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Arrow Projectile Point Types as Temporal Types: Evidence from Orange County, California

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Issues of arrow projectile point morphology, chronometrics, and time-space systematics for southern coastal California are addressed using data from the Newport Coast Archaeological Project and the Cypress College Archaeology Program. These data suggest temporal co-variation within the Cottonwood series, with the floruit of the leaf-shaped type preceding that of the triangular forms, but the data do not support the hypothesis that Cottonwood Triangular basal configurations are time-sensitive. Early Cottonwood Triangular and Leaf-shaped point forms in southern coastal California may have evolved as smaller versions of atlatl morphological types found on the coast, possibly preceding the appearance of the Cottonwood series in the Great Basin. Sonoran series points in Orange County appear to date no earlier than the latter half of the Late Prehistoric Period and offer evidence of a link between the Hohokam culture and the coast.

RECENT discussions of morphological projectile point types serving as temporal markers in the historically occupied coastal Shoshonean area of southern California have been divided between concerns regarding large points (atlatl dart points) (e.g., Koerper et al. 1994) and those regarding small points (arrow points) (e.g., Rice and Cottrell 1976; Koerper 1981; Koerper and Drover 1983; Waugh 1988; Van Horn 1990; Koerper et al. 1992). A morphological type is "a descriptive and abstract grouping of individual artifacts whose focus is on overall similarity rather than specific form or function" (Thomas 1989:660). Temporal types (time markers, horizon markers, index fossils) are those morphological types that are "consistently . . . associated with a particular span of time in a given area" (Thomas 1981:14). Such time-sensitive artifacts are low level empirical generalizations useful for cross-dating and chronology building, particularly when they have been tested against the ability of the temporal type to predict radiocarbon determinations specific to a time interval (Thomas 1986:622).

Excavations of the Newport Coast Archaeological Project (NCAP) (Fig. 1) (Mason et al. 1990; Mason et al. 1991a; Mason et al. 1991b; Mason et al. 1991c; Mason et al. 1992a, 1992b; Mason et al. 1992; Mason et al. 1993; Mason and Peterson 1994), and those of the Cypress College Archaeology Program (CCAP) (Fig. 2) (Koerper and Drover 1983; Koerper et al. 1988; Koerper 1995) provide a data base useful in the investigation of southern coastal California arrow projectile point morphology, chronometrics, and time-space systematics. These data are used to address the questions of when the bow and arrow began to replace the atlatl (spear thrower) and dart, whether temporal co-variation exists between morphological types within the Cottonwood series, and whether time placement for the introduction of our proposed Sonoran

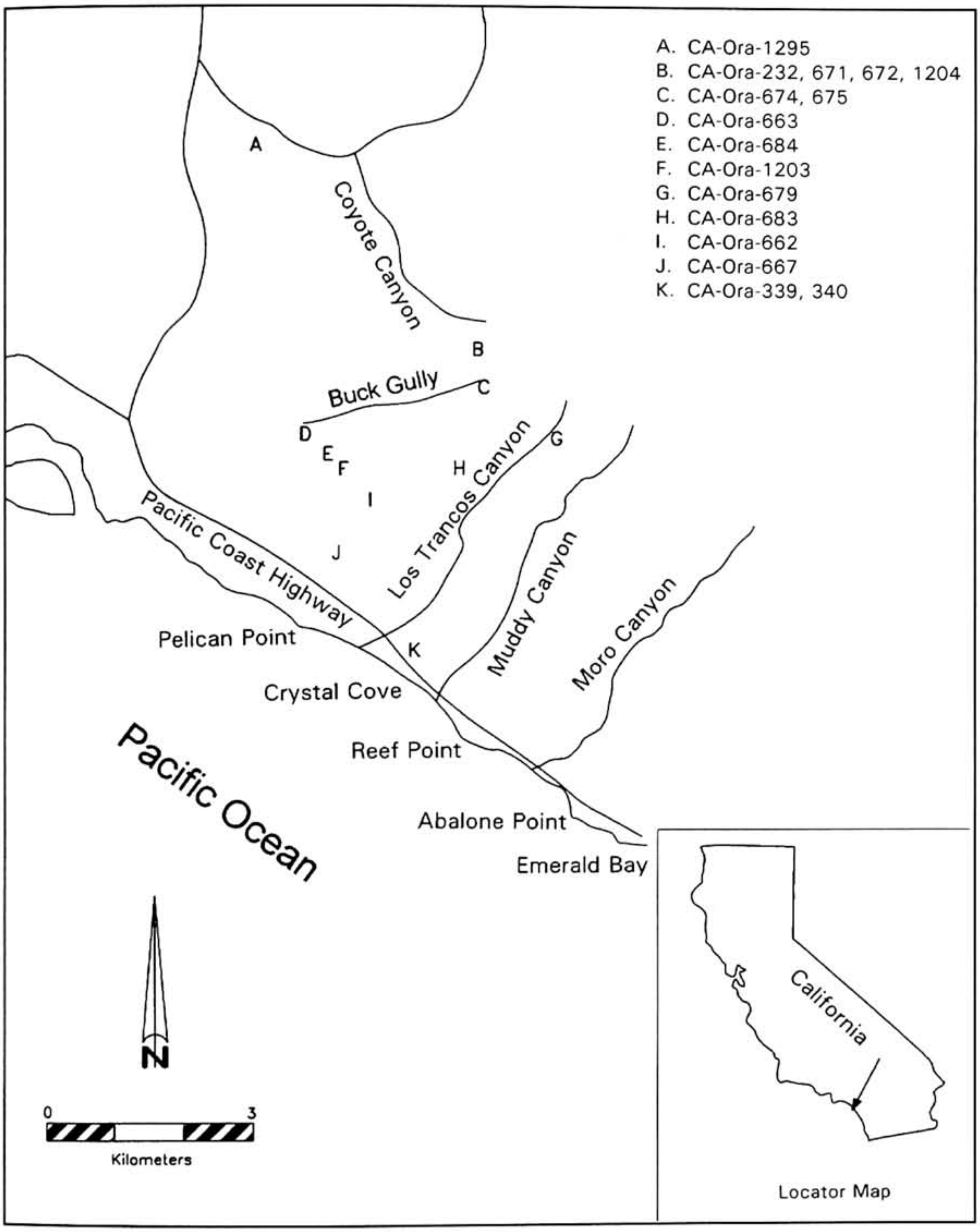

Fig. 1. Location of the Newport Coast Archaeological Project and sites discussed in the text.

series arrow projectile points supports the hypothesis of a trade or other connection between Hohokam and coastal peoples. Within these broad subject areas, we review relevant informa-

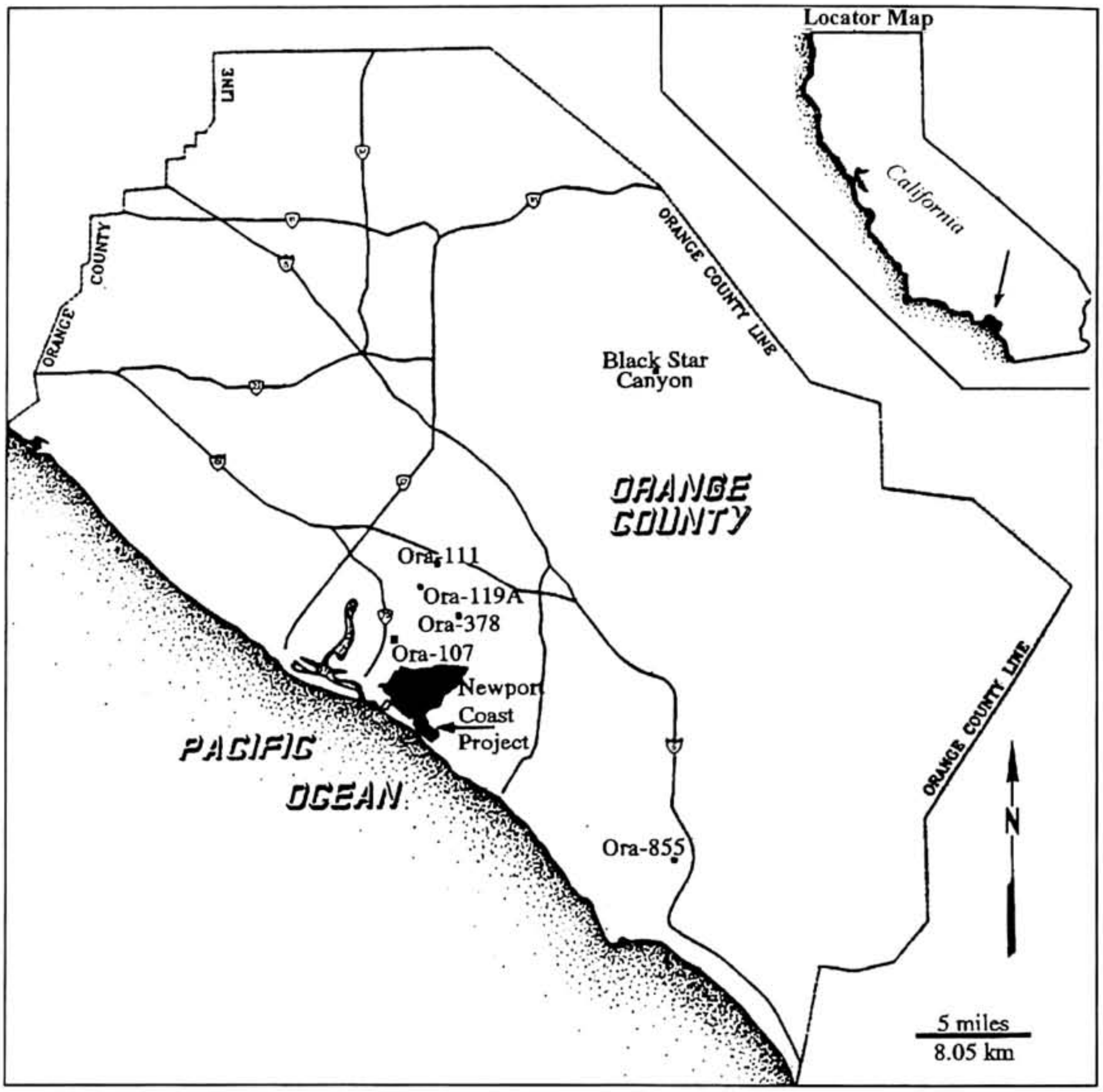

Fig. 2. Cypress College Archaeological Program sites and Works Progress Administration sites referenced in the text.

tion from Great Basin archaeology, compare the efficacy of the bow and arrow against the atlatl and dart, and describe morphological types rarely encountered in Orange County middens. In order to verify the accuracy of projectile point types and measurements, all points from the NCAP and other sites were reanalyzed by two of the authors (HCK and ABS). Points from the CCAP had been previously analyzed by the same two authors. Most of the data presented herein is original data.

