Title

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Journal
American Antiquity, 81(1)

ISSN
0002-7316

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Publication Date
2016

DOI
10.7183/0002-7316.81.1.114

Peer reviewed

REPORTS

TROPHY HEADS OR ANCESTOR VENERATION? A STABLE ISOTOPE PERSPECTIVE ON DISASSOCIATED AND MODIFIED CRANIA IN PRECONTACT CENTRAL CALIFORNIA

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Few items in the archaeological record capture the imagination more than human heads separated from their bodies. Such items are sometimes assumed to indicate warfare practices, where "trophy heads" display power and fighting prowess. Other times, they are interpreted as representing ancestor veneration. Isolated crania are not uncommon in the Early period (ca. 4500–2500 B.P.) in Central California. Some anthropologists interpret them as trophy heads, but isotopic analyses at CA-CCO-548 suggest an alternative interpretation. Strontium isotope analyses on one modified cranium produced values consistent with local individuals, and both headless burials and people buried with extra skulls overlap in carbon and nitrogen isotopes. Further, teeth from two individuals who were buried with extra skulls suggest both were weaned at early ages (before age 2), much earlier than other individuals at the site. Together with contextual information, we argue that the isotopic data are more consistent with the hypothesis that extra skulls and headless burials represent ancestor veneration rather than trophies, shedding new light on Early-period societies in Central California.

Existen pocos elementos en el registro arqueológico que capturen la imaginación tanto como lo hacen las cabezas humanas separadas de sus cuerpos. En algunos casos, se asume que estos elementos indican antiguas prácticas de guerra donde las "cabezas trofeo" fueron utilizadas para demostrar el poder y la destreza en la lucha. En otros, éstas han sido interpretadas como una representación de la veneración a los ancestros. Los métodos isotópicos proveen una línea de evidencia independiente que puede ayudar a los arqueólogos a entender tales hallazgos. Los cráneos aislados no son infrecuentes en California Central en el Período Temprano (ca. 4500–2500 a.P.) y han sido interpretados por algunos antropólogos como cabezas trofeo. Nuestros análisis isotópicos en CA-CCO-548 sugieren una interpretación alternativa. Los análisis de isótopos de estroncio sobre uno de los cráneos modificados produjeron valores consistentes con individuos locales y ambos, enterratorios sin cabezas y gente enterrada con cráneos extra, se superponen en los isótopos de carbono y nitrógeno. Además, los dientes de dos individuos que fueron enterrados con cráneos extra sugieren que ambos fueron destetados a edades tempranas (antes de los 2 años), mucho antes que otros individuos en ese sitio. Nosotros argumentamos que los datos isotópicos, junto con la información contextual, son más consistentes con la hipótesis que los cráneos extra y enterratorios sin cabezas representan la veneración a los ancestros más que los trofeos, lo cual arroja nueva luz sobre las sociedades del Período Temprano en California Central.

Head-taking is a powerful image in human societies, both today and in the past. Trophy heads figure prominently in the iconography and public display of several ancient and recent chiefdoms, states and empires, both in the Americas (e.g., Andrushko 2011; Brown and Dye 2007; Cordy-Collins 1992; Hassig 1992; Ogburn 2007; Seeman 1988) and beyond (Anderson 2001; Axtell and Sturtevant 1980; Gigante 2006; Law 1989; Nagaoka et al. 2010; Okumura and

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American Antiquity 81(4), 2016, pp. 114-131 DOI: 10.7183/0002-7316.81.1.1

Siew 2013). While iconographic and/or textual sources are often more extensive and graphic for complex societies, it is clear that this practice extends to smaller-scale societies as well. Indeed, Chacon and Dye (2007:5) state that human trophy-taking is present in nearly every major culture area of the Americas, except Patagonia.

When archaeologists find isolated crania or headless burials in situ (i.e., taphonomic processes are ruled out), two potential behaviors are typically considered to explain their presence: trophy-taking and ancestor worship. These rather polar interpretations have quite different implications for our reconstructions of ancient societies. The former implicates violent scenarios, including warfare, prisoner-taking, decapitation, and the display of dismembered body parts for ritual displays of power (Moser 1973; Seeman 1988). By contrast, the latter has a non-violent interpretation, suggesting emotional attachments to deceased individuals from the community.

Contextual information in archaeological sites can be important in helping to differentiate between these endpoints, or can indicate an intermediate situation. For example, the plastering and modeling of crania, their placement within domestic features, and associated iconography in Natufian through Neolithic times in a range of sites in Southwest Asia suggest ritual behavior and ancestor veneration (Bonogofsky 2005; Goren et al., 2001; Kuijt 1996; Özbek 2009; Talalay 2004). By contrast, in the Nasca region of Peru, headless burials, caches of skulls with holes drilled through the frontal bone, occasionally with cordage running through the hole still preserved, and iconography depicting severed heads mounted on poles strongly imply trophy-taking (Browne et al. 1993; Conlee 2007; Kellner 2006). Indeed, such finds in Nasca, as well as iconography depicting severed heads, may have prompted Max Uhle to coin the term "trophy head" (Silverman and Proulx 2002:290).

