fish Springs	n/a	8,255
2[1]	Annadel[2]	n/a	n/a
27	Aggregated Data		8,250[3]

[1] Specimens not used in study.
[2] Unable to confidently develop a source-specific, temperature-dependent hydration rate for Annadel obsidian (TLWS points).
[3] Obsidian studies appear to peg the Tulare Lake Widestem Points to an average age of 8,250 calibrated years before present, or dating to the time span when Western Stemmed Points were popular (Lake Mohave Period, 7,000 to 11,000 calibrated years before present). Applying a single standard deviation added to that mean or average provides a time range for the bulk of the Tulare Lake Widestem assemblage from ca. 7,500 to 9,000 years ago.

Chapter 3

A YOKUTS INDIAN DIGGING STICK FROM "THE STICK IN THE MUD SITE" TULARE LAKE, CALIFORNIA

Jerry N. Hopkins

Abstract: *This manuscript focuses on a wooden artifact recovered by the author in early 2009 at the Witt Archaeological Locality (CA-KIN-32). This region was frequented by a number of different occupations spanning a time frame from the terminal Pleistocene/early Holocene to late Historic periods and has yielded impressive numbers of Paleoindian projectile points and other lithic tool-forms from eroded shoreline surfaces. Tulare Lake's prehistoric shorelines were under water much of the time during historic periods resulting from heavy runoffs of snowmelt from the Sierra Nevada at times doubling the size of the lake.*

Groundstone artifacts (e.g., portable mortars, milling stones, shaft straighteners, charmstones and doughnut-shaped stones) and baked clay pottery shards were collected by the author within margins of the oldest sites, suggesting that subsequent dwellers reoccupied the Witt Locality and surrounding territory during later periods.

A wooden object found and identified by the author as an "aboriginal digging stick" was a common implement used in the region by lake culture Yokuts for food procurement and basket production (tule and other plant roots used as dietary supplements and sedge plants (Carex barbarae) for basketry material).

INTRODUCTION

Archaeological investigations in the Tulare Lake Basin have been ongoing since the formation of the Tulare Lake Archaeological Research Group (TULARG) by William Wallace and Francis Riddell back in late 1988. As a member of this group, my interest in the region focused mostly on prehistoric occupations that ensued during terminal Pleistocene/early Holocene times. However, while numerous time-sensitive Paleoindian artifacts have been collected, Native American Indian artifacts from more recent periods were also found resulting from routine field investigations.

DISCUSSION

Tribal Distribution of Yokuts Indians in the Tulare Lake Region

Conservative population estimates of Yokuts Indians living in the basin or visiting it seasonally during European contact was at least 19,000 individuals (Baumhoff 1963); (Cook 1955a); (Preston 1981:39). The principle Yokuts tribes living around the shorelines of Tulare Lake were the Wowol (1,300 – southern shoreline), Chunut (1,300 – eastern shoreline) and Tache (4,000 – extending from the northeastern shore to the Coast Range) (Preston 1981):

Sixteen tribelets inhabited the Tulare lake basin. Around the lakeshore lived the Wowol, Chunut and Tachi. Eastward, on the Kings and Kaweah deltas, were the Wimilchi, Nutunutu, Telamni, Wolasi and Choinok. The Aiticha and Koyeti controlled the adjoining stream plains and further eastward, in the foothill-delta zone, were the Wukchumni, Gawi and Yokod. The Chukamina, Yaudanchi, Bokninuwiad and Kumachisi lived predominantly in the foothills (Preston 1981:40-41).

Bubal, the main Wowol village was probably initially located on the western side of the lakeshore but was moved east (near present day Alpaugh) for better protection from Hispano harassment (Preston 1981:43). If this is correct, the digging stick artifact may have originated from the westernmost location, making it of Wowol manufacture.