Nearly all of the more than 900 radiocarbon dates incorporated into this paper are from either marine shell or charcoal samples recovered at sites located around Newport Bay and environs. The great majority of radiocarbon determinations are derived from conventional decay counting; however, more than 100 were obtained by the accelerator mass spectrometry (AMS) technique. The NCAP provided 41 AMS dates, which were run at the Lawrence Livermore National Laboratories (LLNL) as part of a regional scale radiocarbon study to obtain a local ΔR marine reservoir correction factor (Prior et al. 1996). This LLNL study consisted of comparing AMS radiocarbon dated marine-charcoal pairs obtained from highly discrete Late Period archaeological contexts. The ΔR correction was applied to all marine carbonate samples for the final Newport Bay and environs radiocarbon data base, and dates for this data base were calibrated using either the 1987 version (Rev. 2.1) or the 1993 version (Rev. 3.0.3A) of CALIB software programs that contain the data sets for each of the calibration curves developed at the Department of Geological Sciences and Quaternary Research, University of Washington (see Stuiver and Becker 1986, 1993; Stuiver et al. 1986; Stuiver and Braziunas 1993; Stuiver and Reimer 1993).

All radiocarbon ages in our projectile point study were determined using the CALIB programs (Stuiver and Becker 1986; Stuiver and Reimer 1993). Radiocarbon ages from marine shell samples were calibrated using a locally derived ΔR (correction factor for the effects of marine upwelling) (Mason and Peterson 1994). All radiocarbon reporting and correction procedures followed the radiocarbon standards and conventions described by Stuiver and Polach (1977), including rounding to the nearest 10. The dates discussed herein are given in calibrated radiocarbon years before present (cal yrs BP).

INTRODUCTION OF THE BOW AND ARROW

Archaeological research demonstrates that the Late Holocene introduction of bow-and-arrow technology largely replaced atlatl-and-dart technology in the Great Basin and California culture areas, a fact reflected in long chronology schemes based on projectile point types (e.g., Bettinger and Taylor 1974; Heizer and Hester 1978; Thomas 1981; Koerper and Drover 1983). Aikens (1970:199-200) suggested that the atlatl and dart were superseded by the bow and arrow in western Utah as early as ca. 1,250 B.C. Others have placed the event at around 2,000 or more years ago (Grosscup 1957:380; Davis 1966:151; Grant et al. 1968:51; see also Aikens 1970), but currently a date of ca. A.D. 500 seems to be the most accepted estimate (e.g., Flenniken and Wilke 1989:150).

Rose Spring and Eastgate series projectile points are believed to herald the introduction of the bow and arrow in the Great Basin (Heizer and Baumhoff 1961; Lanning 1963:268; O'Connell 1971:67), and these series are generally regarded as beginning around A.D. 500 (Heizer and Hester 1978; see also Elston 1982) or A.D. 700 (Thomas 1981). Earlier estimates include A.D. 400 (Laurent and Newton 1983), A.D. 300 (Holmer 1986), and even 1,250 B.C. (Aikens 1970). Recent work at the Rose Spring site (CA-Iny-372 [Yohe 1992]) indicated that the introduction of the bow and arrow, inferred from the appearance of Rose Spring projectile points at Locus 1, and based on new radiometric dates, occurred at 1,600 cal yrs BP.

The earliest Cottonwood series projectile points in Orange County may mark the introduction of bow-and-arrow technology locally; however, other kinds of small points, whose forms suggest smaller versions of atlatl dart points, may have preceded Cottonwood forms as arrow points.

POSSIBLE EARLY ARROW PROJECTILE POINTS

Projectile points whose morphologies suggest smaller versions of atlatl dart points may be manifestations of early bow-and-arrow technology. Several NCAP projectile points are similar to Rose Spring, Eastgate, or Rosegate points, morphological types that Heizer and Baumhoff (1961) believed were downsized from Elko templates, coinciding with the introduction of the bow and arrow in the Great Basin (see also

O'Connell 1971:67). Heizer and Baumhoff (1961) formulated an Eastgate series, identifying "expanding stem" and "split stem" types. Lanning (1963:268), who defined "contracting stem," "corner-notched," and "side-notched" Rose Spring types, also believed them to be the earliest arrow points in the Great Basin.

Hester and Heizer (1973:8-9) reported estimates for the first appearance of the bow and arrow in the Great Basin ranging from 1,250 B.C. to A.D. 1; but, equating earliest arrow technology with Rose Spring and Eastgate series, they suggested an A.D. 500 date. Lanning's (1963) range for Rose Spring projectile points was A.D. 500 to A.D. 1300 (see also Clewlow [1967] and Clewlow et al. [1970]). Bettinger and Taylor (1974) placed Rose Spring and Eastgate points between A.D. 600 and A.D. 1300. Following Hester (1973), O'Connell (1975) placed Rose Spring points between 600 B.P. and 1,500 B.P. Thomas' (1981:30-31) Rosegate series, a composite of Rose Spring and Eastgate, was said to begin at around A.D. 700 in Monitor Valley, Nevada, and to end at A.D. 1300. Other ranges include those of Holmer (1986), who suggested A.D. 600 to 1300 for the western and central Great Basin and A.D. 300 to A.D. 1000 for the eastern Great Basin. Laurent and Newton (1983) offered dates of A.D. 400 to A.D. 1600. Yohe (1992:38, 208) suggested that Rose Spring points were first manufactured as early as A.D. 400 and were used until A.D. 1600 or possibly later. In Los Angeles County, Van Horn (1990:33) identified a series of small stemmed points (Marymount series), which closely resemble some Rose Spring points, with a floruit in "the latter half of the first millennium A.D."

There are three projectile points in the NCAP collections whose basal configurations are similar to the Rose Spring Side-notched type (see Heizer and Clewlow 1968:80), but whose weights exceed 3.5 g. Using a 3.5 g. maximum for arrow points (Fenenga 1953), each would be classified as dart points. The complete specimen from CA-Ora-662 (Fig. 3a) weighs 4.6 g., and the incomplete specimen from CA-Ora-662 (Fig. 3b) was probably roughly similar in size. CA-Ora-662 has a full range of Late Prehistoric Period dates (n = 89; from 280 ± 70 to 1,280 ± 100 cal yrs BP), as well as three older radiocarbon dates (2,470 ± 90, 3,390 ± 80, and 4,790 ± 90 cal yrs BP). The points could have been associated with a Late Prehistoric Period occupation, but probably are associated with the earlier period.

The other side-notched point (Fig. 3c) was recovered at CA-Ora-662, Area 13 (ICD-13). There are 13 radiocarbon dates from this location, and only one is not Late Prehistoric (2,350 ± 80 cal yrs BP), placing most of the occupation between 1,230 ± 80 and 580 ± 50 cal yrs BP. Numerous Cottonwood Triangular points were also recovered from this locus, and this specimen is one of the few examples of early notched arrow points in Orange County. It could also be a rejuvenated and/or curated atlatl projectile point, since the vast majority of the points from that locus are Cottonwood Triangular (see Table 1). This incomplete specimen weighs 2.3 g.

Other small notched points, some resembling Elko forms, are among the candidates for early arrow points in Orange County. At CA-Ora-378, three notched points (Fig. 3d-f) weigh less than 3.5 g. and may belong in the "earliest arrow point" category. Two are corner-notched points that appear to be small Elko-like points (similar to Rose Spring Corner-notched) (Fig. 3d-e). Upon close examination, one specimen that appears to be stemmed (Fig. 3f) shows evidence of having been a side-notched point. The end of the "stem" and portions of the sides are broken off, probably from impact. Radiocarbon dates from CA-Ora-378 extend from the early Milling Stone Period to the Late Prehistoric Period, but the great majority of dates ranges from the late Intermediate to the early Late Pre-

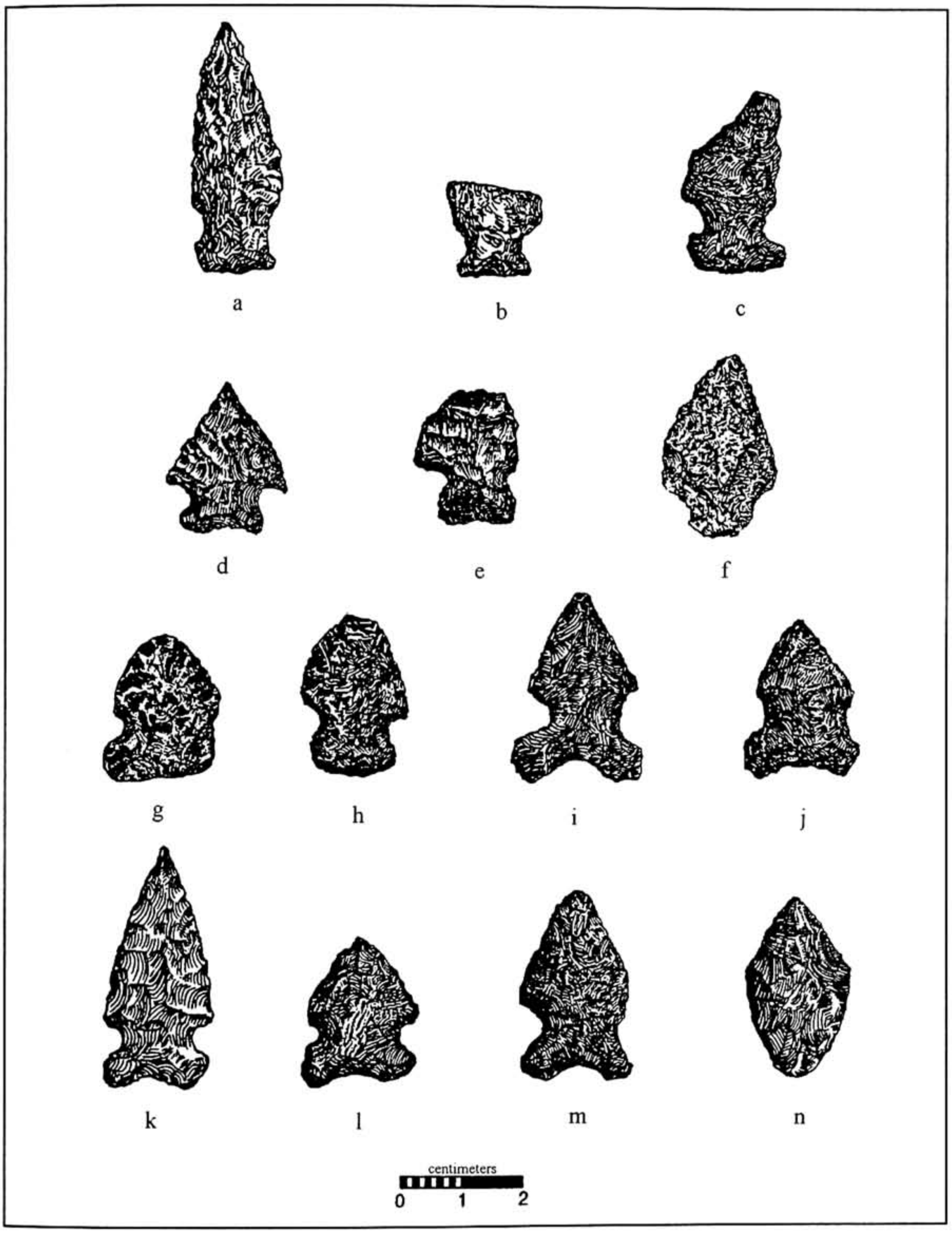

Fig. 3. Projectile points whose morphologies suggest smaller versions of atlatl dart points. Some are rejuvenated dart points and some may be early arrow points: (a-b) CA-Ora-662; (c) CA-Ora-662, Area 13; (d-f) CA-Ora-378; (g-j) CA-Ora-683; (k-n) CA-Ora-667.