More recently, stable isotope analyses provide an independent avenue in which to study and understand the social context of human skeletal remains, including isolated skulls and headless bodies. Stable isotope information can indicate where people resided and what types of food they consumed at different points in their lives. In this respect, we can examine whether individuals buried with extra skulls were local to that region, or whether they consumed different foods than others in the local population, either as adults or as children (e.g., "warriors" may habitually consume different foods). For example, the traditional assumption in the Nasca case mentioned above has been that the decapitated were non-local victims captured during raids and warfare, with trophies displayed as proof of victory in warfare. However, recent strontium isotopic analyses of bone and teeth show, surprisingly, that many of the decapitated were not foreigners, but were locals to the region (Conlee et al. 2009; Knudson et al. 2009). Such isotopic analyses produce data that are difficult to extract using other modern methods. In the Nasca case, strontium isotopes place the trophy heads in a geographic context, showing that they overlap isotopically with the rest of the population and were the heads of local individuals. As a result, Nasca archaeologists recently implicate ritual activities, rather than warfare, to explain their presence.

Isolated skulls and headless bodies are also known from archaeological sites in Central California, especially from the Early period (ca. 4500–2500 B.P.). As in the Nasca case, violence and trophy-taking have often been implicated as the root cause for such findings, though the contextual evidence is less clear. For example, Lillard et al. (1939) report a "trophy skull" lacking cut marks at CA-SAC-107 buried next to the pelvis of an adult of unknown sex. Likewise, Heizer (1949) thought that a calotte (skull cap) fashioned into a container from the same site was that of an "enemy," and Ragir (1972:25) interpreted five isolated skulls from CA-SAC-168 as "heads taken from war victims." Isolated heads have also been reported from sites that post-date the Early period, including CA-SMA-23, CA-SAC-99, and CA-SCL-806 (Schwitalla et al. 2014). In addition, headless burials have also been found and implicated in ancient trophy-taking behaviors. Heizer (1949:28) interprets headless burials from Early-period sites as evidence for "head-taking in war." Based on cutmarks and other information, Krieger (1935:23–25) suggested at least three of several headless burials at CA-COL-2, a Middle to Late period site along the Sacramento River, had been decapitated as part of trophy-taking activities. Many other examples of isolated crania and headless burials are tabulated by Schwitalla (2013; Schwitalla et al. 2014) and interpreted as evidence of warfare and trophy-taking.

Archaeologists who encounter isolated crania or headless burials in Central California often allude to ethnographic data to support their interpretations of warfare and trophy-taking. Kroeber (1925:157, 179) described trophy-taking practices for a range of California groups (see also Mason 1912:180). As summarized by Lambert (2007), head-taking and scalping was more common among some linguistic families (e.g., Penutian and Hokan) and geographic areas (e.g., Southern California, Sacramento Valley), but was reported in over 75 percent of the 49 tribes for which such behavior could be ascertained. Ethnographically, such trophy-taking was typically associated with warfare, and trophies were commonly mounted on poles for public display.

Unlike the Nasca case, isotopic information has not been collected in Central California, but could provide important data to test the "trophy head" hypothesis. Many of the early archaeological accounts cited above did not include detailed osteological or other contextual evidence to provide empirical support for their claims, or adequately consider alternative explanations. As in the Natufian and Neolithic cases in Southwest Asia, other behaviors such as ancestor veneration could account for such findings.

CA-CCO-548

Recent excavations and subsequent osteological and isotopic analyses at an Early-period site in Central California, CA-CCO-548 presented the opportunity to test the "trophy head" hypothesis. CA-CCO-548, also referred to as the Marsh Creek or Pearl site, lies on the western edge of the large California Delta at approximately 50-m elevation (Figure 1). The site borders the northeastern edge of the Diablo Range along Marsh Creek, a seasonal stream that originates near the eastern summit of Mount Diablo and that flows into the California Delta. The site lies within a broad open grassland community with scattered oak trees. An urban development project resulted in near-complete destruction of the site, necessitating large-scale excavation under the California Environmental Qualities Act (CEQA) that, in addition to a range of cooking and domestic features, unearthed nearly 500 human burials (Wiberg 2010).

Radiocarbon dates from CA-CCO-548 show that the site was occupied from at least 7,000 years ago until the time of Euroamerican contact. However, direct AMS radiocarbon dates from collagen on over 130 burials indicate that the cemetery is constricted to a narrower temporal window. All but five collagen dates fall between 4300 and 2950 cal B.P. (Eerkens, Bartelink, et al. 2013:12). The burials discussed below all date within this temporal window.

Of the 480 individuals identified during excavation, 15 display an unusual burial treatment with respect to crania. Eight individuals were interred with an extra skull (but no other additional postcranial elements), and seven were buried missing their skull. In each case, the extra skull was discovered next to the cranium of the main burial, with the exception of Burial 285 (Table 1), where the extra skull was found in the abdominal region. No evidence of healed or perimortem trauma (e.g., cut marks) was observed on any of the extra skulls; however, three of the extra skulls exhibited traces of red ocher (those associated with Burials 107, 197, and 426). Fourteen of the 15 individuals with special burial treatment were adults at the time of death, while one individual (Burial 69) was of indeterminate age. Males and females are represented in approximately equal numbers among both burials containing an extra skull (4 males, 2 females) and those missing their heads (2 males, 2 females), while the remaining one-third (n = 5) are indeterminate for sex. Three individuals, Burials 107, 109, and 137 are of particular interest in our analyses and are described in greater detail below. Summary age, sex, radiocarbon date, and isotopic data for all 15 individuals with unusual burial treatment are given in Table 1.

