

Ancient long-distance trade in Western North America: new AMS radiocarbon dates from Southern California

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Abstract

Eleven *Olivella biplicata* spire-lopped shell beads from six sites located 250–365 km inland from the Pacific coast of southern California produced AMS dates between 11,200 and 7860 CAL BP. *Olivella* shell beads were well-documented items of prestige and media of exchange in Native California, and recovery of these examples from inland contexts indicates low-level exchange between resident populations of the coast and the southwestern Great Basin by at least 10,300–10,000 CAL years BP. These findings represent some of the earliest unequivocal evidence for long-distance trade in western North America and push the antiquity of this important form of inter-group interaction back several thousand years earlier than previously thought.

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1. Introduction

One of a handful of topics that draws the attention of hunter–gatherer scholars to California is the well-documented socio-political complexity of such groups as the Chumash [1–3,6,27,36,41,67,68,77,82], and the Yurok [88]. The ethnographic record testifies to the presence of such traits as hierarchical political organization and social stratification among these groups – supported to greater or lesser degrees by the late Holocene archaeological record [2,35,51,78,79]. The prehistoric record speaks more substantially to intensive and elaborate forms of trade as one of the most visible

material correlates of socio-political complexity. While study of trade has a long history in the region (see [21,24–26,33,34,49,78,95,103] among others), interest has intensified in the last decade due largely to Arnold's [2–4] proposal for a relatively recent and punctuated emergence of socio-political complexity among the Chumash intimately tied to a dramatic increase in shell bead exchange. While it is only one of several broad-scale models focused on variation in exchange through time in prehistoric California (see also [22,34,52,56,67]), this model has engendered significantly more debate (see [5,7,36,68,90,91]). Others envision incremental or gradual diachronic change – with either more commodities exchanged over greater distances through time [33,34] or over shorter distances [56]. Still other alternatives suggest historical fluctuation in exchange between the Great Basin and California [52] including punctuated decrease during the late Holocene due to climatic

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catastrophe [40,71]. None of these models has been fully validated or negated, but they share the view that long-distance and/or intensive exchange was closely tied to the evolution of complex hunter–gatherer societies in California. This view provides archaeologists with a mandate to track the development of exchange systems over time and to pay particular attention to the quantities and types of items traded, distances, and directionality.

In this paper we report evidence for exchange between the southwestern Great Basin and the California coast between at least 10,300–10,000 CAL BP and possibly as early as 11,200 CAL BP. This evidence consists of 13 Accelerator Mass Spectrometry (AMS) radiocarbon dates obtained from *Olivella biplicata* shell beads: 11 from archaeological sites 250–365 km inland from the Pacific coast and 2 from nearshore sites with well-dated Early Holocene components. The latter produced dates that were consistent with other chronostratigraphic findings from the same sites and corroborate the general accuracy of the AMS shell dates. Recent findings establish the presence of human populations on the northern Channel Islands off southern California as early as 13,000–12,000 CAL BP [27,67] and on other islands, coastal mainland and nearshore of central and southern California as early as 9000–10,300 CAL BP [20,27–30,41,71]. Findings reported by Morris and Erlandson [85] indicate that these coastal people were using *O. biplicata* shell beads at least as early as 9000 CAL BP. The current findings indicate that early coastal people established trade relationships with interior populations at least a millennium earlier.

2. Previous estimates for the antiquity of California–Great Basin bead exchange

While the ethnographic record speaks to the exchange of any number of perishable goods between California and the Great Basin [95,24,49], prehistoric trade is largely traceable via obsidian and marine shells. Hughes [52, pp. 367] points out that other durable commodities may eventually prove useful as indices of trade or long-distance movement, but some studies of such materials have produced highly misleading findings (see comments by Koerper et al. [80] and Shackley [97] on Cottrell [23]). Obsidian (traced to source via XRF analysis) and marine shell artifacts recovered from contexts far from the nearest ocean offer more secure inferences on the movement of goods.

Previously, the general consensus for the earliest exchange of marine shells between the Great Basin and California was during the “Early Archaic” ca. 6000 RCYBP [16,53], although slightly older shell beads have been reported from the Great Basin, most of which were dated not directly but rather by stratigraphic

association. From the Leonard Rockshelter in northwest Nevada (Fig. 1), for example. Heizer [48, p. 92] reported two *O. biplicata* spire-lopped beads from the lowermost cultural level, dated to ca. 7000 RCYBP (Table 1) on the basis of radiocarbon results from wooden artifacts recovered from the same stratum as the shell beads. At the Marmes Rockshelter in the Lower Snake River region of southeast Washington, Rice [93, p. 128] reported 12 *O. biplicata* spire-lopped beads from a Windust Phase component dated ca. 10,000–8000 RCYBP. Other *O. biplicata* beads not directly dated but of possible Early or Middle Holocene age have been recovered from Hogup Cave [1], Danger Cave [65], and Cowboy Cave [66] (Fig. 1). At Hogup Cave, the deepest *O. biplicata* “pendant” came from Stratum 6 dated about 6400 RCYBP [1, p. 91–92]. Danger Cave produced two spire-lopped or end ground *O. biplicata* beads from near the bottom of the deposit [65]. At least one spire-lopped *O. biplicata* was found at Cowboy Cave where overall occupation dates from 8300 to 1500 RCYBP [66, p. 24–25], but the exact provenience of this bead was not reported and its age remains somewhat ambiguous [81, p. 97–98].