Table 1
ATTRIBUTES[a] OF COTTONWOOD TRIANGULAR ARROW POINTS

Cat. No.	Weight	Thick.	Length	Axial Length	Width	Lithic Material	Cord	Straight Base[b]	Broad Base[c]	Deep Base[d]	Type
						CA-Ora-232					
76	1.18	4.6	25.6	24.5	12.3	B.C. metasedimentary[e]	1.1	9.470	12.106	4.395	Broad
13199	0.75	4.2	12.2	9.7	16.0	quartz	2.5	5.834	17.138	20.037	Deep
13303	0.52	2.5	16.4	15.3	11.9	chalcedony	1.1	0.083	3.832	-0.876	Broad
13777	1.24	4.3	18.2	15.6	--	basalt	2.6	6.149	18.004	21.477	Deep
14916	0.69	4.0	22.2	19.7	11.7	metavolcanic	2.5	4.940	16.350	19.535	Deep
						CA-Ora-339					
10291	0.71	3.3	10.3	10.2	--	metavolcanic	0.1	4.979	2.264	-10.758	Straight
11673	0.81	3.3	22.4	20.6	13.2	Piedra de Lumbre "chert"	1.8	2.735	10.288	9.455	Broad
11989	1.82	5.0	23.9	22.5	14.3	cherty shale	1.4	10.862	15.098	8.966	Broad
13087	0.47	2.8	19.3	18.3	9.2	B.C. metasedimentary	1.0	1.556	4.542	-1.312	Broad
13120	1.13	4.0	21.1	20.0	15.0	Monterey chert	1.1	6.788	9.742	2.889	Broad
						CA-Ora-340					
200	2.00	5.4	25.2	23.2	--	B.C. metasedimentary	2.0	11.858	19.506	17.104	Broad
1101	0.99	4.5	17.0	16.1	--	Monterey chert	0.9	9.287	10.768	1.766	Broad
11055	1.18	3.8	35.4	33.9	14.4	Monterey chert	1.5	5.366	10.842	7.143	Broad
						CA-Ora-662, Area 13					
10	1.93	4.8	32.4	29.0	--	Monterey chert	3.4	7.328	23.750	32.244	Deep
11231	1.64	4.8	23.2	22.0	--	quartz	1.2	10.232	13.366	6.086	Broad
11598	1.09	3.3	25.8	25.8	12.8	Monterey chert	0.0	5.111	1.792	-11.947	Straight
12845	0.73	4.2	15.1	13.6	13.5	Monterey chert	1.5	7.154	12.418	8.147	Broad
13037	1.62	4.7	18.4	17.3	17.5	metavolcanic	1.1	9.917	12.500	4.646	Broad
13712	1.31	4.3	19.0	18.0	--	quartz	1.0	8.261	10.452	2.453	Broad
16208	0.85	3.5	18.7	17.0	15.0	Piedra de Lumbre "chert"	1.7	3.761	10.604	8.768	Broad
16209	1.91	4.3	24.2	22.0	21.1	Monterey chert	2.2	6.677	16.116	16.721	Deep
17746	1.64	3.4	34.3	33.3	14.0	chert	1.0	4.238	6.906	0.194	Broad
						CA-Ora-671					
11009	0.56	3.8	12.8	11.2	12.4	quartz	1.6	5.234	11.314	8.332	Broad
11025	1.46	5.2	23.4	21.0	13.0	metasedimentary	2.4	10.436	20.606	21.358	Deep
11086	0.81	3.4	21.0	19.8	10.6	Monterey chert	1.2	3.974	7.850	2.572	Broad
11089	0.58	3.3	14.6	14.5	13.8	jasper	0.1	4.979	2.264	-10.758	Straight
11104	0.81	3.3	20.1	16.3	--	Piedra de Lumbre "chert"	3.8	0.095	19.728	33.235	Deep
11106	0.92	4.0	19.2	18.4	13.1	jasper	0.8	7.184	8.326	-0.678	Broad
11107	1.22	5.8	25.3	22.6	14.2	metavolcanic	2.7	12.722	24.386	26.431	Deep
11116	0.39	3.1	17.4	17.1	8.3	chalcedony	0.3	3.821	2.420	-8.882	Straight
11118	0.96	4.2	20.3	17.9	18.1	Piedra de Lumbre "chert"	2.4	5.966	16.666	18.848	Deep
11140	2.35	4.2	29.3	28.6	19.6	Piedra de Lumbre "chert"	0.7	8.210	8.642	-1.365	Broad
11151	1.55	3.6	21.4	20.5	15.9	chalcedony	0.9	5.264	7.222	-0.493	Broad
11155	0.90	4.2	23.3	21.6	10.1	Monterey chert	1.7	6.890	13.362	10.525	Broad
11169	0.35	2.1	16.0	13.4	11.7	chalcedony	2.6	-3.685	9.336	15.955	Deep
11170	0.76	5.0	24.4	23.8	11.8	Monterey chert	0.6	11.918	11.322	-0.546	Straight
11187	0.48	3.4	14.2	14.2	9.3	Monterey chert	0.0	5.558	2.186	-11.696	Straight
11195	0.86	3.4	19.4	18.4	13.7	chalcedony	1.0	4.238	6.906	0.194	Broad
11211	0.65	3.9	9.4	8.4	11.6	Monterey chert	1.0	6.473	8.876	1.449	Broad
11221	1.31	3.3	27.5	25.4	15.4	Monterey chert	2.1	2.339	11.704	13.022	Deep
11225	2.67	6.0	29.6	28.0	16.2	metavolcanic	1.6	15.068	19.982	13.854	Broad
11242	0.38	3.2	10.2	7.6	11.2	Piedra de Lumbre "chert"	2.6	1.232	13.670	18.716	Deep
11265	0.75	4.4	17.1	14.8	14.0	chalcedony	2.3	6.992	16.982	18.161	Deep
11301	1.10	4.0	23.8	20.4	11.0	jasper	3.4	3.752	20.598	30.236	Deep
11302	0.58	4.8	17.8	15.1	12.4	chalcedony	2.7	8.252	20.446	23.921	Deep

Table 1 (Continued)
ATTRIBUTES[a] OF COTTONWOOD TRIANGULAR ARROW POINTS

Cat. No.	Weight	Thick.	Length	Axial Length	Width	Lithic Material	Cord	Straight Base[b]	Broad Base[c]	Deep Base[d]	Type
						CA-Ora-671 (Continued)					
11303	2.00	4.4	20.9	20.9	16.6	Monterey chert	0.0	10.028	6.126	-9.186	Straight
11304	0.98	3.4	19.6	18.4	16.2	B.C. metasedimentary	1.2	3.974	7.850	2.572	Broad
11314	0.72	4.1	12.1	10.2	11.4	Monterey chert	1.9	6.179	13.912	12.652	Broad
11323	1.16	5.6	15.4	17.4	15.0	Monterey chert	-2.0	18.032	1.414	-29.954	Straight
11335	0.50	3.8	17.2	14.0	13.0	metavolcanic	3.2	3.122	18.866	27.356	Deep
11352	2.10	4.8	20.2	20.2	18.6	Monterey chert	0.0	11.816	7.702	-8.182	Straight
11362	0.63	3.8	16.0	15.0	12.2	chalcedony	1.0	6.026	8.482	1.198	Broad
11368	1.63	3.4	31.8	29.7	14.9	quartzite	2.1	2.786	12.098	13.273	Deep
11381	3.72	5.5	49.8	48.0	18.2	cherty shale	1.8	12.569	18.956	14.977	Broad
11391	0.70	3.2	23.6	21.0	12.3	Piedra de Lumbre "chert"	2.6	1.232	13.670	18.716	Deep
11410	0.87	3.1	26.1	23.4	17.2	chalcedony	2.7	0.653	13.748	19.654	Deep
11416	1.57	4.5	31.2	29.1	12.5	metavolcanic	2.1	7.703	16.432	16.034	Broad
11417	1.87	5.0	30.1	28.6	15.2	Monterey chert	1.5	10.730	15.570	10.155	Broad
11420	1.00	3.8	15.4	13.3	16.1	chalcedony	2.1	4.574	13.674	14.277	Deep
11421	1.12	4.7	25.8	24.6	13.2	quartz	1.2	9.785	12.972	5.835	Broad
11425	1.35	3.2	35.6	31.8	18.0	quartzite	3.8	-0.352	19.334	32.984	Deep
11429	1.51	3.8	21.0	20.6	15.5	chert	0.4	6.818	5.650	-5.936	Straight
11430	0.50	3.4	12.0	14.2	13.8	chert	-2.2	8.462	-8.198	-37.854	Straight
11443	0.34	2.8	15.8	14.3	12.0	Monterey chert	1.5	0.896	6.902	4.633	Broad
11445	0.53	3.8	17.8	16.2	10.0	chalcedony	1.5	5.234	11.314	8.332	Broad
11446	1.21	4.4	22.9	21.4	13.0	quartzite	1.5	8.048	13.206	8.649	Broad
11451	1.44	3.8	19.0	15.7	19.5	metavolcanic	3.3	2.990	19.338	28.545	Deep
11457	0.80	3.9	20.8	20.8	11.2	Monterey chert	0.0	7.793	4.156	-10.441	Straight
11461	0.64	3.3	22.1	18.7	12.0	chalcedony	3.4	0.623	17.840	28.479	Deep
11463	0.90	3.6	22.6	21.3	13.2	quartz	1.3	4.736	9.110	4.263	Broad
11474	0.44	3.9	21.8	20.5	12.9	chert	1.3	6.077	10.292	5.016	Broad
11481	0.81	3.6	16.3	14.8	16.2	Monterey chert	1.5	4.472	10.054	6.641	Broad
11492	1.95	5.0	27.1	24.6	15.9	chert	2.5	9.410	20.290	22.045	Deep
11493	1.22	4.4	17.1	15.2	15.1	quartz	1.9	7.520	15.094	13.405	Broad
11500	1.91	5.3	24.7	22.9	17.4	Monterey chert	1.8	11.675	18.168	14.475	Broad
11520	0.32	3.3	14.2	13.8	6.9	chalcedony	0.4	4.583	3.680	-7.191	Straight
11539	1.00	5.0	17.9	17.2	13.8	metavolcanic	0.7	11.786	11.794	0.643	Broad
11575	0.67	4.2	18.0	15.9	10.3	chalcedony	2.1	6.362	15.250	15.281	Deep
11593	1.87	5.4	22.4	21.4	18.0	Monterey chert	1.0	13.178	14.786	5.214	Broad
11599	1.63	3.9	32.3	25.0	19.1	chalcedony	7.2	-1.843	38.612	76.356	Deep
11601	1.59	5.1	22.1	22.1	16.2	quartz	0.0	13.157	8.884	-7.429	Straight
11608	0.38	2.6	20.0	19.8	12.0	chert	0.2	1.718	-0.022	-11.326	Straight
11637	0.57	3.6	13.3	11.6	11.1	metavolcanic	1.7	4.208	10.998	9.019	Broad
11646	0.68	3.0	24.7	23.0	12.7	Monterey chert	1.7	1.526	8.634	7.513	Broad
11651	0.39	3.4	8.8	7.0	10.3	quartzite	1.8	3.182	10.682	9.706	Broad
11662	0.82	3.2	27.1	24.7	10.6	cherty shale	2.4	1.496	12.726	16.338	Deep
11668	0.46	2.5	14.6	12.6	14.3	chalcedony	2.0	-1.105	8.080	9.825	Deep
11669	0.83	4.0	16.1	14.4	14.1	metavolcanic	1.7	5.996	12.574	10.023	Broad
11692	2.44	5.6	33.0	31.1	19.1	quartzite	1.9	12.884	19.822	16.417	Broad
11725	1.22	3.9	23.9	20.7	14.5	metavolcanic	3.2	3.569	19.260	27.607	Deep
11977	0.43	3.5	12.8	10.3	10.4	chalcedony	2.5	2.705	14.380	18.280	Deep
12041	1.10	3.9	32.1	30.4	16.0	B.C. metasedimentary	1.7	5.549	12.180	9.772	Broad
12092	0.43	2.8	10.1	8.8	14.6	chalcedony	1.3	1.160	5.958	2.255	Broad
12967	0.39	3.6	13.3	13.9	9.1	chert	-0.6	7.244	0.142	-18.328	Straight
13407	0.81	4.2	24.6	21.0	14.3	jasper	3.6	4.382	22.330	33.116	Deep
13541	1.09	5.2	15.1	12.9	16.2	cherty shale	2.2	10.700	19.662	18.980	Broad
14856	0.37	4.4	12.8	11.0	9.2	jasper	1.8	7.652	14.622	12.216	Broad
14857	0.75	3.4	23.0	19.1	11.6	metavolcanic	3.9	0.410	20.594	34.675	Deep
15193	0.38	3.5	13.1	9.1	10.2	jasper	4.0	0.725	21.460	36.115	Deep
15730	0.82	3.8	12.3	8.1	18.2	metavolcanic	4.2	1.802	23.586	39.246	Deep
15986	2.33	3.9	36.0	34.5	16.8	B.C. metasedimentary	1.5	5.813	11.236	7.394	Broad