Several researchers doubted the accuracy of this population distribution. In 1852 a special census listed the Tache population at 425, Chunut at 425 and Wowol at 550 (see Siefkin 1999:41). Siefkin suspects that the precontact Tache population ranked somewhere between 1,300 and 2,000 people. Cabot counted 1,000 Tache in 1814 (compared to l,700 each for the Chunut and Wowol), slightly higher than estimates generated for the Chunut and Wowol by Cook (1955a:43-44) (Siefkin 1999:41-42).

Tulare Lake Basin Flora

Regional swamps and inundated land were covered in most places by dense growths of marsh grasses and tules. Tule is the common bulrush of California, either (*Scirpus californicus* or *Scirpus tatura)* (Gifford and Schenck 1926:18). Shorelines did not always hold back the lake's rising water levels as flood waters periodically overflowed banks, creating shallow creeks and sloughs a half mile or more beyond the lake's shorelines. Thick stands of cattail (*Typha sp.*), rushes (*Juncus sp.*) and tules bordered these waterways. Tule growths, having a bulbous branching root system eight to ten-inches long and six to eight-inches in diameter, were commonly ten to twelve-feet high. Pollen, seed and tule roots were dug up (using digging sticks) and eaten by aboriginal Yokuts Indians and sedge (*Carex* spp.) roots were harvested for basket construction.

Local drainages to the Lake basin were once lined with riparian flora consisting of cottonwood (*Populus fremontii*), sycamore (*Platanus racemosa*), white alder (*Alnus rhombifolia*) and willow (*Salix spp*). Aside from this scattering of growth, surprisingly little timber grew in the Tulare lake basin.

Discovery Site

The discovery site of the digging stick artifact exposed during a routine field investigation by the author is located on the 190–195 foot contour of Tulare Lake's southern shoreline near Dudley Ridge. Ongoing investigations were conducted in this area and continue today. Upon arriving at this location in April 2009, I was both surprised to find and curious about a shallow irrigation ditch that was being dug that cut directly across a prehistoric shoreline of the lake. This fallow shoreline has seen little change over the past several years. Closer investigation revealed a wooden stick protruding from the bottom of the trench (Figures 3.1 and 3.2). The proximal end of the rod, exhibiting cut-marks, is tapered to a rounded tip on its distal end (Figures 3.3 and 3.4). The artifact identified as a Yokuts Indian digging stick reveals severe splitting extending over most of its length. Aside from this splitting, the stick is remarkably well-preserved.

To my knowledge, this is the only complete Native American artifact (made of wood) ever recovered from Tulare Lake's natural environment, implying that the probability for preservation of other wooden artifacts in the region is unlikely or minimal at best. The shoreline's sandy composition and marginal soil quality brought about by a lack of water and asphaltum waterproofing of the artifact likely enhanced preservation.

Gifford and Schenk (1926:109) reported that two articles of wood were recovered during their early investigations in the Tulare Lake region. One was a portion of an arrow shaft found in the orbit of a human skeleton and the other was a piece of yellow pine board with both ends stained red and each bordered by a black transverse streak on the inner side. It was suggested that it might have been a grave marker. Neither artifact was dated and was believed to be of recent age.

Also, Gerrit Fenenga found a notched piece of well-weathered wood within the area of the digging stick discovery which he identified as "a handle-like object" (personal communication 2009) and in late 2008, a hollow cattle horn (catalog DRL61) with a drilled suspension-hole (presumably a knife handle) was found by the author in the same area. Many horses and cattle were stolen by deserting coastal Mission Indians during late periods, driven to the west side of the Lake, hidden in thick tule thickets and slaughtered for food. The bone artifact is not highly mineralized like other prehistoric terrestrial remains occurring at the site and nearby shorelines and may have come from a rustled mission cow.

Nelson Siefkin (1995d 8(11):3-6) reported on Latta's (1930) undisturbed excavations (18) at the Alamo Solo Site (CA-KER-152) in northwestern Kern County, near the town of Devil's Den located in the Sunflower Valley. Nine burials were reported by Latta to contain associated burial goods. Of particular interest here is burial number nine. Among other articles, this burial included an asphaltum covered wooden "staff" with shell bead appliqué and a asphaltum mask with a *Haliotis* pendent appliqu´e covering the cranium suggesting that its owner may have been of high rank or stature. Dimensions of the "staff" were not reported nor was there mention of doughnut stones in Siefkin's manuscript discussing the excavations. The Alamo Solo assemblage seems to reflect an early to middle-Late period occupation (Siefkin 1995d 8(11):4).