Until recently, the oldest directly dated *O. biplicata* beads in the Great Basin came from Cowbone Cave at Lake Winnemucca in northwest Nevada, where a string of beads found around a mummy returned a date of 6550 CAL BP [87, p. 125] (Table 1). *Olivella* grooved rectangle (ORG) beads, a rather unique type classified as either N1 or N2 by Bennyhoff and Hughes [16], have recently been reported from the Fort Rock Basin of south central Oregon [62] and western Nevada [104]. Eight directly dated single bead specimens from these sites returned dates between 4400 and 5400 CAL years BP [104, p. 945]. A substantially older group of nine directly dated *Olivella baetica* ($n = 3$) and *O. biplicata* ($n = 6$) spiral-lopped beads were recently reported by Jenkins et al. [63] from sites in the Fort Rock Basin of eastern Oregon. These beads returned AMS calibrated ages between 6310 and 8580 CAL years BP [63].

3. New findings from central and southern California

Our findings consist of 13 AMS dates obtained from an equal number of *O. biplicata* spire-lopped shell beads recovered from six sites in the Mojave desert of southeastern California, and two sites from peri-coastal valleys of central California (Fig. 1). Twelve of the 13 beads were either directly identified by the authors as *O. biplicata* or were identified as such in the primary reports [13,32,43,96,98]. The single bead not specifically identified as *O. biplicata* was simply identified as a “medium-size spire-modified *Olivella* form” [12, p. 66] and may be *O. biplicata*, *Olivella dama* or *O. baetica*

[84]. Seven of the beads were recovered by one of us (Schroth) during the course of a dissertation research at two sites. The remaining southern California dates were obtained during CRM investigations on the Fort Irwin Military Reservation [12,13,43], but have not been more

widely reported. The last two Early Holocene shell bead dates were obtained from central California sites by the senior author, one from a recent CRM project, and the other with a grant acquired specifically as part of the research for this paper.