Table 1 (Continued)
ATTRIBUTES[a] OF COTTONWOOD TRIANGULAR ARROW POINTS

Cat. No.	Weight	Thick.	Length	Axial Length	Width	Lithic Material	Cord	Straight Base[b]	Broad Base[c]	Deep Base[d]	Type
						CA-Ora-671 (Continued)					
16078	1.58	4.6	23.8	23.5	17.8	chalcedony	0.3	10.526	8.330	-5.117	Straight
16161	0.35	3.0	16.0	14.6	11.4	Monterey chert	1.4	1.922	7.218	3.946	Broad
16249	0.81	3.7	17.6	14.3	13.8	metasedimentary	3.3	2.543	18.944	28.294	Deep
16320	0.52	3.1	18.1	13.8	13.1	chalcedony	4.3	-1.459	21.300	38.678	Deep
16344	0.30	3.2	12.2	11.0	9.2	Monterey chert	1.2	3.080	7.062	2.070	Broad
16483	0.64	3.8	15.2	14.1	11.6	Monterey chert	1.1	5.894	8.954	2.387	Broad
16538	0.22	3.2	6.1	5.3	9.9	jasper	0.8	3.608	5.174	-2.686	Broad
17409	0.19	3.0	6.1	3.4	11.3	quartz	2.7	0.206	13.354	19.403	Deep
17590	0.34	3.9	10.0	5.2	14.5	metavolcanic	4.8	1.457	26.812	46.631	Deep
19177	1.87	4.5	32.6	31.2	15.6	Piedra de Lumbre "chert"	1.4	8.627	13.128	7.711	Broad
						CA-Ora-674					
11003	0.41	2.5	12.5	12.0	10.4	metavolcanic	0.5	0.875	1.000	-8.010	Broad
11028	0.89	4.1	16.2	16.2	11.4	metasedimentary	0.0	8.687	4.944	-9.939	Straight
11084	1.40	4.2	35.7	34.5	13.1	Monterey chert	1.2	7.550	11.002	4.580	Broad
11106	1.49	4.8	27.4	24.8	17.2	chert	2.6	8.384	19.974	22.732	Deep
11134	2.20	4.8	44.0	41.4	16.5	Monterey chert	2.6	8.384	19.974	22.732	Deep
11234	1.23	4.1	23.3	22.0	12.3	Monterey chert	1.3	6.971	11.080	5.518	Broad
11322	1.98	5.2	17.0	16.5	18.9	Monterey chert	0.5	12.944	11.638	-1.233	Straight
11531	2.41	4.3	36.6	34.5	20.2	metasedimentary	2.1	6.809	15.644	15.532	Broad
12712	0.43	2.3	14.0	12.8	13.0	chalcedony	1.2	-0.943	3.516	-0.189	Broad
						CA-Ora-675					
11005	1.27	4.5	18.2	17.7	18.3	Piedra de Lumbre "chert"	0.5	9.815	8.880	-2.990	Straight
11216	1.35	4.1	35.2	32.8	11.8	Monterey chert	2.4	5.519	16.272	18.597	Deep
12172	2.42	4.2	33.4	33.1	17.4	Piedra de Lumbre "chert"	0.3	8.738	6.754	-6.121	Straight
						CA-Ora-679					
11044	0.71	3.1	23.1	20.0	14.0	jasper	3.1	0.125	15.636	24.410	Deep
11053	0.90	4.0	21.2	18.6	--	quartz	2.6	4.808	16.822	20.724	Deep
11148	0.77	3.8	15.2	15.2	12.2	Monterey chert	0.0	7.346	3.762	-10.692	Straight
11449	0.59	3.8	11.0	8.4	13.7	Monterey chert	2.6	3.914	16.034	20.222	Deep
12357	2.48	6.4	22.2	20.3	20.0	Monterey chert	1.9	16.460	22.974	18.425	Broad
12525	0.21	2.0	13.6	10.6	--	chalcedony	3.0	-4.660	10.830	20.460	Deep
12772	0.36	3.0	12.6	11.1	10.4	jasper	1.5	1.790	7.690	5.135	Broad
						CA-Ora-684					
10704	2.27	3.8	32.0	31.5	19.9	metavolcanic	0.5	6.686	6.122	-4.747	Straight
11554	2.74	4.6	34.7	33.1	19.2	metavolcanic	1.6	8.810	14.466	10.340	Broad
						CA-Ora-1204					
10186	0.59	3.3	20.5	17.0	10.4	chalcedony	3.5	0.491	18.312	29.668	Deep
10480	0.92	4.1	24.7	24.2	11.0	Monterey chert	0.5	8.027	7.304	-3.994	Straight
11084	0.34	3.6	13.9	12.9	8.2	Monterey chert	1.0	5.132	7.694	0.696	Broad
11173	0.81	5.1	25.9	21.7	14.1	chert	4.2	7.613	28.708	42.509	Deep

[a] Metric attributes are in grams and millimeters.
[b] Straight Base = (Thickness x 4.47) + (Cord x -1.32) - 9.64 (after Waugh 1988:109).
[c] Broad Base = (Thickness x 3.94) + (Cord x 4.72) - 11.21 (after Waugh 1988:109).
[d] Deep Base = (Thickness x 2.51) + (Cord x 11.89) - 20.23 (after Waugh 1988:109).
[e] B.C. = Bedford Canyon.

historic Period (Koerper 1995:Sec. 6:7-10). These points may also be rejuvenated atlatl points or early notched arrow points.

The negative evidence from CA-Ora-855 is instructive. Over 250 arrow projectile points have been recovered from this terminal Late Prehistoric Period site, but none resembles the apparent small notched points under discussion (Koerper et al. 1988).

Four of the 17 side-notched points from CA-Ora-683 weigh less than 3.5 g. (Fig. 3g-j); however, all appear to have been resharpened from larger projectile points and are probably small, reworked dart points. All 10 radiocarbon dates are from marine shell and relate to a Late Prehistoric Period occupation (270 $\pm$ 80 to 870 $\pm$ 60 cal yrs BP). Although there are many projectile points at CA-Ora-683 that indicate a much earlier component, none are associated with the shell deposit.

From CA-Ora-667, there is a diminutive Elko Eared point weighing 2.7 g. (Fig. 3k), and there are two side-notched points weighing 2.4 (Fig. 3l) and 3.6 (Fig. 3m) g. Also unearthed was a small 3.2 g. point (Fig. 3n) with a shape reminiscent of the Martis Stemmed Leaf type (see Hester and Heizer 1973:27). The large suite of shell-derived radiocarbon dates (n = 25) encompasses about two millennia, from 3,580 $\pm$ 70 to 5,660 $\pm$ 70 cal yrs BP. On the basis of these dates, the four projectile points are determined to be small dart points rather than arrow points, and as such they serve as an object lesson; Fenenga's (1953) weight separation should not be applied without further collaborating data. The small size of these specimens (<3.5 g.) probably reflects rejuvenation (resharpening) of broken atlatl dart projectile points.

We do not believe that true Rose Spring/ Eastgate (or Rosegate) arrow projectile points are present in Orange County. Although some of the small notched examples may be early arrow points, most are probably the result of rejuvenation and resharpening of atlatl-and-dart points and did not function as arrow points.

COTTONWOOD SERIES

The majority of Cottonwood series projectile points recovered locally are triangular shaped (Fig. 4a-k). Cottonwood points were first described by Riddell (1951) for an assemblage excavated at CA-Iny-2 (Cottonwood Creek) in Owens Valley. Riddell and Riddell (1956) discussed their use and established temporal assignments in their study of the prehistory of the area.

Lanning (1963:252) changed the designation from a type to a series, and described five types within the series. The four types described by Lanning all had straight sides and included the following types: (1) straight base with round or angular corners; (2) concave base, sometimes with small barbs at the corners; (3) straight or slightly convex base, with a single notch in the center; and (4) convex base. A fifth type, Leaf-shaped, had a convex base and convex sides.

Thomas (1981) further defined Cottonwood Triangular points as having weights equal to or less than 1.5 g., lengths of less than 30 mm., and thicknesses of less than 4.0 mm. Further, the basal width/maximum width ratio is said to be greater than 0.90. The weight and length criteria, especially, are too restrictive for the range of what might usefully be classified as Cottonwood Triangular points on the coast. Eberhart (personal communication to Marshall 1979:24) used the terminology "Coastal Cottonwood" to set coastal Cottonwood points apart from the very similar desert region arrow points.

In their report on the projectile points from the Humboldt Lakebed site (NV-Ch-15), Heizer and Clewlow (1968:64) proposed an additional Cottonwood type, the Cottonwood Bipointed variety, which was described as a "small bipointed type with a slight shoulder usually about one-third of the way up from the base," but Thomas (1981:16) questioned the validity of that type.