During my initial survey, I flagged the discovery spot of the artifact (Figure 3.5) and sketched a dimensional profile of the discovery area. Measurements were recorded (*in situ)* from the modern surface level of the discovery location to each end of the stick. Measurements were about 80 cm. to the proximal end of the shaft and roughly 140 cm. to the distal end which was buried in the clay soil level. It is reasonable to conclude that the object was buried in the upper 80 cm. of the sandy soil and was displaced from that level when a portion of the water-logged eastern sidewall of the trench caved in, carrying the stick to the floor of the trench where it was found stuck in its muddy bottom. Consequently, the site was coined "The Stick in the Mud Site". It was concluded that if the stick was exposed by the heavy excavation equipment employed to dig the channel, it most likely would have been damaged or broken. There are no mechanical gouges or other surface damages to the stick associated with contact of the digging equipment.

Later in June 2009, Gerrit Fenenga and I revisited the discovery site. To our surprise, we discovered a distinct, thick layer that resembled charcoal weathering out of the east sidewall of the trench directly above where the proximal end of the shaft was positioned (Figures 3.5–3.8). We estimated that the charcoal-like layer occurs within the upper two strata which are 20 to 80 cm. thick. Yokuts campsites likely appeared at this shallow shoreline depth. Or, the charcoal layer may have resulted from a grass wildfire or possibly a modern-day sheepherder's fire pit. A soil sample of the layer was collected by the author and will be discussed later in the manuscript (see Concluding Remarks).

Site Stratigraphy

Several years earlier, Gerrit Fenenga, along with California State University Bakersfield (CSUB) field school students (under his guidance), initiated a test excavation program in the vicinity of where the stick was discovered (Fenenga 1993:25-38). These excavations, revealed three basic pedogenic units forming the upper several meters of soil in this particular loci of the Witt Locality. Fenenga reported:

> *The upper two strata contain cultural and macrofaunal material, while the lower unit does not and may be described as follows: The uppermost soil is a light gray (Munsell 10 YR 7/1) to light brownish gray (Munsell 10 YR 6/2), alkali-rich silt. It is homogeneous in appearance and varies from approximately 20 to 40 cm. in thickness.*
>
> *Underlying the upper horizon, is a lighter colored white (Munsell 2.5 YR 8/2) to pale yellow (Munsell 2.5 YR 8/4) to very pale brown (Munsell 10 YR 7/3) sandy soil. This layer contains numerous visible rodent intrusions (krotovina) that are not noticeably present in the upper soil unit. This middle or intermediate soil horizon also contains faunal materials and lithic artifacts, but generally in much lower frequencies. The middle soil horizon varies from approximately 20 to over 40 cm. in thickness.*
>
> *The deepest soil unit is distinctively different from the upper two. It consists of a light gray (Munsell 5 YR 7/2) clay-like, dense and homogeneous soil, although in places, marked by abundant iron stain casts. Based on our investigations in test pits and exposures excavated in the sides of nearby canals, this unit is entirely devoid of shellfish remains, mineralized bone or artifactural materials. The thickness of this "clay layer" is unknown. It is our opinion that this soil unit is culturally sterile (Fenenga 1993:29).*

DIGGING STICK ARTIFACT

Metric Attributes and Condition of the Artifact

The digging stick artifact measures 86.5 cm. long with a diameter of 2.0 cm. at its proximal end, tapering down to approximately 1.4 cm. at its distal end. The diameter at mid-length of the stick is 1.6 cm. It's important to note that present diameter dimensions are somewhat skewed since the stick, through weathering, had split several times and exhibits continuous separations running most of its length. These splits have caused diameter dimensions to measure slightly greater than they would have lacking deformation (see Figures 3.9 and 3.10). The specimen weighs 169 gr. and was identified by Tim Carpenter (Archeometrics Inc.) as having been manufactured from the wood of a willow tree (*Salix ssp).*