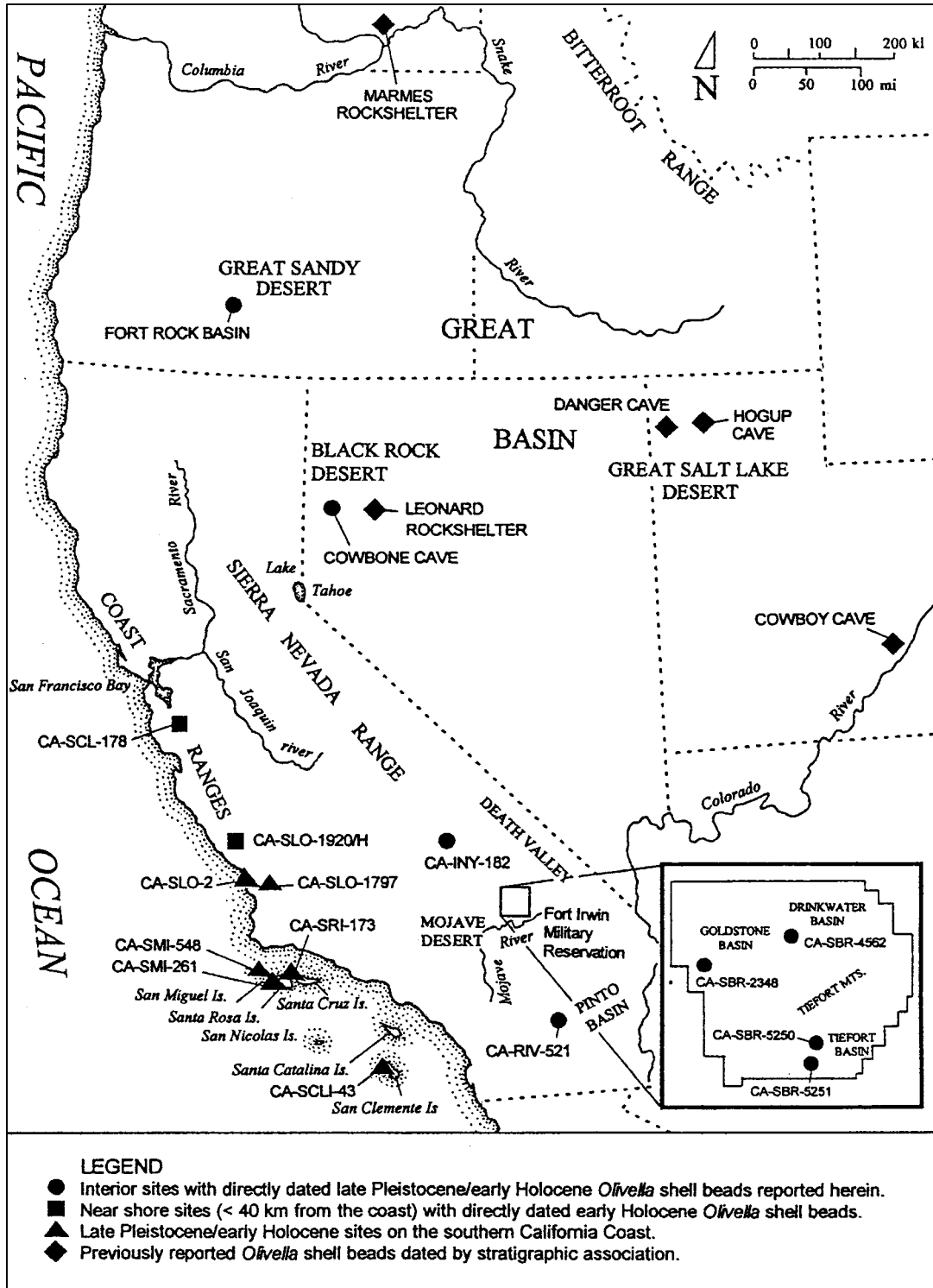


Fig. 1. Sites mentioned in text.

Table 1
Previously reported radiocarbon dates on *Olivella* spire-topped beads and shell beads dated by stratigraphic association

Sites	Material	Laboratory number	Unit and depth (cm)	Measured ^{14}C age years BP	Corrected $^{13}\text{C}/^{12}\text{C}$ years BP ^a	Calibrated age range years BP (* $\Delta R = 290 \pm 35$)	Calibrated age range years BP (* $\Delta R = 225 \pm 35$)	Reference
Cowbone Cave	<i>Olivella</i> Spire-topped bead	NA	NA	5970 \pm 150	6380 \pm 150	6190 (6520) 6860	6270 (6590) 6950	[84, p. 125]
Leonard Rockshelter	Wood artifacts	NA	Area B	7038 \pm 350	7038 \pm 350	–	7210 (7880) 8590	[47, p. 93]
Locality III Fort Rock Basin	<i>Olivella</i> spire-topped bead	Beta-101739	Unit A-5 176 cm	7850 \pm 60	8260 \pm 60	8290 (8430) 8590	8340 (8490) 8680	[60, p. 86]
Hogup Cave	Charcoal	GaK-1567	Stratum 6	5960 \pm 100	5960 \pm 100	–	6500 (6790) 7150	[1, p. 28]
Hogup Cave	Charcoal	GaK-1563	Stratum 6	6400 \pm 100	6400 \pm 100	–	7030 (7320) 7550	[1, p. 28]
Marmes Rockshelter	<i>Margaritifera falcata</i>	WSU-209	85N/45.5W, 92.2–92.5	7400 \pm 110	7675 \pm 110	–	8190 (8470) 8930	[89, p. 31]
Marmes Rockshelter	<i>Margaritifera falcata</i>	WSU-210	87–88N/40W, 89.6–89.8	7870 \pm 110	8150 \pm 110	–	8720 (9110) 9460	[89, p. 31]
Marmes Rockshelter	<i>Margaritifera falcata</i>	WSU-120	90N/25W, 89.0	7550 \pm 100	7825 \pm 100	–	8410 (8640) 8980	[89, p. 31]
Marmes Rockshelter	Charcoal	W-2208	Cremation hearth	8700 \pm 300	8700 \pm 300	–	9020 (9770) 10,550	[89, p. 31]
Marmes Rockshelter	<i>Margaritifera falcata</i>	W-2207	Cremation hearth	9010 \pm 300	9285 \pm 300	–	9600 (10,520) 11,230	[89, p. 31]
Marmes Rockshelter	<i>Margaritifera falcata</i>	Y-2482	Base of shelter mouth	9200 \pm 110	9475 \pm 110	–	10,430 (10,880) 11,160	[89, p. 31]
Marmes Rockshelter	<i>Margaritifera falcata</i>	Y-2210	Base of shelter mouth	9540 \pm 300	9815 \pm 300	–	10,300 (11,300) 12,590	[89, p. 31]
Marmes Rockshelter	<i>Margaritifera falcata</i>	WSU-366	73–76N/20W, 89.0	10,475 \pm 270	10,750 \pm 270	–	11,700 (12,690) 13,370	[89, p. 31]
Marmes Rockshelter	<i>Margaritifera falcata</i>	WSU-363	73–76N/20W, 89.0	10,810 \pm 275	11,085 \pm 275	–	12,350 (12,500) 13,100	[89, p. 31]
Marmes Rockshelter	<i>Margaritifera falcata</i>	WSU-211	87–88N/23.5–24.5W, 88.27	10,750 \pm 90	11,025 \pm 90	–	12,170 (13,040) 13,805	[89, p. 31]

Calibrated with CALIB 4.3 Stuiver and Reimer [102]. *Rounded calendar ages include midpoint (in parentheses) and age at two sigma using two established regional marine reservoir correction rates of 225 ± 35 years (Kennett et al. [76]), for southern California and 290 ± 35 years (Ingram and Southon [55]), for central California in order to account for unknown source of the *Olivella* shell. Charcoal dates and *Margaritifera falcata* (Western pearl shell), a fresh water mussel are expressed without marine reservoir factor.