Burial 107 is an adult male aged 35–45 at the time of his death. He was buried in an extended position with his head pointing south in a common pit with two other males (Burials 105 and 106). Aside from slight periodontal disease and a partially healed mandibular fracture, there was no evidence indicating nutritional stress, disease, or additional physical trauma on the skeleton. Burial 107 was interred with a modified calotte covered in red ochre, placed next to his right arm. The calotte was from an adolescent or young adult,

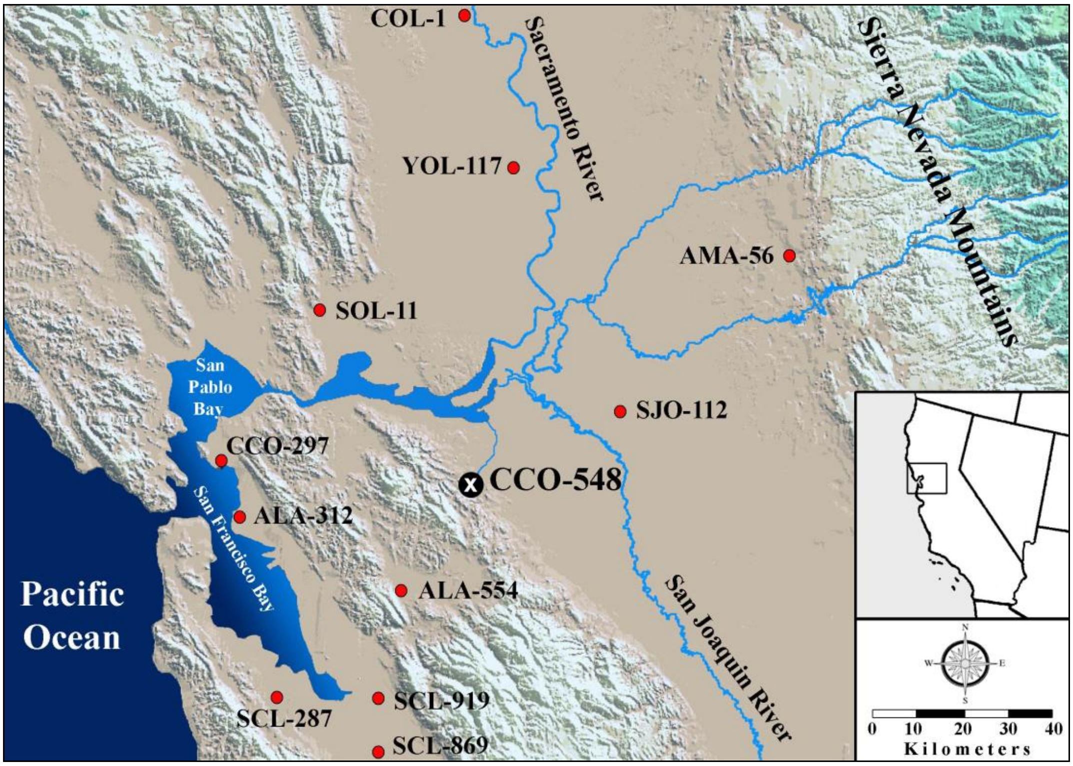

Figure 1. Map of Central California showing CA-CCO-548 and other comparative sites included in isotopic analyses.

sex indeterminate, and had been cut near the superciliary arches and exhibited highly polished edges (Wiberg 2010:125). Such polishing could be intentional from initial fabrication, but could also be a byproduct of extensive handling in ancient times. The calotte had an unfused metopic suture, suggesting that liquids would have leaked through the bottom if it had been used as a bowl. In addition to the calotte, Burial 107 was also interred with one pointed bone artifact fragment and a serpentine phallic charmstone fragment.

Burial 109 is an adult female who was 35+ years of age at the time of her death. She was buried in a semiflexed position with her head oriented in an easterly direction. An isolated skull (cranium with a mandible) was interred directly adjacent to her head, but vertebral and other postcranial skeletal elements from this second individual were not present. Although highly fragmented, the entire cranium from this second individual appears to be present. Based on tooth wear, the individual represented by the isolated cranium is also estimated at 35+ years of age, though sex is indeterminate.

Burial 137 is an adult male who was 40+ years of age at the time of death. He was buried in a semiflexed position with his head pointed towards the east. Four other adults, three females and one of indeterminate sex (Burials 134, 135, 136, and 138), were buried in close proximity to Burial 137 in the same burial pit. An isolated modified calotte of an adult (sex indeterminate) was found next to the skull of Burial 137 and may have been placed in his left hand at the time of interment. The calotte is shown in greater detail in Figure 2. Like the modified calotte found with Burial 107, this artifact had been cut from the cranium just above the superciliary arches, exhibited rounded and highly polished edges. This item, however, had fused sutures and could have been used as a small bowl for liquids. A small piece of bone was removed from the calotte and analyzed for $^{87}Sr/^{86}Sr$.

The presence of skulls isolated from their postcrania (n = 8), as well as the presence of headless burials (n = 7), was interpreted as potential evidence for warfare at CA-CCO-548 (Wiberg 2010:332,447). Termed "trophy heads," these find-

Table 1. Burial Data, Chronology, and Isotope Results.