The distal (digging) end of the stick appears to have been purposely charred, presumably for fire-hardening the working end (Figure 3.11). A split on the proximal end contains a dark residue in its separations which smells like petroleum, resembling asphaultum (Figure 3.10). This sticky tar-like substance, likely from the nearby McKittrick Tar Seeps, was commonly used during late periods by Native American Indians for water-proofing and as an adhesive (for decorating objects, bolstering mechanical hafts and repairing broken equipment). Catalog No. TL2DRL2, a doughnut shaped stone in the author's collection (Table 3.1), also exhibits traces of asphaltum on sidewalls of its perforation and is suggested to have been used to secure a weight to the stick for improving its effectiveness as a digging implement.

Upon closer examination of the condition of the rod, another interesting discovery was made. A mark was noticed on the rod, slightly over half-way up from its distal end. It is suggested that the fabricator or owner of the stick marked the stick to indicate where the weight component should be placed and anchored (Figure 3.12 and 3.13).

Digging Stick Weights

Perforated stone weights are considered probable components of digging sticks by many researchers. Wallace (1991) wrote an account of doughnut stone weights in a TULARG newsletter. He reported:

> *Among prehistoric objects found from time to time around the shores of Tulare Lake are stone disks with a large hole, biconically-drilled, through the center. Because of their size and shape, they are often called "doughnut stones." Most often, they have been identified as digging stick weights fixed like a collar to the middle of the stick or slightly below to increase its effectiveness as a digging implement. The Tulare Lake Indians do not appear to have used them in this manner, for, although a Yokuts woman's equipment included one or more digging sticks, weights were not added (Gayton 1948:78-79). Lithic materials of differing degrees of hardness were selected for the manufacture of the doughnut-shaped stones (Wallace 1991(4):2-4).*

A utility of these stones can be suggested in an account of the life of Yoimut (Josie Alonzo), reportedly the last Chunut Yokuts of unmixed descent. According to Yoimut, they were utilized by medicine men to influence the weather (Latta 1977:691). The "thunder and lightning" stones also served as gaming pieces and the same type stones were used to straighten their arrows and shafts for gigging fish (reported by Thomas Jefferson Mayfield, a white man who spent his boyhood in a Choinimni village on the Kings River) (Latta 1977:694).

Gifford and Schenck also commented on a possible use for the perforated stones:

> *The bore is quite smooth and countersunk and could result from using it for grinding "charmstones" into shape. It seems possible that this was the purpose of this type of object (Gifford and Schenck 1926:90).*

The largest bores could accommodate most of the charmstone body shapes in the author's collection gathered from the region. The smaller bores may have been used as dies for shaping charmstone elements known as piles, buttons and nipples (i.e., Catalog Numbers TL6HR, TL9DRL2, TL12LTS, TL13DRL5) (Table 3.1). Using perforated stones made of hard materials to shape charmstones fashioned from softer materials (e.g., steatite, limestone, mudstone, sandstone, serpentine, schist, shale and slate), in my view, has validity.

There are fourteen circular doughnut stones (digging stick weights) in the author's collection from Tulare Lake (see Table 3.1). They range from a maximum diameter of 5.6 cm. to 13.6 cm. (mean 8.5 cm.) and weigh from 85 gr. to 1,348 gr. (mean 391 gr.). One of the weights (Catalog Number TL7DRL5) was found during an earlier excursion less than 50-yards (45.72 m.) from the discovery location of the present digging stick. It ended up on the same shoreline contour and may have been the original weight used with the digging stick. Upon placing this weight on the stick, I was able to slide it slightly above the aforementioned mark. By combining the weight of the granite stone weight with the digging stick, the total tool weight, made of granite (minus the estimated weight of the asphaltum admixture) approximates 607 gr.