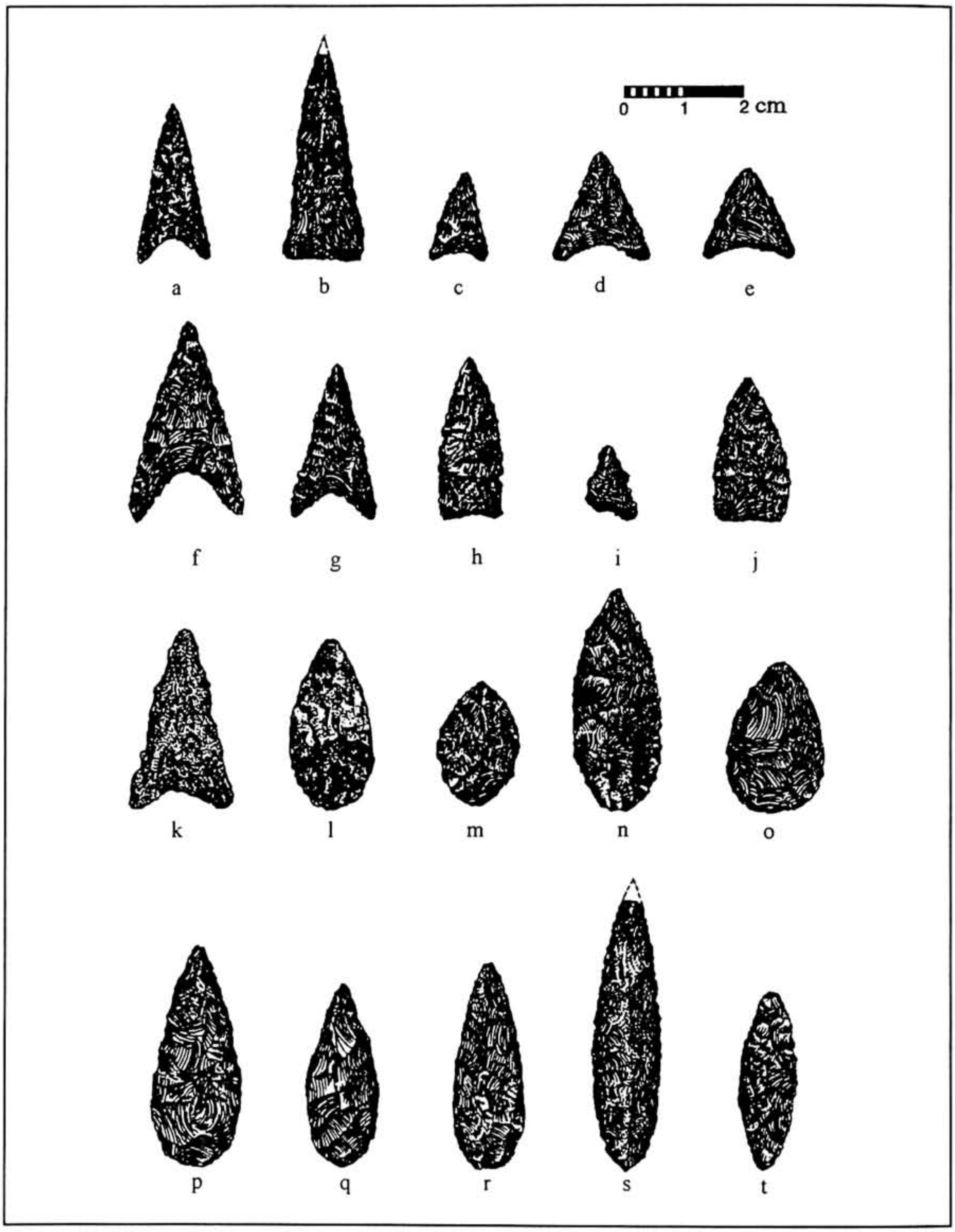

Fig. 4. Cottonwood type projectile points from Orange County: (a-b) CA-Ora-378; (c-d) CA-Ora-662; (e-f) CA-Ora-671; (g) CA-Ora-679; (h-i) CA-Ora-683; (j-k) CA-Ora-855; (l-n) CA-Ora-119-A; (o) CA-Ora-671; (p) CA-Ora-672; (q) CA-Ora-673; (r) CA-Ora-662, Area 13; (s) CA-Ora-378; (t) CA-Ora-855.

The bipoints illustrated in Heizer and Clewlow (1968:81) are not as obviously pointed at the base as are the very rare examples of Orange County bipoints, one from CA-Ora-378 (Fig. 4s) (Koerper 1995) and the other from the terminal Late Prehistoric site of *Putuidem* (CA-Ora-855 [Koerper et al. 1988]) (Fig. 4t). Speculatively, the CA-Ora-855 specimen may have had other than a utilitarian purpose (Koerper et al. 1988: 15). The CA-Ora-378 specimen is fused shale and was probably traded into Orange County in finished form (Koerper 1995:Section 7:22).

Dating Coastal Cottonwood Points

Two dates for the inception of Cottonwood Triangular points in the Great Basin are often cited, one around A.D. 900 (see Heizer and Hester 1978:165; see also Garfinkel et al. 1980: 66-67), and one around A.D. 1300 (Clewlow 1967; Bettinger and Taylor 1974:20; Thomas 1981). To demonstrate that the series occurs earlier on the coast than in the Great Basin necessitates documentation of sites which contain significant numbers of Cottonwood points and whose radiocarbon assays predate any purported Great Basin inception.

Several sites in the NCAP contain data that promote the notion that the A.D. 900 date may be a better estimate than the A.D. 1300 date. These sites include CA-Ora-340, CA-Ora-663, and CA-Ora-684. At CA-Ora-340, four Cottonwood Triangular and three Cottonwood Leaf-shaped points were recovered. The radiocarbon dates are 1,280 ± 70, 670 ± 80, and 1,120 ± 80 cal yrs BP, with an outlier of 3,200 ± 90 cal yrs BP. At CA-Ora-663, the four classifiable projectile points are leaf-shaped types, of which three are arrow-sized. The CA-Ora-663 radiocarbon dates are 870 ± 80, 920 ± 70, and 800 ± 60 cal yrs BP. At CA-Ora-684, two of the three classifiable points are triangular, and one is leaf-shaped. Two radiocarbon assays on shell yielded dates of 1,310 ± 90 and 830 ± 60 cal yrs BP. Disregarding the outlier, then, the two earliest NCAP dates associated with the Cottonwood series are around 1,300 cal yrs BP.

Cottonwood Triangular and Leaf-shaped arrow point forms might be viewed, speculatively, as having derived stylistically from similarly shaped atlatl dart points, such as those specimens illustrated in Figures 5a-b (CA-Ora-119-A; Koerper and Drover 1983) and 5c-e (CA-Ora-378; Koerper 1995).

Temporal Types Within the Cottonwood Series

Southern California archaeologists have sought to identify temporal co-variation between morphological types and subtypes of the Cottonwood series. For instance, to test Carrico and Taylor's (1983) suggestion that basal configurations of Cottonwood Triangular points may be time sensitive, Waugh (1988) derived equations for three subtypes (based on thickness and degree of basal indentation) that could be tested for temporal significance against the archaeological record. The methodology has been criticized, one problem being that Waugh (1988) ignored the proposition that basal configuration probably is the consequence of fitting a projectile point to a preformed arrow shaft (Koerper et al. 1992: 12).

To test Waugh's hypothesis, we first measured Cottonwood Triangular points from ten NCAP sites (see Table 1), each of whose Late Prehistoric radiocarbon dates clustered relatively tightly (Mason and Peterson 1994:Appendix I-D). Following Waugh's (1988) sets of operations, each projectile point was identified as either a straight base, broad base, or deep base subtype (Table 1). We compared proportions of subtypes between sites ordered temporally in an attempt to recognize any time sensitivity in these subtype percentages. Table 2 provides a summary of radiocarbon data and point types by site, and Figure 6 provides a graphic representation using the same data for similar analysis. The radiocarbon data presented in Tables 2 and 3 were calibrated using the 1987 version of

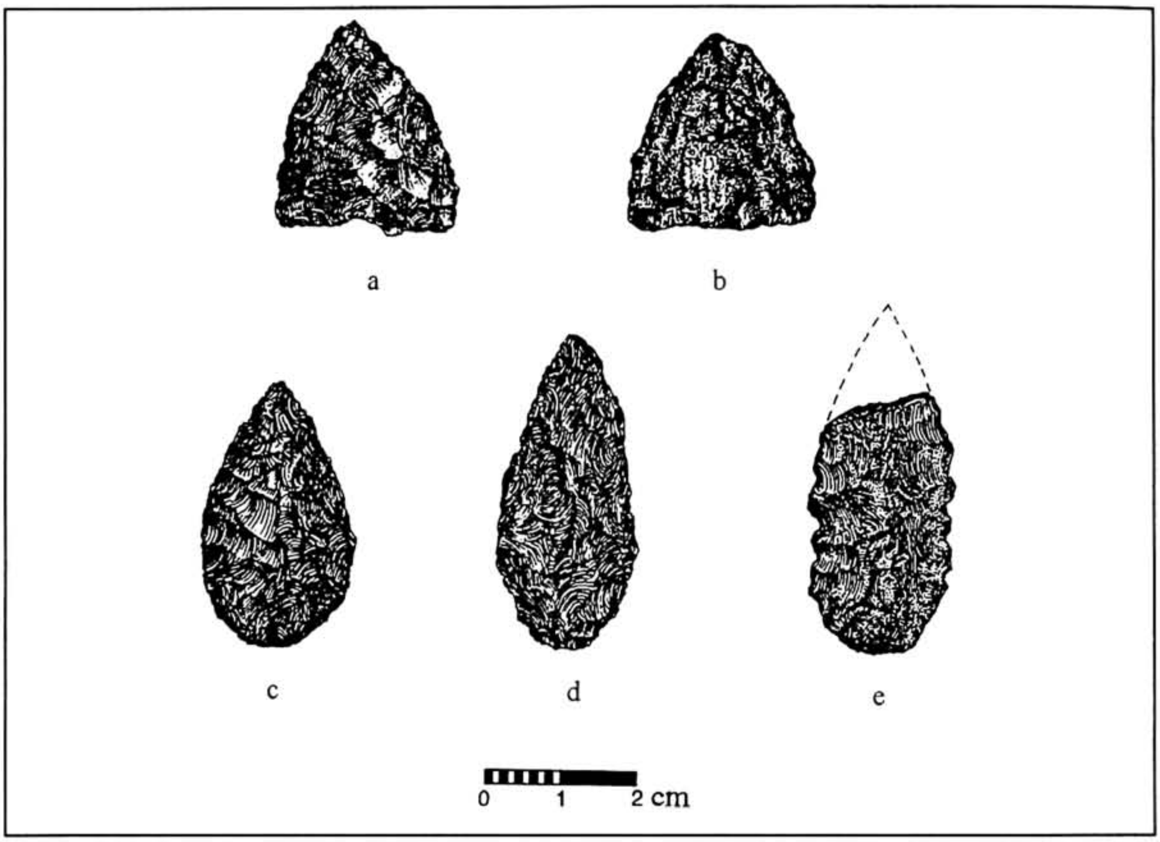

Fig. 5. Triangular and leaf-shaped atlatl dart projectile points: (a-b) CA-Ora-119-A; (c-e) CA-Ora-378.

CALIB (Rev. 2.1). Radiocarbon age determinations for marine carbonates were obtained from the calibration curve developed by Stuiver et al. (1986). The wood-charcoal samples were calibrated following Stuiver and Becker (1986). We found no apparent time sensitivity based on basal configuration in the NCAP sample.