Individual	Extra or MissingSkull	Sex	Age	$\delta^{15}N$ (‰)	$\delta^{13}C$ (‰)	87Sr/86Sr Tooth	87Sr/86Sr Bone	^{14}C Date (uncal.B.P.)
Burial 9	Missing skull	M	35–40	9.8	-19.2			3100 ± 20
Burial 69	Missing skull	I	Indet.					
Burial 129	Missing skull	F	Adult	9.6	-20.0			2980 ± 25
Burial 130	Missing skull	I	Adult					
Burial 241	Missing skull	M	Adult	11.2	-19.0			
Burial 363	Missing skull	F	40+	8.0	-19.2			3590 ± 30
Burial 374	Missing skull	I	Adult					
Burial 107	Extra skull	M	35–45	8.8	-19.5	.70732	.70735	3505 ± 30
Burial 109	Extra skull	F	35+	8.8	-19.5	.70736	.70736	3465 ± 30
Burial 119	Extra skull	I	40–50	10.5	-20.6	.70739	.70734	3570 ± 25
Burial 137	Extra skull	M	40+	8.5	-19.9			3510 ± 40
Calotte	With Burial 137	I	Adult				.70731	
Burial 197	Extra skull	M	40–45	6.6	-21.7			
Burial 207	Extra skull	F	18–25	9.0	-19.4	.70735	.70729	3335 ± 30
Burial 285	Extra skull	I	Adult					
Burial 426	Extra skull	M	Adult					
Male Mean			39.9	9.5	-19.9	.70729	.70727	
Male SD			9.4	1.2	.7	.00011	.00005	
Female Mean			41.4	9.3	-19.8	.70728	.70729	
FemaleSD			10.8	1.0	.7	.00012	.00005	

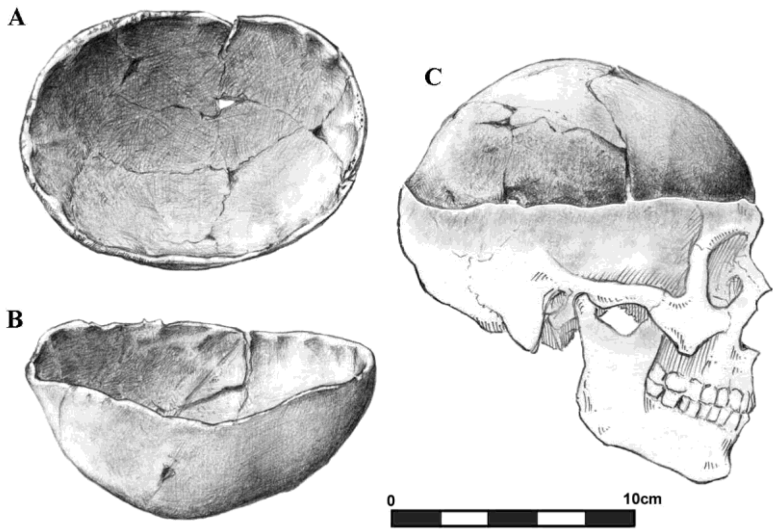

Figure 2. Drawings of modified human calotte associated with Burial 137: (a) internal, inferior; (b) left side; (c) right side and portion of original cranium used.

ings played a significant role in a follow-up study (Van Buren and Wiberg 2011) suggesting that individuals from the Central California coast may have immigrated to the site, violently subjugated local residents, and then took up residence themselves. This hypothesis presumes a high level of interpersonal violence; however, there is very little evidence of craniofacial trauma or projectile point injury at the site (Wiberg 2010:447), a finding consistent with other contemporaneous sites in Central California (Bartelink et al. 2013). As discussed below, we believe that new isotopic data bring this interpretation into question.

Methods

Following discussions with the Most Likely Descendant (MLD; co-author Ramona Garibay), we initiated stable isotope analyses and radiocarbon dating to begin the process of reconstructing life histories for a sample of the individuals recovered during excavation. We sampled bone, tooth, and calculus from approximately 200 individuals. This study focuses on a smaller sample of people either missing or containing an extra skull, but we use the larger population as a baseline for comparison.

Stable isotope analyses allow the deceased to reveal certain aspects of their lives, on an individual-by-individual basis, particularly dietary and mobility patterns. Furthermore, because different biogenic tissues form over different temporal windows within the lifetimes of individuals, we are able to estimate certain aspects of diet and mobility across those windows of time. We contrast information from the early childhood years, using isotopic signatures preserved in first molars or other early-forming teeth, with that from adult years, using bone. We estimate diet for individuals using collagen extracted from either dentin (childhood) or bone (adult) and changes in residence using strontium isotopes from enamel and bone.

Early childhood diet was reconstructed by examining stable isotope values in serial samples taken from the dentin of intact first molars (see Eerkens et al. 2011; Eerkens and Bartelink 2013). Biological tissues in the human body are synthesized from imbibed water and consumed food, which often have different isotopic baselines. These isotopic signatures are then transferred to various human tissues, sometimes with slight fractionation effects in the human body (i.e., where one of the stable isotopes of an element is differentially incorporated into a particular tissue). We were interested, in particular, in whether individuals who were buried with extra skulls had unusual childhood diets, though they lived into adulthood. Of course, because no teeth are present, we cannot reconstruct childhood diet from headless burials.