The weight could have initially been positioned almost to the proximal end of the stick had splitting of the shaft not have occurred. Such a location approximates the positions of weights on two replicas made by a Chumash Indian, Juan Pico, living at present day Ventura in 1894. Those two stone-weighted digging sticks were made at the request of Henry W. Henshaw (Heizer 1971:65) and are cataloged under Accession Number 28296 bearing Catalog Numbers 168803 and 168857 in the U.S. National Museum, Smithsonian Institution. Their measurements are as follows:

> *Catalog Number 168803: overall length - 85 cm., diameter of the stick at mid-grip - 2.6 cm., maximum diameter of the stick - 3.6 cm., total tool weight (with stone weight and asphalt cement) - 942 gr. The stone weight is made of soapstone.*
>
> *Catalog Number 168857: 96.0 cm. long, diameter of the stick at mid-grip - 2.4 cm., maximum diameter of the stick - 1.3 cm., total tool weight - 1254 gr. The stone weight is made of sandstone or siltstone.*

Heizer went on to report:

> *Archaeological work in the territory occupied by the Chumash which has been carried on for the last hundred years has yielded examples whose total runs into several hundreds, if not thousands, of the circular, perforated stones which are identified as weights for digging sticks. Henshaw (1887) records that the largest specimen (presumably from the Wheeler Survey or P. Schumacher collections) in the U.S. National Museum weighed 7 lb. (3,000 gr) and the smallest weighed 1 oz. (28 gr.).*
>
> *No general study has ever been made of the variety of form, size, weight and materials of the digging stick weights from the Santa Barbara region, even though many archaeological reports illustrate and describe specimens which abound in institutional and private collections. The perforated stones are so common and so variable that they must have served a variety of purposes. Only a careful study of these will enlighten us as to their probable functions.*
>
> *Pico provided a description of the digging stick's manufacture and mode of use. The stone is said to may have been made in the way it was customary to make them 200 years ago. Henshaw's papers of 1887 and 1955 contain much useful information on stone-weighted digging sticks of the Chumash (Heizer 1971:65).*

Functions of Digging Sticks and Perforated Stones

Various uses have been suggested for digging sticks. They (with or without a weight component) are many and varied, ranging from utilitarian to symbolic use. Archaeological evidence and/or ethnographic testimony from Native coastal southern California also support the use of several kinds of smoothly finished stone objects as talismans. One of these forms is a globular doughnut shape stone, a magico-religious object commingled with digging stick weights under a single rubric (Koerper 2006:87).

Henshaw (1887) and Putnam (1879b) were in agreement that the doughnut-shaped artifacts were of several utilitarian types (Koerper 2006:91). Putnam had written:

> *A careful study of the hundred examples of these stones from California…has confirmed my belief that they were used for various purposes by the old Californians, and that while some may, possibly, have been used as weights for digging sticks and for net sinkers, as Mr. Schumacher believes, it would certainly be going too far to include all the specimens in these two groups, even should we agree with Mr. Schumacher regarding many of the smaller specimens as toys for children (Putnam 1879b:161).*

Functions for perforated stones, (i.e., weights for digging sticks, net weight sinkers, fish line sinkers, toys for children, counter weights, hammerstones, club heads, spindle whorls, sling shots or other missiles, bolas, gaming pieces, (e.g., hoop-and-pole), dies for fashioning tubes, pipes, rope smoothers and gauges for working and polishing arrow and spear shafts have been suggested (Koerper 2006:91), supporting the author's (and others) suspicions that the perforated stones were used mostly for utilitarian purposes. In any event, it is beyond the scope of this report to enter into magical, ritual aspects of doughnut stones.

A miniature digging stick weight thought to be a toy weight was discovered at CA-LAN-240, a vegetal procurement and processing station in southern California. Amusement in the lives of native California children included mimicking the vocational activities of their parents and other adults (Koeper and Gust 2007:128). Catalog Numbers TL10HR and TL11HR (see author's collection of weight components) are two examples that may be toy digging stick weights and disk shaped TL5DRL5 may have functioned as a club head (see Table 3.1).