Note: Cowbone Cave and Danger Cave radiocarbon dates omitted due to lack of provenience data on location of shell beads and/or reliable dates assigned to location of shell beads in the deposit.

^a All $^{13}\text{C}/^{12}\text{C}$ ratio corrections with the exception of the recent date from Locality III of Fort Rock Basin derived from Canadian Archaeological Radiocarbon database table (<http://www.candaianarchaeology.com/radiocarbon/card/whatif.htm>).

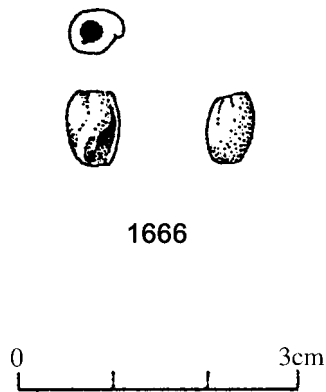


Fig. 2. *Olivella biplicata* spire-lopped shell bead from CA-SCL-178.

All of the specimens were simple spire-lopped *O. biplicata* beads of either type A1a, A1b, or A1c, (small, medium, and large) as described in the Bennyhoff and Hughes [16] typology. This bead type consists of nearly complete *Olivella* shells with the spire absent (Fig. 2). Spires may have been intentionally broken off or ground down or they may have been naturally waterworn [16, p. 115]. *O. biplicata* shells lacking a spire can be readily found on California beaches in areas with appropriate habitat. Such specimens are useable as beads without modification. This species occurs naturally from Vancouver Island to Baja California. King [78] established the spire-lopped *Olivella* as one of the earliest bead types in southern California. *O. baetica* species is also found in the shallow waters along the Pacific coast, but the *O. dama* is found exclusively in the Gulf of California and thus is an indicator of trade connections in a different direction [62].

4. Recovery contexts of specimens from the interior

4.1. CA-INY-182, Stahl Site

The Stahl Site is located in the southern portion of Rose Valley, west of the Coso Mountains, directly south of the Owens Valley in eastern California (Fig. 1) [96, p. 151]. Excavated by the Southwest Museum under the direction of Mark R. Harrington in the 1940s and 1950s [47], the site is one of the most well known in southern California. It lies on the tip of a large alluvial fan and covers approximately 21,600 m². Two large lava dikes bisect the site on a north–south direction, and it was near these dikes where Harrington excavated 484 m² of surface area down to “hardpan” [96, p. 160]. Harrington’s extensive excavations yielded numerous features including “house circles”, rock cairns, burials, and over 3800 artifacts. Despite all this work, he did not recover enough charcoal for a single radiocarbon date. In the absence of absolute dates, Harrington estimated the age

of the materials to be approximately 3000–4000 years [47, p. 72].

Schroth conducted excavations at the Stahl Site in 1991 as part of her doctoral research centered on the temporal placement of Pinto series projectile points [96, p. 1]. During the course of her investigations she recovered three *O. biplicata* spire-lopped beads from three different units between 70 and 170 cm below surface. AMS dates from these three beads along with five dates from composite bone samples were used to bracket an Archaic occupation between 10,000 and 4900 CAL BP [96, p. 323].

4.2. CA-SBR-2348, Goldstone Site

CA-SBR-2348 is one of four sites within Fort Irwin National Training Center (NCT), a sprawling military reservation of about 2590 km² in the north central Mojave Desert, to produce terminal Pleistocene/Early Holocene shell beads. Numerous archaeological investigations have been conducted at Fort Irwin during the last 20 years as part of Section 106 and 110 compliance for the Department of Defense (e.g., [8–15,17,41–43,45, 56–58,73–75,81,83,86,101,102,106,107]). As a whole, this focused body of work represents a major contribution to the archaeological record of the northern Mojave Desert.

The Goldstone Site is located in the west central area of Fort Irwin, along the eastern edge of the Goldstone Lake basin (Fig. 1). CA-SBR-2348 is a massive site with at least 16 discrete depositional loci recorded within an area of ca. 500,000 m². These loci range from moderate–dense subsurface deposits, to substantial but diffuse concentrations, to light scatters of cryptocrystalline debitage [44]. Prior to investigations in the early 1990s, the site was visited by Elizabeth and William Campbell, who collected surface artifacts in the 1930s and 1940s, and by Emma Lou Davis in the 1960s and 1970s [44]. In the 1990s, a systematic inspection and thorough recording of all the loci was completed along with a partial surface collection and limited excavation (two 1 × 1-m units in one locus, and one in another). A single *O. biplicata* spire-lopped bead recovered from the 30–40 cm level of one of the two units in Locus G was submitted for radiocarbon analysis (Table 1).