Collagen is a protein that helps to form connective tissues in bone and dentin and is synthesized mainly from dietary protein (Ambrose and Norr 1993; Froehle et al. 2010; Kellner and Schoeninger 2007; Schwarcz 2000; Tieszen and Fagre 1993). Collagen in bone is continually remodeled throughout the lifetime of an individual, with residence times varying from about five to 20 years, depending on the remodeling rate of the skeletal element (Hedges et al. 2007; Manolagas 2000). Isotopic data from bone collagen, then, informs primarily on the protein source consumed during the last several years of life prior to death. Teeth, on the other hand, do not remodel and preserve a signature of dietary behavior over the temporal window during which those tissues formed. For permanent first molars, this begins at about birth, when the crown starts forming, and ends around age 9.5 when the apical ends of the roots are completely formed (Dean and Vesey 2008; Hillson 1996). Like bone, dentin includes significant amounts of collagen. Unlike bone, however, tissues in teeth accrue in a predictable manner. Dentinal tissue forms in nearly horizontal layers in the crown, with oldest layers at the top near the dentin-enamel junction (DEJ), and in concentric cones with truncated tops in the root. Dentinal tissue accumulates from DEJ downward over time (Hillson 1996). Isotopic variation in the collagen of dentin, then, can tell us about dietary variation throughout the first 9.5 years of life (Dean et al. 1993; Dean and Vesey 2008; Eerkens et al. 2011; Hillson 1996; Liversidge et al. 1993).

Some secondary and tertiary dentin can be deposited within a tooth later in life, after tooth formation, and is laid down along the walls of the pulp chamber (Beaumont et al. 2012). However, the relative mass of secondary dentin is minor compared to the mass of primary dentin in the crown and root. Moreover, in many cases it is possible to remove much of this later-forming dentin by reaming out the pulp chamber.

For sampling teeth, we follow methods described in our previous research (Eerkens et al. 2011; Eerkens and Bartelink 2013). This process includes sampling a first molar with at least a portion of the crown preserved, as well as a complete root. First molars were measured, noting in particular the location of the DEJ, if present, and the cementum-enamel junction (CEJ). The distance from the CEJ to the apical root tip was then measured. Teeth were bisected vertically with a saw to expose the pulp chamber, which was reamed out. The tooth exterior was then cleaned of all cementum and enamel using a drill bit. Cleaned samples were then washed and sonicated in deionized water and immersed in .5M HCl at 1°C for demineralization. HCl was replaced every one to two days until the tooth no longer visibly reacted with the HCl solution and was spongy in texture (approximately 5 to 14 days). Following demineralization, the tooth was rinsed and sliced with a scalpel into thin parallel sections approximately 1 to 2 mm thick, perpendicular to the central axis of the root. These sections do cross growth lines, but it is not presently possible to cut cone-shaped sections from the tooth. Demineralized sections were then placed in separate glass vials and treated with .125M NaOH for 24 hours to remove humic contaminants. Samples were then rinsed with dH_2O, immersed in pH ò 3 water, and placed in an oven at 80°C for 24 hours to solubilize the collagen. Sectioned samples were centrifuged, with the liquid fraction removed and freeze-dried. Typically, we were able to generate between 8 and 12 serial sections per tooth, depending on the degree of tooth wear and the size of the tooth. Because we needed 1 mg of collagen for each run on the mass spectrometer, in some cases we had to combine collagen from successive serial sections after freeze-drying to reach this amount. Overall, we averaged between 7 and 8 isotopic analyses per tooth.

Bone samples followed the same procedure as above, being cleaned, demineralized, and treated to remove humic contaminants, but were not otherwise sectioned. Tooth and bone collagen d^{13}C and d^{15}N was measured by continuous-flow mass spectrometry (PDZ Europa ANCA-GSL elemental analyzer interfaced to a PDZ Europa 20-20 isotope ratio mass spectrometer) at the Stable Isotope Facility, University of California at Davis. The atomic C/N ratio was also measured; this is a useful indicator of sample quality and was used to eliminate poorly preserved collagen samples (DeNiro 1985; van Klinken 1999).

d^{15}N values of human collagen are highly dependent on the trophic level of protein consumed by an organism. In foodwebs, d^{15}N values increase by about 2 to 4‰ with each trophic level (DeNiro and Epstein 1981; Minagawa and Wada 1984; Schoeninger 1985). As a result, an infant that is completely dependent on breastmilk for protein will display an elevated d^{15}N value over its mother by one trophic level. This effect has been shown in both controlled studies as well as in archaeological studies of human bone collagen of infants (Eerkens et al. 2011; Fogel et al. 1989; Fuller et al. 2003, 2006; Katzenberg et al. 1996; Schurr 1997). As a child is weaned on solid foods, the d^{15}N value decreases. The rate of decrease depends on how abruptly a child is weaned and the quantity of solid foods incorporated in the diet over time. The source of the weaning food will also affect how much the d^{15}N value will decline. Children weaned on low-trophic-level foods such as plant gruels, will have lower d^{15}N values than children weaned on a mix of meat and plant products. By analyzing serial sections of collagen from tooth dentin, we can follow the weaning process from high d^{15}N values in pre-weaning times to more adult-like diets, as well as the general trophic levels of foods consumed across this process. Further, because the roots of first molars continue growing until age 9.5, and humans are weaned well before this age, we can continue to follow diets through the early childhood years.