Observations

The digging stick artifact probably originated in Fenenga's intermediate soil horizon (see above). Had the stick been in the upper level (agricultural plow zone), it most likely would have experienced mechanical damage, (i.e., by tractor or plow). Similar damage has been observed on numerous ground stone artifacts collected, (e.g., charmstones and doughnut stones) in the region.

Bill Olsen, upon completing his Archaeological Site Survey Record for the Witt Site (January 1966), noted that the area was under cultivation (planted in grain). It was not until 1978 that the author was aware of prehistoric artifact discoveries at the Witt Site, where this artifact was found. At that time, this marginal farm land lay fallow and few crops have been planted since then. However, seasonal disking for agricultural weed and insect control has persisted, threatening preservation of artifacts eroding from the shallow deflated shorelines.

DATING THE WOODEN ARTIFACT

A sample of wood, extracted by the author from the interior of the artifact to avoid possible asphaltum contamination, was submitted to Beta Analytic Inc. for accelerator mass spectrometry (AMS) radiocarbon dating. The sample, pretreated with acid/alkali/acid, yielded a measured radiocarbon age of 60 +/- 40 B.P. and a conventional radiocarbon age of 50 +/- 40 B.P. The two-sigma calibrated result is cal A.D. 1,690 to 1,730 (cal 260 to 220 B.P.) and A.D. 1810 to 1920 (cal 140 to 30 B.P.). Dates are reported as RCYBP (radiocarbon years before present, "present" = AD 1950). Radiocarbon dating results (Beta 275508) indicate that the artifact may fall within either of these two-sigma ranges supporting a historic or protohistoric age for the artifact.

CONCLUDING REMARKS

Accounts of early Spanish expeditions (1773 to 1824) and reports from American explorers who traveled to the southern San Joaquin Valley region from 1826 to 1870 helps us narrow the time frame of when the digging stick artifact may have been made.

After Lieutenant Derby's time (1850), the Indian seems to have faded away and by 1853 there was a regular road from Los Angeles to the western shores of Buena Vista and Tulare Lakes (Gifford and Schenck 1926:28). The historic record presents evidence that suggests a dwindling native population, decimated by pre-Mission diseases (measles, influenza and syphilis) for which aboriginals had no immunity (e.g., malaria and cholera epidemics (at times reducing populations by as much as seventy-five percent (Cook 1955b:322). In addition, disruption brought about by intrusive American fur trappers and game hunters encroaching upon Yokuts lands in the late eighteenth century took its toll. Between 1860 and 1870, most of the once vast Indian population was gone and by 1905 there were only 154 Yokuts in the Tulare Lake basin. Most of those survivors were likely taken to the Santa Rosa reservation near present day Lemoore (Preston 1981:83).

These occurrences along with the radiocarbon results (above) leads me to suggest that the artifact may have been made as early as 319 years or as late as 89 years before 2009 (when it was discovered). It is surprising that the wooden shaft could have survived such a time span with as little deterioration as the shaft displays. However, when one reflects on the surviving asphaltum-coated "staff" recovered from a burial at the Alamo Solo Site (CA-KER-152), it's conceivable that the suggested asphaltum-coated digging stick buried in the lake's sandy shoreline may very well have provided the necessary constituents for prolonged preservation.

A sandy soil sample, suggestive of containing charcoal, was collected (see above) and will be retained for possible radiocarbon dating in the future. Monitoring the location and surrounding area where the digging stick was recovered continues today.

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Figure 3.1 (Image 8871)

Figure 3.2 (Image 8883)

Figure 3.3 (Image 8876)

Figure 3.4 (Image 8877)

Figure 3.5 (Image 8886)

Figure 3.6 (Image 8920)

Figure 3.7 (Image 8924)

Figure 3.8 (Image 8925)

Figure 3.9 (Image 8880)

Figure 3.10 (Image 8881)

Figure 3.11 (Image 8879)

Figure 3.12 (Image 8939)

Figure 3.13
(Image 8940)