4.3. CA-SBR-4562, Awl Site

CA-SBR-4562, better known as the Awl Site, is located to the north and east of the Goldstone Site and west of the Drinkwater Lake playa [12]. Originally recorded in 1981 [46], the site is marked by two main cultural loci (A and B) encompassing an area of nearly 24,000 m² [12]. More extensive investigations conducted in the early 1980s revealed cultural deposits extending to a depth of over 2 m in locus A [64]. Additional

excavations and surface collection were completed in 1986 and 1989 resulting in 83 m³ of deposit were excavated from 42 units [12]. The combined excavation and surface collections yielded an impressive assemblage of chipped stone and ground stone tools, including 79 projectile points, over 26,000 faunal remains, and a single spire-lopped bead. The bead, identified only as an *Olivella* type A1a, was recovered from a depth of 130–140 cm in the lowermost stratum of locus A (Area 6, Unit S60/W72) [12, p. 66].

4.4. CA-SBR-5250, Rodgers Ridge

The final two sites on Fort Irwin (CA-SBR-5250 and 5251) that yielded ancient *O. biplicata* beads are located in Tiefert Basin in the southeastern portion of the base [43,61]. CA-SBR-5250, or “Rodgers Ridge” is one of the better known and most extensively studied sites at Fort Irwin. It derives its name from Malcolm J. Rodgers who collected artifacts there in the 1920s. Three major investigations were carried out at the site in the 1980s [43,59,60] including an extensive surface collection, shovel tests, and 112 excavation units of various size for a total of 165.6 m³ of controlled subsurface recovery volume [43]. These excavations provided a considerable body of chronometric data including 124 obsidian hydration readings, 197 temporally diagnostic projectile points, 19 aboriginal ceramic sherds, 5 *O. biplicata* spire-lopped beads and 9 radiocarbon determinations [43]. Eight of the radiocarbon dates were obtained from bulk soil samples or charcoal from features (hearths, a pit, and midden remnants). These samples produced dates between 1280 and 8400 RCYBP. The ninth date was obtained a year later [13] from one of the five *Olivella* beads (Table 1).

4.5. CA-SBR-5251, Flood Pond

CA-SBR-5251, the Flood Pond Site, is located 600–700 m west of Rodgers Ridge on and around a lunate-shaped dune that covers more than 123,000 m² [43, p. 131]. Originally investigated by M. J. Rodgers in the 1920s, the site was studied twice in the 1980s [43,60]. As with Rodgers Ridge, the investigations were extensive, including 81 hand excavated units (totaling 70.1 m³ of deposit), and 12,000 m² of systematic surface collection. Chronological data include 36 projectile points, 26 obsidian hydration readings, 88 ceramic sherds, 5 *O. biplicata* spire-lopped beads and 3 radiocarbon dates. Two of the dates obtained from samples of feature charcoal yielded uncorrected dates of 6640 ± 65 and 820 ± 70 RCYBP. The third date (Table 1) was derived from one of the five *Olivella* shell beads, recovered from the surface and as with the date on the bead from Rodgers Ridge, was not reported until the following year [13].

4.6. CA-RIV-521

The final site producing ancient *Olivella* shell beads is in the Pinto Basin 200 km south of Fort Irwin in Joshua Tree National Monument. CA-SBR-521 is part of a large complex of sites that extends from 8 to 9.5 km along the Pinto Wash [96]. Originally this nearly continuous string of loci was regarded as a single site (“the Pinto Basin site”) by its first investigators, Elizabeth and William Campbell who conducted archaeological investigations in this area in the 1920s and 1930s. [19]. Following the Campbells, the area was re-investigated in the 1950s by the Janishes, another local amateur couple, under the direction of Mark Harrington [96]. In 1972, George Jefferson on a “casual reconnaissance” of the area made important geological observations which led to further surface collections and limited excavations at three sites (CA-RIV-520, -521, and -522) [96]. Schroth conducted additional excavations at these three locations, including CA-RIV-521. Among other findings from this investigation were four *O. biplicata* spire-lopped beads from depths of 25–130 cm in three different units [96, p. 329].

5. Specimens from the coast

To further corroborate the accuracy of shell bead dates, two additional *O. biplicata* spire-lopped beads were selected for AMS analysis for the current study. The beads were from two coastal sites with well delineated early Holocene components: CA-SCL-178 and CA-SLO-1920/H (Fig. 1). The chronostratigraphic contexts of the two beads suggested that they should yield early Holocene dates. CA-SCL-178 is a complex, deeply stratified deposit situated in an alluvial fan in the southern Santa Clara Valley, ca. 35 km inland from the Pacific Ocean [50]. Extensive excavations completed in the early 1980s revealed cultural materials as deep as 9 m below the surface [49]. Radiocarbon determinations from charcoal suggested that cultural materials 3–9 m below surface represented a local manifestation of the California Milling Stone Culture dating to the Early Holocene ca. 8500–9600 RCYBP. A “burned earth feature” that included charcoal, ash, fire cracked rocks, debitage, two handstones, burned bones, and fresh water shell fragments at a depth of 4.5–4.9 m produced an AMS date of 9400 CAL BP from several fragments of burned rabbit bone [32] (Table 3). The *O. biplicata* spire-lopped bead (Fig. 2) dated for the present study was obtained from a depth of 5 m.