Strontium isotope ratios of ^{87}Sr to ^{86}Sr in bone vary mainly as a function of geologic age and the concentration of strontium and rubidium in sediments (Capo et al. 1998; Faure 1986). Plants take up strontium from the soil and pass it up the food chain with little to no additional fractionation. Because most small-scale forager societies obtain the majority of their food from locations near their residence, strontium signatures in biological tissues generally reflect the geographic residence of an individual at the time those tissues formed. As a result strontium isotope analysis helps archaeologists evaluate whether an individual was a local or immigrant to the site where they were buried (Bentley et al. 2002; Price et al., 1994, 2002). Unfortunately, no simple baseline strontium isotope maps exist for Central California that would allow us to match our archaeological samples to a geographic origin. Instead, our study builds empirically on previous analyses conducted at several Central California archaeological sites, including CA-CCO-548 (Eerkens, Barfod, Jorgenson, et al. 2014; Eerkens, Barfod, Leventhal, et al. 2014; Jorgenson 2012; Jorgenson et al. 2009). These studies demonstrate that prehistoric inhabitants from within Central California show significant variation in their strontium isotope signatures between different geographic regions.

To isolate strontium, bone and enamel (~ .05 g of powder each) were treated with 2 mL of 15 percent hydrogen peroxide (H_2O_2), sonicated for 5 minutes and then soaked for 24 hours to remove organic material. Samples were then rinsed in distilled water, dried down, and treated with 2 mL of.1 N Acetic Acid for 24 hours to remove secondary non-biogenic carbonates. They were then rinsed two times with distilled water, dried down, and dissolved with 4 mL of 2.5 N hydrochloric acid (HCl). All samples were dissolved completely (i.e., no residual solids remained) by placing them on a hotplate for 24 hours while soaking in HCl. Samples were dried down to evaporate HCl and brought up in 800 µL of 8 N Nitric Acid (HNO_3) and centrifuged. The supernatant was loaded onto teflon columns containing Eichrom® Sr Spec resin. Rubidium (Rb), barium (Ba), lead (Pb), and most other elements were eluted in 2 mL 3 N HNO_3. Strontium was collected in 2.8 mL of .5 N HNO_3, dried down, and reloaded onto the columns a second time (in 8 N HNO_3) to ensure complete purification of strontium from rubidium. All acids used were distilled to ensure their purity and titrated to ensure the correct concentrations. Strontium isotope ratios were determined by Nu Plasma HR MC-ICP-MS at the Interdisciplinary Center for Plasma Mass Spectrometry, University of California at Davis. Repeat sampling shows that instrument precision for ^{87}Sr/^{86}Sr in bone and enamel is typically less than ± .00002.

Samples Analyzed

Our original research design focused on reconstructing the childhood and adult diets, and mobility patterns, of individuals from the site, and was not focused on violence or ritual behavior. As a result, we chose individuals who were best-preserved for our original sample, as measured by skeletal completeness. Extra skulls, by virtue of their skeletal incompleteness, were unfortunately not sampled, and fewer (four of seven) of the headless burials were sampled due to their greater incompleteness. Following the removal of

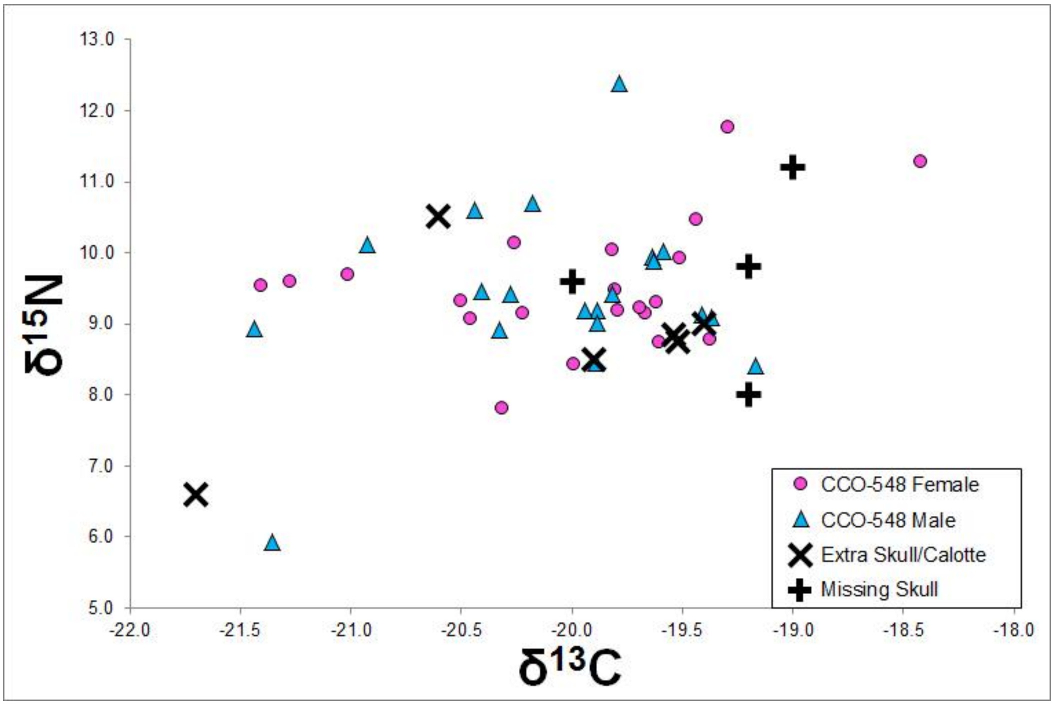

Figure 3. Comparison of d^{13}C and d^{15}N in bone collagen for individuals from CA-CCO-548.