Holding greater promise is the hypothesis that the Cottonwood Leaf-shaped type has an earlier florescence than the Cottonwood Triangular forms. In the Santa Monica Mountains, the leaf-shaped type appears to give way to the triangular type (King et al. 1968:93). A culture chronology chart for the Santa Barbara/Catalina area (Finnerty et al. 1970:15) illustrates a long temporal overlap of leaf-shaped and concave base triangular points, but with the former flourishing earlier. The theme of transition from convex to concave shaped bases was repeated by Rice and Cottrell (1976:21-28) in their stylistic analysis of projectile points as a method of seriating several local sites, but serious methodological problems have negated their efforts (Koerper 1981). At CA-Ora-193, Lyneis (1981:42-43) documented a frequency shift (lower to upper levels) from Cottonwood Leaf-shaped to Cottonwood Triangular arrow points, but cautioned that her sample from the lower strata is small. Van Horn (1990:35) reported that the Loyola site, which was abandoned about A.D. 400 to 500, yielded Cottonwood Leaf-shaped arrow points exclusively, evidence that these points preceded Marymount (or Rose Spring-like) types, as well as Cottonwood Triangular points in Los Angeles County.

The most practical method of testing the hy-

Table 2
SUMMARY OF RADIOCARBON DATA AND POINT TYPES BY SITE

Site	No. of Dates	Average Age[a] (cal yrs BP[c])	Age Range[b] (cal yrs BP)	Number of Points with: Straight Base	Broad Base	Deep Base	Percent of Points with: Straight Base	Broad Base	Deep Base
CA-Ora-1204	2	476	450 ± 70 to 500 ± 70	1	1	2	25	25	50
CA-Ora-671	11	518	290 ± 70 to 620 ± 70	15	41	33	17	46	37
CA-Ora-679	2	523	520 ± 80 to 530 ± 90	1	2	4	14	29	57
CA-Ora-232	4	564	370 ± 90 to 730 ± 70	0	2	3	0	40	60
CA-Ora-339	2	644	590 ± 90 to 700 ± 80	1	4	0	20	80	0
CA-Ora-675	8	652	520 ± 100 to 740 ± 80	2	0	1	67	0	33
CA-Ora-674	4	655	520 ± 60 to 930 ± 60	2	5	2	22	56	22
CA-Ora-662	12	863	580 ± 50 to 1,230 ± 80	1	6	2	11	67	22
CA-Ora-340	3	1,022	670 ± 80 to 1,280 ± 70	0	3	0	0	100	0
CA-Ora-684	5	1,100	770 ± 60 to 1,310 ± 90	1	1	0	50	50	0

[a] Not rounded off.
[b] Dates reported with one sigma value.
[c] cal yrs BP = calibrated years before present.

pothesis that the Cottonwood Leaf-shaped type had an earlier florescence than the Cottonwood Triangular forms involves identifying NCAP sites which represent limited times during the Late Prehistoric Period, placing these sites—with their Cottonwood Leaf-shaped to Cottonwood Triangular point ratios—in a temporal order (based on average radiocarbon dates) (Mason and Peterson 1994:Appendix I-D), and noting any correspondence between chronology and ratio change. A decrease in the ratio of leaf-shaped to triangular-shaped points with advancing time may be observed in Tables 3 and 4. In this analysis, radiocarbon dates that were obvious outliers were eliminated.

The evidence from CA-Ora-855 supports the hypothesis. Except for two modern dates, the seven calibrated dates fall between 110 ± 100 and 540 ± 70 cal yrs BP (see Koerper et al. 1988:9). Only 18 leaf-shaped arrow points, as compared to 185 triangular specimens (≈1:10 ratio), were documented.

Discussion

Cottonwood Triangular and Leaf-shaped arrow points, as well as small notched projectile points of possible early bow-and-arrow technology, may have developed as smaller versions of atlatl morphological types. The early Cottonwood series points, especially the Leaf-shaped type, appear to be earlier than the Cottonwood series in the Great Basin, and thus it is reasonable to suggest that diffusion of the series may have been from the coast eastward into the desert. Finally, the inception of the Cottonwood series on the coast provides a convenient, if somewhat arbitrary, circa A.D. 600 ± 200 (1,350 B.P.) line for separating the Late Prehistoric Period from the Intermediate Period.

SONORAN SERIES

Koerper and Drover (1983:16-17) documented eight arrow points from CA-Ora-119-A characterized as elongated, sometimes needle-nosed points that flare at the base into pointed "ears" (Fig. 7a-c; see 7n-p for other examples). The midsection from CA-Ora-232 (Fig. 7g) may be this type of point. According to Koerper and Drover (1983), such forms are uncommon in the Great Basin, but occur frequently in late Hohokam deposits, as in the Sacaton phase at Snaketown (Gladwin et al. 1937:Plate 85; Haury

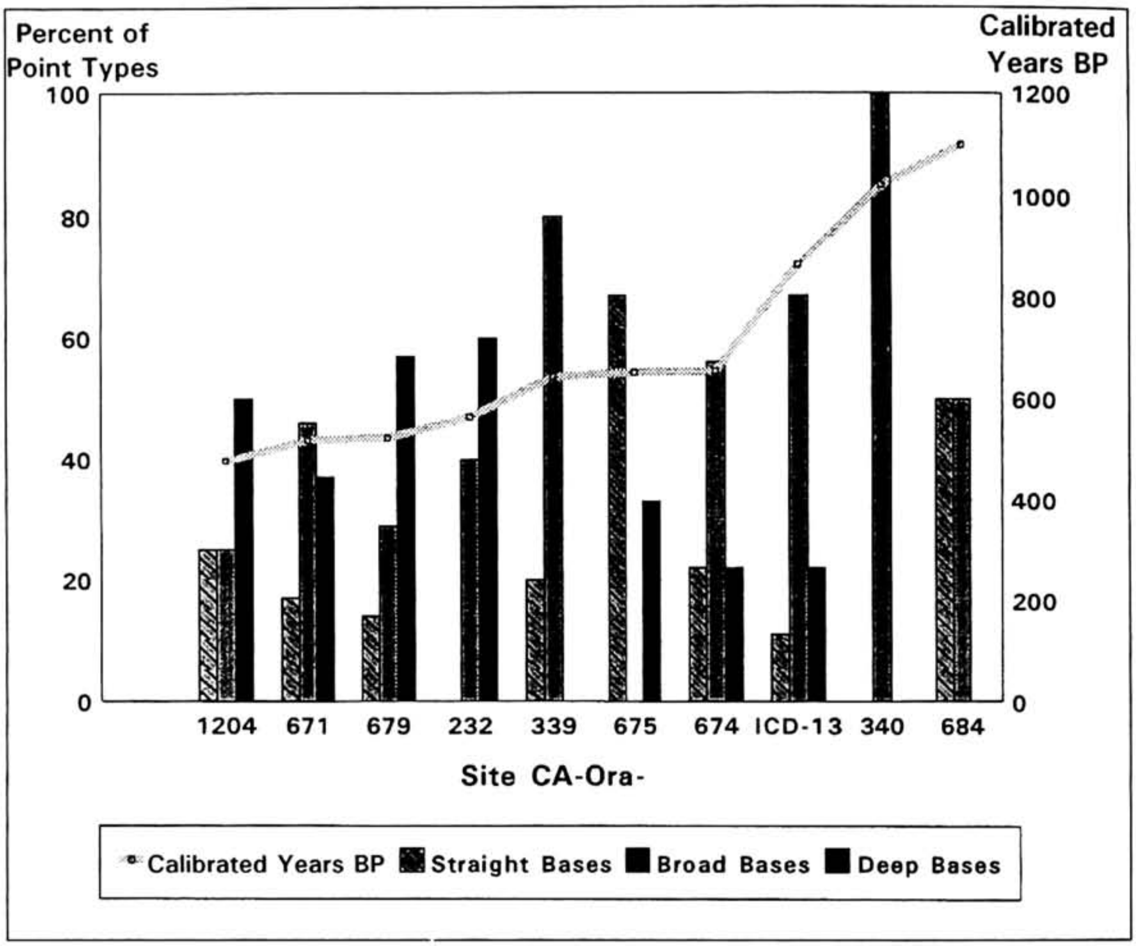

Fig. 6. Point type and radiocarbon data comparison. Summary data used to test Waugh's (1988) hypothesis.

1976:Fig. 14.39) and in historic Papago contexts, as at Batki (Haury 1950:Fig. 56). Such projectile points were common funerary offerings, especially before A.D. 1100 (Doyel 1991: 231; see also Bayman 1995:53-55). It was the striking resemblance between these southern California coastal points and the southwestern points that first inspired the name "Sonoran," hence the type name "Sonoran Eared."

A second type of Sonoran point recognized by Koerper and Drover (1983:18) was a tanged (stemmed) variety, the only three examples from Orange County (Fig. 7d-f) having been recovered by WPA crews working at the Bonita site (CA-Ora-107, see Fig. 2). All three were associated with a single burial (Winterbourne 1969: 40). We believe that they were trade items. The "Sonoran Tanged" type resembles points that are numerous in the Santa Cruz phase (ca. A.D. 700 to 900) of the Hohokam (Gladwin et al. 1937:Plate 91).

Another proposed Sonoran type, the Sonoran Straight-base projectile point (Koerper et al. 1992), matches the Type 11 projectile point illustrated by True (1966:Figs. 4e and 4f). This type is characterized by a rectangular or block-like base, straight or slightly convex curved at the proximal end. One such point occurs at

Table 3
COTTONWOOD LEAF-SHAPED/TRIANGULAR POINT RATIOS BY LATE PREHISTORIC SITE COMPONENTS IN CHRONOLOGICAL ORDER

Site	Average cal yrs BP[a]	Age Range (cal yrs BP[a])	Leaf-shaped/Triangular Ratio[b]
CA-Ora-1295	461	250 ± 70 to 570 ± 90	1:3
CA-Ora-1204	476	450 ± 70 to 500 ± 70	0:3
CA-Ora-671	518	290 ± 70 to 620 ± 70	1:6.1 (16:98)
CA-Ora-679	523	520 ± 80 to 530 ± 90	1:2.6 (5:13)
CA-Ora-232	564	370 ± 90 to 730 ± 70	1:5
CA-Ora-339	644	590 ± 90 to 700 ± 80	1:3 (2:6)
CA-Ora-675	652	520 ± 100 to 740 ± 80	1.1.5 (2:3)
CA-Ora-674	655	520 ± 60 to 930 ± 60	1:4 (2:8)
CA-Ora-1203	839	770 ± 90 to 910 ± 80	1:0
CA-Ora-663	861	800 ± 60 to 920 ± 70	3:0
CA-Ora-662 "Area 13" (ICD-13)	863	580 ± 50 to 1230 ± 80	1:1.125 (8:9)
CA-Ora-340	1022	670 ± 80 to 1280 ± 70	1:1.3 (3:4)
CA-Ora-684	1100	770 ± 60 to 1310 ± 90	1:2

[a] cal yrs BP = calibrated years before present.
[b] Actual frequencies are in parentheses when they differ from ratio.