CA-SLO-1920/H is a large complex midden deposit located in northern San Luis Obispo County approximately 40 km from the coast. Investigated in 2000 in anticipation of a large housing development [98], this site produced abundant evidence for early Holocene

occupation with four radiocarbon dates on shell and mammal bone between 8700 and 9100 CAL BP from depths between 50 and 120 cm below surface (Table 3). An *Olivella* spire-lopped bead from 120 cm, the only such specimen recovered from the site, was selected for AMS analysis.

6. Methods

Samples from the interior were processed at the University of Arizona Accelerator Mass Spectrometry Laboratory, Tucson Arizona. Sample specific ¹³C/¹²C stable isotope ratios were not calculated for these samples and the uncorrected ¹⁴C ages provided by the laboratory were adjusted for ¹³C/¹²C through application of the value of +410 years proposed by Stuiver and Polach [100, p. 358] as a proxy (Table 2). Radiocarbon dates on non-marine shell materials also not corrected for ¹³C/¹²C stable isotope ratios, (Table 1) were calculated based on estimates from thousands of already reported commonly dated materials as collected and presented by the Canadian Archaeological Radiocarbon Database. The two specimens from the central California coast sites (CA-SCL-178 and CA-SLO-1920/H) were sent to Beta Analytic and dated at the Center for Accelerator Mass Spectrometry (CAMS) at the Lawrence Livermore National Laboratory. In this case, the laboratory provided sample specific ¹³C/¹²C values. All corrected dates were calibrated with CALIB 4.3 [101,102]. Because we could not be entirely certain of the point of origin for the shell beads found in the interior, two alternative ΔR values were potentially applicable: a figure of 225 ± 35 developed by Stuiver et al. [99] for southern California south of Point Conception and a value of 290 ± 35, developed by Ingram and Southon [55] for central and northern California. Both values were used as alternatives for the current study. Recent research has also demonstrated temporal variability in ΔR (e.g., [76]) along the California coast which further complicates calibration of dates, as does variability of 100–200 years in dates obtained from different portions of the same shell (see discussion by Rick et al. [94, p. 936]). We think it most prudent to consider the calibrated age estimates as reasonable approximations accurate only to within 100–200 years.

7. Results

The 13 *O. biplicata* spire-lopped beads produced dates between 10,960 and 7790 CAL BP with a ΔR of 290 ± 35 years and 11,200–7860 CAL BP with a ΔR of 225 ± 35 years. The two beads from near coastal sites produced dates fully compatible with their

Table 2
Radiocarbon dates on *Olivella* spire-lopped Beads from the Mojave Desert, southern California

Site	Distance inland from the coast (km)	Laboratory number ^a	Unit and depth (cm)	Measured ¹⁴ C age years BP	Corrected ¹³ C/ ¹² C ^b years BP	Calibrated age range years BP (ΔR = 290 + 35) ^c	Calibrated age range years BP (ΔR = 225 + 35)	Reference
CA-SBR-2348 (Goldstone)	275	AA-12403	1; 30–40	9125 ± 80	9535 ± 80	10,290 (9840) 9540	10,300 (10,000) 9590	[13, pp. 26–27]
CA-SBR-4562 (Awl)	265	AA-12404	S60/W72; 130–140	9450 ± 110	9860 ± 110	11,110 (10,290) 9830	11,110 (10,370) 9870	[13, pp. 26–27]
CA-SBR-5250 (Rodgers Ridge)	250	AA-12405	S122/W2; 0–5	10,085 ± 85	10,495 ± 85	11,589 (10,960) 10,640	11,900 (11,200) 10,830	[13, pp. 26–27]
CA-SBR-5251 (Flood Pond)	250	AA-12406	N0/W15 Surface	8930 ± 85	9340 ± 85	10,260 (9670) 9120	10,270 (9730) 9150	[13, pp. 26–27]
CA-INY-182 (Stahl)	365	AA-8620	4; 70–80	8670 ± 85	9080 ± 85	9790 (9220) 8990	9780 (9390) 9050	[96, pp. 314–332]
CA-INY-182 (Stahl)	365	AA-8621	9; 110–120	8625 ± 110	9035 ± 110	9770 (9250) 8940	9780 (9330) 9000	[96, pp. 314–332]
CA-INY-182 (Stahl)	365	AA-8622	6; 160–170	8400 ± 85	8810 ± 85	9570 (8970) 8820	9620 (9070) 8860	[96, pp. 314–332]
CA-RIV-521	300	AA-8613	8; 25–30	9330 ± 90	9740 ± 90	10,580 (10,260) 9720	11,040 (10,170) 8010	[96, pp. 314–332]
CA-RIV-521	300	AA-8614	4; 40–50	7920 ± 85	8330 ± 85	8820 (8480) 8330	8840 (8580) 8380	[96, pp. 314–332]
CA-RIV-521	300	AA-8615	3; 100–110	7225 ± 85	7635 ± 85	7970 (7790) 7630	8030 (7860) 7670	[96, pp. 314–332]
CA-RIV-521	300	AA-8616	3; 120–130	7730 ± 85	8140 ± 85	8470 (8330) 8120	8570 (8370) 8170	[96, pp. 314–332]