our bone and tooth samples, but prior to isotopic analysis, all human remains were reburied near the site at the request of the MLD, with the exception of one modified calotte. The latter item was retained as an artifact and was made available for sampling at a later date.

For this study, we analyzed bone d^{13}C and d^{15}N stable isotope values of four individuals missing their skull (two males, two females), six individuals buried with an extra skull (three males, two females, one individual of indeterminate sex), and the bone strontium isotope ratio of only one of the extra skulls, the modified calotte interred with Burial 137. We also analyzed strontium isotopes from early-growing teeth and bone for four individuals buried with an extra skull to determine where they lived as children vs. as adults. The bone collagen d^{13}C and d^{15}N values and ^{87}Sr/^{86}Sr data are compared against the larger sample of intact burials from the site (n = 100+).

In addition, for this study we reconstructed the early childhood diets from serial first molar samples from two individuals buried with an extra skull, Burial 107 (male) and Burial 109 (female). This childhood dietary information is compared to a larger sample of 16 individuals from CA-CCO-548 who were not buried with an extra skull, including eight females, seven males, and one individual of indeterminate sex (see Eerkens and Bartelink 2013).

Results

Table 1 presents demographic and isotopic data from burials missing skulls, those containing an extra skull, and the calotte interred with Burial 137. Also given are the mean isotope values for males and females from the site as a whole and direct collagen radiocarbon dates, when available.

Bone Isotopes

Figure 3 plots bone collagen data, comparing burials missing their skulls, burials interred with an extra skull, and a sample of other males and females. The figure shows that burials lacking or buried with an extra skull or calotte completely overlap other individuals from the site in their isotopic distribution.

Figure 4 plots bone ^{87}Sr/^{86}Sr for a sample of males and females from CA-CCO-548 (data from Jorgenson 2012), as well as a sample of faunal and floral remains from the site. These data help

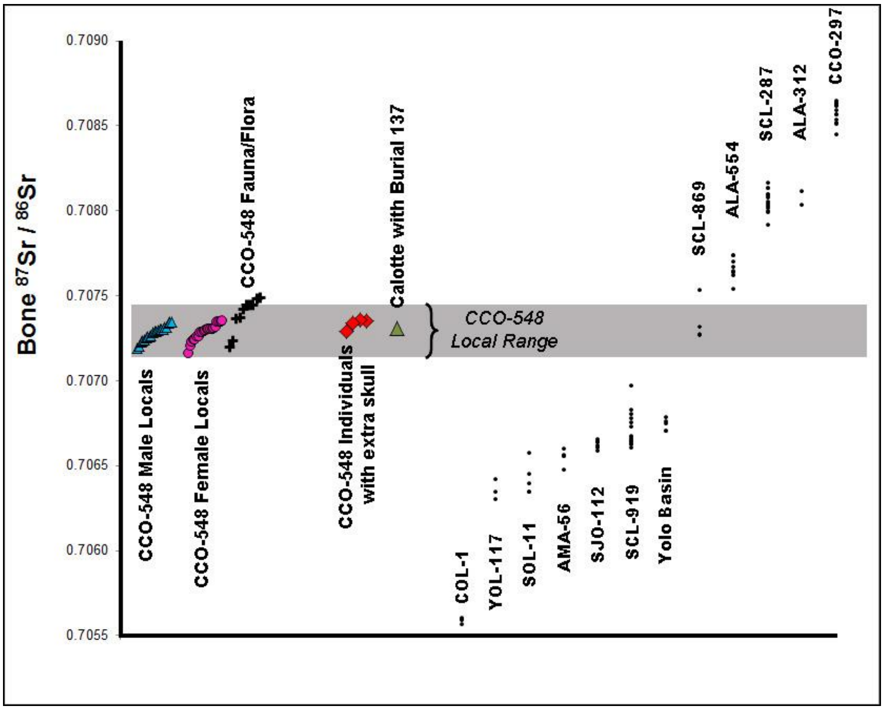

Figure 4. $^{87}Sr/^{86}Sr$ **values from bone comparing CA-CCO-548 burials and calotte against other regional sites.**

establish a "local" $^{87}Sr/^{86}Sr$ signature for a forager living in the region, determined to be between .70720 and .70745 and highlighted in gray. Also plotted are four individuals buried with extra skulls, as well as the calotte associated with Burial 137, from CA-CCO-548. To the right, $^{87}Sr/^{86}Sr$ bone data from a range of other sites in Central California are also shown. The figure highlights the distinctive $^{87}Sr/^{86}Sr$ ranges associated with different archaeological sites. Only one other site, SCL-869, overlaps with the ranges recorded at CA-CCO-548. The figure clearly shows that the four individuals buried with an extra skull, and the calotte associated with Burial 137, are entirely within the range expected for individuals living at CA-CCO-548.