NCAP site CA-Ora-662 (Fig. 7k), a site with a great variety of Late Prehistoric dates. True (1966:220) noted that such points are Late Prehistoric in both Shoshonean (northern) and Yuman (southern) areas of San Diego County. Similar arrow points are associated with the Sacaton phase (ca. A.D. 900 to 1100) Hohokam (Gladwin et al. 1937:Plate 89).

Only a few points that could be considered for the proposed Sonoran series were recovered in the NCAP excavations. Three points from CA-Ora-662 have thin distal ends, concave sides, and a flared look to the proximal end and are thus close to Sonoran in configuration (Fig. 7h-j). Although these may just be finely worked Cottonwood Triangular points, they may constitute a fourth Sonoran type, for which we tentatively propose the type name "Sonoran Concave-sided." These points might be distinguished in part by their lack of ears, tangs, or rectangular (block-like) bases. With this possible new type, we recognize that the specimen in Figure 7b may be closer to the "Concave-sided" than to the "Eared" variety, and we also recognize the need for more in-depth research for the Sonoran series.

Other sites with late dates and similar projectile points with concave sides include CA-Ora-672 (Fig. 7l) and CA-Ora-674 (Fig. 7m). The 10 CA-Ora-672 radiocarbon dates are all Late Prehistoric, the range being from 270 ± 100 to 820 ± 90 cal yrs BP. Cottonwood and earlier projectile points were present here. Such points with concave sides almost suggest a cross between Sonoran and Cottonwood varieties.

The historically recorded village of *Putuidem* (CA-Ora-855) in the San Juan Capistrano Valley was occupied mainly during the last third of the Late Prehistoric Period and into the ethnohistoric present (Koerper et al. 1985, 1988). Five or six projectile points may be categorized to the Sonoran series; nearly all of the remaining 250 plus arrow projectile points are Cottonwood Triangular points. Those illustrated in Figure 7n-p

Table 4
SUMMARY OF COTTONWOOD LEAF-SHAPED/TRIANGULAR RATIOS

< 600 cal yrs BP[a,b]	Between 600 and 800 cal yrs BP[c]	> 800 cal yrs BP[d]
23:122	6:17	16:15
≈ 1:5	≈ 1:3	≈ 1:1

[a] cal yrs BP = calibrated years before present.
[b] CA-Ora-232, -671, -679, -1204, and -1295.
[c] CA-Ora-339, -674, and -675.
[d] CA-Ora-340, -662 Area 13 (ICD-13), -663, -684, and -1203.

appear to be of the Sonoran Eared variety.

The proposed Sonoran series in Orange County is not elaborate compared to Santa Cruz and Sacaton specimens, and it is important to note that by A.D. 1100, funerary projectile points were becoming qualitatively inferior to earlier specimens (Doyel 1991:239; see also Bayman 1995:53-55). Orange County Sonoran projectile points may actually have arrived on the coast during the Classic Period (A.D. 1100 to 1450) of Hohokam culture. The proposed designation "Sonoran" maintains a separation of that series from the more typical Cottonwood Triangular points or Desert Side-notched points. The designation also maintains the suggestion of the continuity of the form throughout a large part of the Greater Southwest and possible historical links via diffusion or direct contact between Hohokam culture and coastal California.

Consistently, terminal Late Prehistoric dates for the proposed Sonoran series points on the coast support a contemporaneity with similar Hohokam projectile points, lending credibility to the hypothesis of historical connections between the two areas (see Koerper [n.d.], Heizer [1941, 1946], Walker [1945], Dixon [1960], Ruby [1970], Hedges [1973], and Bissel [1983] for descriptions of Southwestern artifacts found in southern coastal California sites). That is not to say that all Sonoran points on the coast are trade items. Many are made of local material and exhibit forms that probably were inspired by a few trade specimens.

OTHER RARE AND UNUSUAL PROJECTILE POINTS

Along the San Diego coast, the geographic demarcation between northern Diegueño (southern San Diego County) and Luiseño (northern San Diego County) peoples is possibly reflected in the presence and absence, respectively, of Desert Side-notched points (True 1966), first defined by Baumhoff and Byrne (1959) and generally thought to date from A.D. 1300 (e.g., Hester and Heizer 1973; Bettinger and Taylor 1974). In terms of archaeological cultures, this has historically been the distinction between Cuyamaca culture and the San Luis Rey Complex (True 1970). Not surprisingly, no unequivocal Desert Side-notched point was recovered in either the NCAP or CCAP excavations, although there is at least one such Orange County specimen (Fig. 8a). This specimen was found in Black Star Canyon by the WPA (Anonymous 1937; also see Fig. 2), and it exhibits possible stylistic parallels to certain Hohokam arrow points (see Gladwin et al. 1937:Plate 86).

Another very rare small point is a specimen (Fig. 8b) from CA-Ora-671. In plan view, the form resembles certain atlatl-and-dart or spear types (compare with specimens labeled Lake Mohave and Martis Stemmed Leaf in Heizer and Hester [1978, Figs. 5a-c and 6g]). Ten of the 11 prehistoric radiocarbon dates from CA-Ora-671 are from the latter part of the Late Prehistoric Period (between 290 ± 70 and 620 ± 70 cal yrs BP).

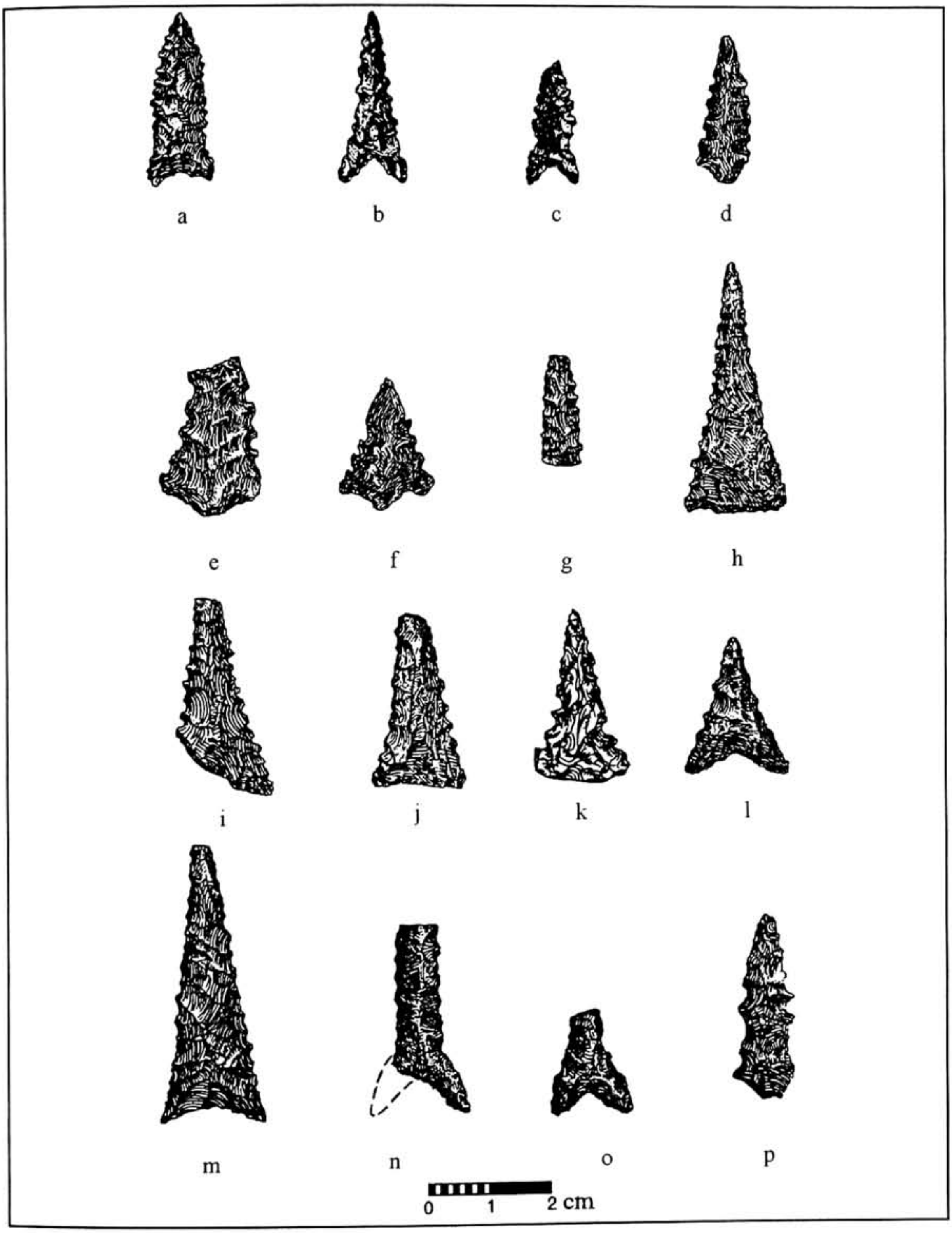

Fig. 7. Sonoran series projectile points from Orange County: (a-c) CA-Ora-119-A; (d-f) CA-Ora-107; (g) CA-Ora-232; (h-k) CA-Ora-662; (l) CA-Ora-672; (m) CA-Ora-674; (n-p) CA-Ora-855.

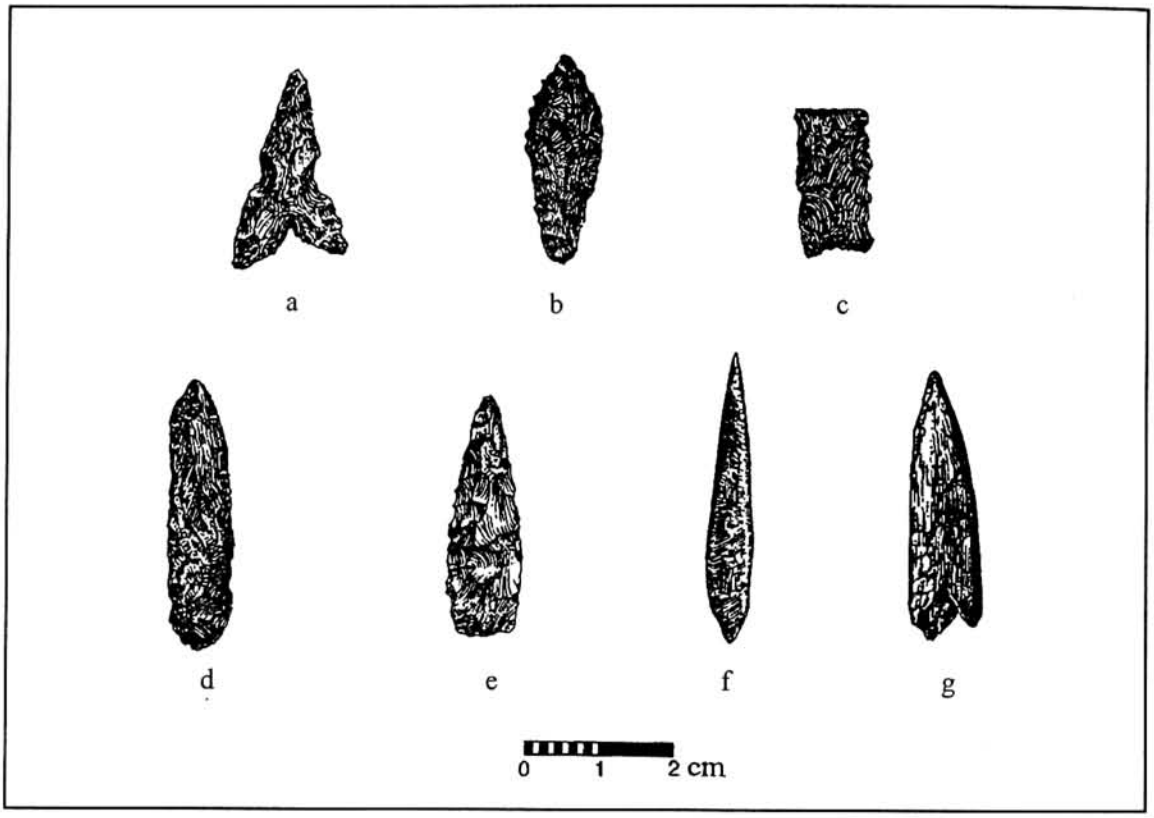

Fig. 8. Unusual arrow projectile points from Orange County: (a) Black Star Canyon; (b) CA-Ora-671; (c, e-f) CA-Ora-855; (d) CA-Ora-671; (g) CA-Ora-119-A.