^a All radiocarbon dates processed at University of Arizona Accelerator Mass Spectrometry Lab, Tucson Arizona.

^b All ¹³C/¹²C assumed by University of Arizona Accelerator Mass Spectrometry Lab to be 0‰.

^c Calibrated with CALIB 4.3 (Stuiver and Reimer [102]). Rounded calendar ages include midpoint (in parentheses) and age range at two sigma probability.

Table 3
Early Holocene radiocarbon dates on *Olivella* spire-lopped beads and other materials from coastal sites

Sites	Material	Laboratory number	Unit & depth (cm)	Measured ¹⁴ C age years BP	Corrected ¹³ C/ ¹² C years BP	Calibrated age range years BP (ΔR = 290 ± 35)*	Calibrated age range years BP (ΔR = 225 ± 35)*	Reference
CA-SCL-178 (Blood Alley)	<i>Olivella</i> spire-lopped bead	Beta-186022	13; 500	8110 ± 50	8520 ± 50	8580 (8730) 8890	8620 (8790) 8950	–
CA-SCL-178 (Blood Alley)	<i>Syritagus atudboni</i>	Beta-183408	731; 460–490	8390 ± 50	8370 ± 50	–	9160 (9400) 9520	[31, p. 30]
CA-SCL-178 (Blood Alley)	charcoal	UCLA-2329B	13; 330	8500 ± 300	8500 ± 300	–	8650 (9510) 10,220	[48, p. 7–23]
CA-SCL-178 (Blood Alley)	charcoal	UCLA-2329C	13; 350	9200 ± 1000	9200 ± 1000	–	8110 (10,540) 13,120	[48, p. 7–23]
CA-SCL-178 (Blood Alley)	charcoal	UCR-1294	704; 750	9190 ± 600	9190 ± 600	–	8780 (10,450) 12,580	[48, p. 7–23]
CA-SCL-178 (Blood Alley)	charcoal	UCLA-2329D	13; 510	9960 ± 500	9960 ± 500	–	10,220 (11,560) 12,930	[48, p. 7–23]
CA-SLO-1920/H (Bunkhouse)	<i>Olivella</i> spire-lopped bead	Beta-151613	3; 110–120	8400 ± 40	8830 ± 40	8860 (9000) 9580	8900 (9070) 9590	[48, p. 7–23]
CA-SLO-1920/H (Bunkhouse)	<i>Saxidomus nuttallii</i>	Beta-147055	1; 64	8090 ± 70	8520 ± 70	8540 (8730) 8910	8590 (8790) 8960	[94, p. 76]
CA-SLO-1920/H (Bunkhouse)	<i>Ursus arctos horribilis</i>	Beta-158533	5; 50–60	7850 ± 60	7910 ± 60	–	8590 (8760) 8990	[94, p. 76]
CA-SLO-1920/H (Bunkhouse)	<i>Cervus elaphus nannodes</i>	Beta-154320	1; 100–110	8120 ± 40	8170 ± 40	–	9010 (9120) 9270	[94, p. 76]

Calibrated with CALIB 4.3 Stuiver and Reimer [102]. * Rounded calendar ages include midpoint (in parentheses) and age at two sigma using two established regional marine reservoir correction rates of 225 ± 35 years (Kennett et al. [76]), for southern California and 290 ± 35 years (Ingram and Southon [55]), for central California in order to account for unknown source of the *Olivella* shell.

chronostratigraphic contexts. The specimen from CA-SCL-178 from a depth of 5 m produced a date of 8730 CAL BP (ΔR = 290 ± 35) or 8790 (ΔR = 225 ± 35) which is consistent although slightly younger than the range of dates on charcoal and bone samples from 3.3 to 7.5 m depth from this site. The bead recovered from a depth of 120 cm from CA-SLO-1920/H produced a date of 9000 CAL BP (ΔR = 290 ± 35) or 9070 (ΔR = 225 ± 35) which is consistent with other early Holocene dates obtained from similar depths of this deposit. While small in number, these findings from interior valleys in coastal central California lend support to the overall antiquity and wide geographic distribution of *O. biplicata* spire-lopped beads.