Other highly unusual small stone projectile points include two relatively straight-sided points, one from CA-Ora-855 (Fig. 8c) and one from CA-Ora-671 (Fig. 8d). Another specimen that fits no recognized type is one from CA-Ora-855 (Fig. 8e).

Bone arrow projectile points are reported ethnographically for the Gabrielino and the Chumash (Harrington 1942:14). The bone object illustrated in Figure 8f is more likely an arrow point than part of a composite fish hook (P. Langenwalter, personal communication 1993). A terminal Late Prehistoric Period split base bone arrow point from CA-Ora-119-A (Fig. 8g) is a unique projectile point that went through an adult male's right orbit, penetrating to the nasal cavity (Koerper and Fouste 1977). This circumstance suggests the possibility of a ritual killing.

SUMMARY AND CONCLUDING REMARKS

Certain arrow projectile point types are useful for chronology building in southern coastal California archaeology. Temporal indicators include a possible Sonoran series, as well as Cottonwood Triangular, Cottonwood Leaf-shaped, and perhaps several small notched point types. The bow and arrow probably appeared on the coast in the early first millennium, ca. A.D. 400, a date comparable to that found by Yohe (1992) at the Rose Spring site in Inyo County. The earliest arrow points may have been types downsized from atlatl-and-dart projectile points of similar form, but it is not currently possible to identify any single type with the earliest use of the bow and arrow in Orange County.

The floruit of Cottonwood Leaf-shaped arrow points occurs earlier than that of Cottonwood Triangular types. The small Cottonwood Leaf-shaped points also may have preceded the notched arrow points, such as Marymount projectile points (Van Horn 1990). A Los Angeles County site (CA-LAn-61B), which has a terminal date of A.D. 400 to 500, has a point assemblage composed exclusively of the Cottonwood Leaf-shaped type (Van Horn 1990:35).

Cottonwood Triangular points certainly were in use and common by A.D. 900. Our data do not indicate any temporal co-variation occurring between Waugh's (1988) Cottonwood Triangular point categories (straight, broad, and deep base forms). We believe that the degree of basal notching is a function of thinning a point base to fit a preformed arrow shaft and not a reflection of a specific predetermined form.

The advantages of bow-and-arrow over atlatl-and-dart weaponry for combat and/or hunting probably account for the apparent rapid transition to the newer technology. The comparative advantages and disadvantages of the implements have been succinctly outlined by King (1989), an archaeologist who is a practicing archer and bow hunter. The larger atlatl dart points, with their greater cutting surface, may be potentially more lethal than arrow points once penetration has occurred, and since dart shafts are relatively long, fewer would have been lost than is the case with spent arrows whose size more easily allows them to disappear beneath grass or undergrowth. Using bows and arrows, however, hunters can minimize their movement, allowing shots to be fired from concealment and in a number of positions (King 1989).

The behavior required to propel an atlatl dart necessitates an exposed position for the hunter whose overhand motion, if detected by game, is detrimental to accuracy and precludes opportunities to launch additional darts. Hunters using the atlatl and dart, therefore, must seek controllable encounters, specifically targeting a particular species and hunting from strategically placed blinds:

> From a blind the atlatl hunter can wait for passing game to provide nearly the same shot, repetitively. Perhaps assisted by drivers or by intimate and species specific knowledge of game movements, such a hunter increases the odds by controlling the encounter and from knowing the kind of shot he is likely to be offered [King 1989:9].

Bow and arrow hunters need not be focused on a particular animal. Their flexibility allows rapid adjustment to a variety of game opportunities (King 1989). Interestingly, Hall and Barker (1975) reported a 280% increase in artiodactyl remains at Danger Cave coinciding with the appearance of the bow and arrow (see also Thomas 1970).

Further, the authors speculate that selection for the bow and arrow was due to their advantages over the atlatl and dart in warfare and other agonistic behavior. Bow-and-arrow weaponry allows for more firepower with less detection conducted at safer distances against an atlatl-and-dart equipped enemy.

Because the adoption of small projectile points over large ones seems not to have been gradual, a chronological boundary of convenience is suggested, to wit, the Intermediate Period on the coast giving way to the Late Prehistoric Period around A.D. 600. Curiously, it is at around this temporal interface that the local coastal area may have experienced a significant increase in population. Figure 9 shows an upsurge in radiocarbon dates after A.D. 600 in the San Joaquin Hills—a result, we suggest, of population pressure in the area surrounding Newport Bay.[1]

We further suggest that these two major events—population increase and adoption of bow-and-arrow weaponry—may be related. Further, the increase in population may have necessitated different social structures, including the realignment of hunting traditions from group (atlatl and dart) to individual (bow and arrow)

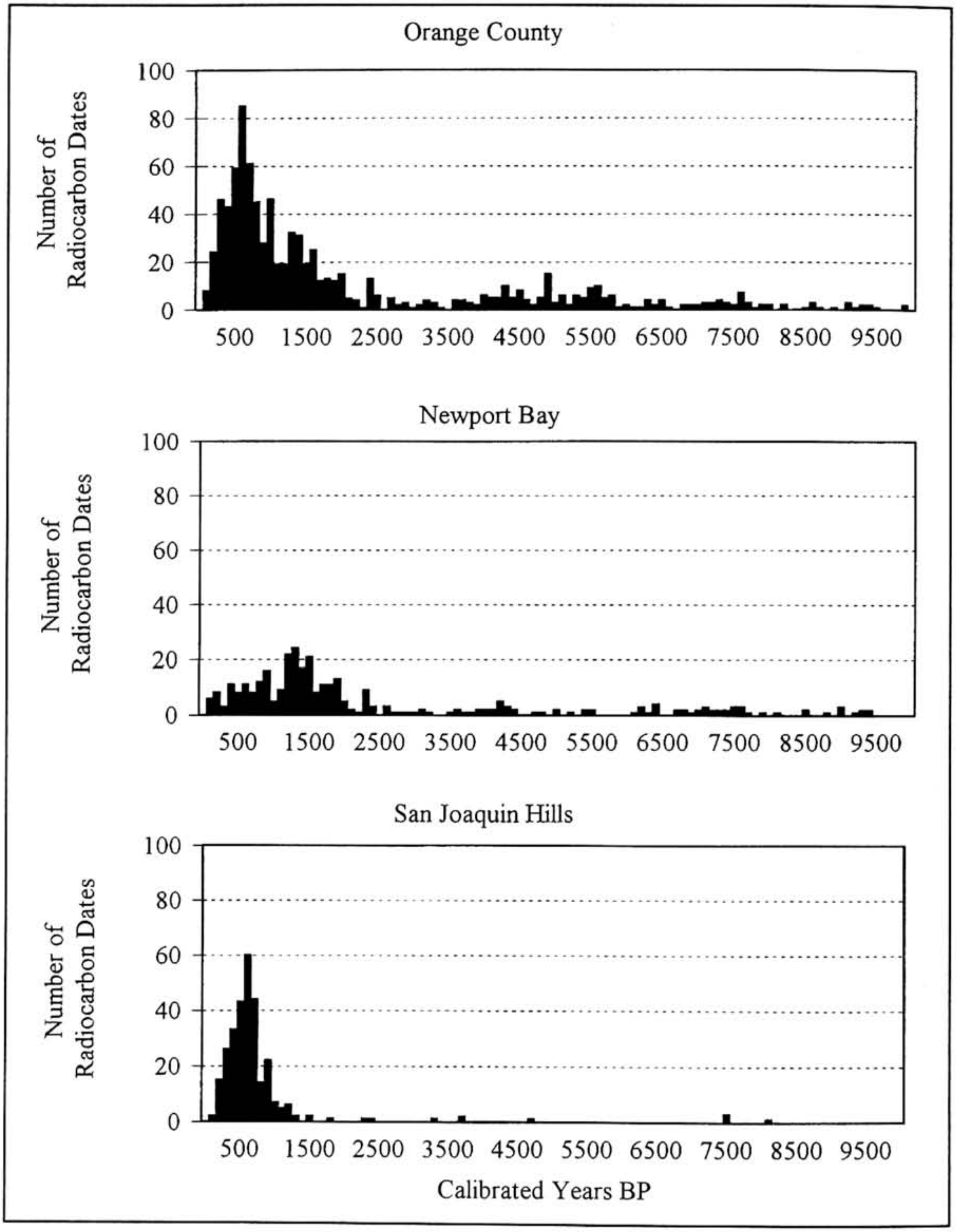

Fig. 9. Orange County regional radiocarbon chronology by geographic area.

strategies. Assuming such an association, we are inclined to place primary emphasis on these historical phenomena in distinctions drawn between the Intermediate and Late Prehistoric periods.

NOTE

1. The total set of over 900 radiocarbon ages shown in Figure 9 was summarized from a variety of sources and radiocarbon inventories. The NCAP accounts for 326 dates, while most of the remaining dates were secured from two compendia (Schroth 1983; Breschini et al. 1996). The sources contained radiocarbon determinations that were not consistent with regard to the corrections applied and the conventions employed, and it was necessary to uniformly calibrate or recalibrate each date. It was often necessary to apply preliminary reservoir corrections to account for fractionation effects. To maintain consistency, the ΔR value generated from the LLNL study (Prior et al. 1996) was applied to all shell dates to adjust for the marine upwelling and other reservoir factors. In the event that a date was not reported as a conventional age (i.e., uncorrected for isotopic fractionation), the radiocarbon ages were normalized with respect to the PDB standard, depending on the sample material. Isotopically uncorrected dates were changed to conventional radiocarbon ages by adjusting the date by the appropriate number of years either by assuming an average $\delta^{13}C$ (Del-13) value calculated from known $^{13}C/^{12}C$ stable isotope ratios for all wood-charcoal and marine shellfish samples in a particular radiocarbon subset or by using an assumed value of -25.0 o/oo with respect to PDB for wood charcoal and a -0.0 o/oo with respect to PDB for marine carbonates. The radiocarbon age determinations for both marine carbonates and wood-charcoal used to construct Figure 9 were calibrated using the 1993 version (Rev. 3.0.3A) of CALIB (Stuiver and Reimer 1993).

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