Eleven beads from six inland sites produced dates between 10,960 and 7790 CAL BP with a ΔR of 290 ± 35 years and 11,200–7860 CAL BP with a ΔR of 225 ± 35 years. The single date of 11,200/10,960 CAL BP from Rodgers Ridge is older than the remaining 10 dates that fall between ca. 10,300 and 7800 CAL BP and must be regarded with caution. Among the remaining dates, however, two from separate sites (CA-SBR-4562 and CA-RIV-521), situated 265 and 300 km inland, respectively, yielded dates of ca. 10,300 CAL BP, and five from sites 250–300 km inland fell between ca. 10,300 and 8500 CAL BP. Three dates from the Stahl Site, 365 km inland, fall between 9300 and 9000 CAL BP.

8. Summary and discussion

The principal reason that the Fort Irwin bead dates were never reported to wider audiences were suspicions expressed by the site investigators about the accuracy of radiocarbon determinations from marine shell samples [11,13]. California archaeologists have a longstanding tradition of mistrusting dates obtained from materials other than charcoal, especially those from marine shell (see discussion by Erlandson [27]). Several important studies in the 1990s (e.g., Erlandson [27], Ingram [54], and Ingram and Southon [55]), however, demonstrated conclusively that, when properly corrected and calibrated, marine shells provide age determinations nearly identical to those from charcoal. Findings from 15 paired charcoal and shell samples from the West Berkeley Shell Mound in the San Francisco Bay area reported by Ingram and Southon [55] are particularly telling in this regard. Obtained from a full range of depth proveniences from this 5–6 m deep shell midden, the charcoal samples gave an age range between 4860 and 1250 CAL BP while the shell samples dated between 4820 and 960 CAL BP [55, p. 107]. Differences between the charcoal and shell dates were generally no greater than 100–200 years throughout the deposit.

Nevertheless, some caution is warranted when directly dating shell beads and ornaments as pointed out by Vellanoweth et al. [105] and Erlandson et al. [30] who warn that the use of “old shells” for beads could produce misleading radiocarbon results. The idea underlying this caution is the possibility that *Olivella* shells could be “mined” from uplifted beach deposits or otherwise exposed fossil shell beds resulting in greatly exaggerated radiocarbon dates [13]. This problem was encountered at the Cave of the Chimneys site (CA-SMI-603) on San Miguel Island where a date of $30,450 \pm 100$ RYBP was obtained from an 8000-year-old stratum [30]. Ancient shell beds containing fossil *Olivella* are known to exist on the mainland of southern California but these predate human presence in the New World by a substantial amount of time (e.g., San Diego Formation dated to 2–3 million years old in southern California). The bead dates in this paper, however, are not chronologically out of line with the deposits from which they were derived. Indeed, each shell bead originated from a site exhibited recognizable elements and diagnostic artifacts of well-documented early Holocene archaeological cultures, including the coastal Milling Stone Culture and the Lake Mohave/Pinto complexes of the interior deserts.

There remains the possibility that the presence of *O. buplicata* spire-lopped beads in the interior of southeastern California represents the activities of widely ranging, highly mobile terminal Pleistocene/early Holocene foragers (i.e., the beads represent direct acquisition not long-distance trade [8]). Distances between source and point of deposition of Clovis and other Paleoindian stone tools across much of North America suggest that these early groups did indeed range over vast territories [15,18,42,70,108]. Nonetheless, we feel there is little point in considering the specimens reported here as anything other than products of trade. While there is no consensus on what distance can be confidently attributed to exchange rather than direct acquisition, the specimens recovered from the Stahl Site are separated from the coast by 365 km, including two substantial mountain ranges. Archaeological studies have shown that the inland and coastal areas exhibit different cultural patterns during the interval indicated by the radiocarbon results: the Milling Stone Culture or Horizon on the coast and Lake Mojave/early Pinto complexes in the interior. Recent investigations [27–30,69,72] have provided strong evidence that each of these complexes was associated with distinctive settlement patterns and subsistence practices which suggests they represent at least two different resident populations – not a single highly mobile people. Furthermore, the *Olivella* shells that produced the early Holocene dates are non-utilitarian items that figured prominently in the exchange networks throughout ethnographic California and unequivocally in other prehistoric contexts. It is

reasonable to assume that the current specimens are the products of the same types of exchange activities. The dates from these specimens indicate that marine shell beads were being transported from the coast to locations 250–365 km inland by 10,300 to 10,000 CAL BP via at least one exchange between groups. As such, the current findings represent some of the earliest unequivocal evidence for long-distance trade in western North America.

At this time depth it is difficult if not impossible to evaluate the type of trade that was taking place (e.g., down the line, or free lance trade [92]) or its social context, particularly without comparable data from intervening areas. What is evident is that the exchange networks so well documented for Native California have very deep roots [16,24,95,36–39,49,78]. While the low level of long-distance trade indicated by the present findings certainly is not a sign of significant political complexity, it sets a new chronology for the establishment of the types of inter-regional relationships that eventually led to more regularized trade and elaborate socio-political structures in southern California.

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