Together, the bone isotope data suggest that individuals lacking skulls, as well as those containing an extra skull, completely overlap with other individuals at the site. They are not isotopically distinct, as we might expect of individuals who traveled to the site during battle, and were killed and buried there, or trophies gained during a raid of a more distant village. Even the calotte interred with Burial 137 produced a $^{87}Sr/^{86}Sr$ value of .70731 that is nearly identical to the overall site average (.70729), suggesting that the person from which this artifact was made was living at the site during the several years prior to his/her death. Further, $^{87}Sr/^{86}Sr$ data from early-growing teeth of four individuals buried with extra skulls also show local signatures. This suggests that these four individuals were also born and raised at or near CA-CCO-548, the same place they lived as adults and were ultimately buried.

Tooth Collagen Isotopes

Sections from first molar (M1) collagen allowed us to reconstruct childhood diets for 18 individuals. The right-hand side of Figure 5 shows the M1 $d^{15}N$ and $d^{13}C$ values for serial sections of Burials 107 and 109. Adult bone collagen values are shown at the very right side of each curve. The left-hand side of Figure 5 shows curves for two additional burials from the site, revealing what are more typical patterns in serial section profiles. While both of the latter show later weaning, around age three to four years, one (Burial 180) shows a pattern where $d^{15}N$ values gradually drop with weaning, as expected, but quickly rebound during early childhood years. The other (Burial 59) shows a pattern where $d^{15}N$ also gradually drop, but do not increase again following weaning, staying low during the early childhood years. Comparison of the curves from Burials 180 and 59 point to differences in the types of food

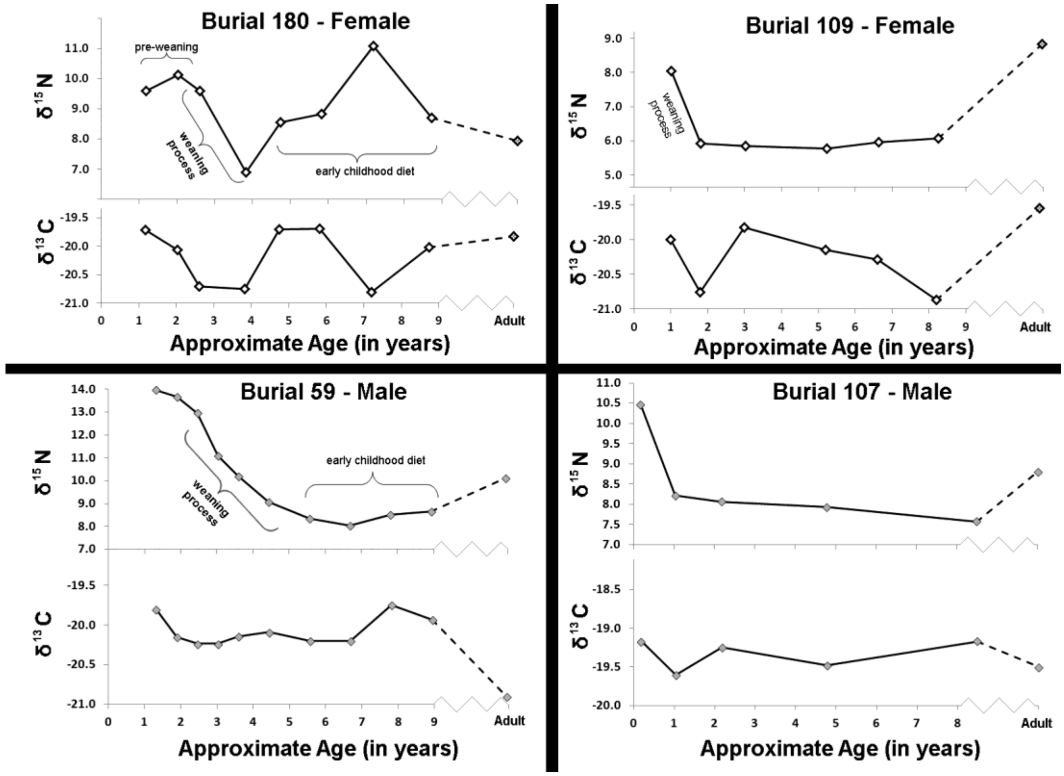

Figure 5. Childhood dietary isotope profiles: left, for two typical burials; right, for two individuals buried with an extra human skull.

each consumed after weaning, during childhood. Burial 180 appears to have consumed protein from a higher trophic level than Burial 59, perhaps consuming greater amounts of freshwater fish and/or terrestrial game.

By comparison, the right side of Figure 5 highlights the more abrupt drop in the $d^{15}N$ values, and to a lesser extent $d^{13}C$, in the two individuals associated with extra skulls on the figure (Burials 107 and 109). As well, both these individuals show the drop in the $d^{15}N$ values at an early age, suggesting early and abrupt weaning onto solid foods. We estimate that breastmilk input ceased by age 1 year and 1.8 years for burials 107 and 109, respectively. This is much earlier than the average for the site as a whole, where females average 3.6 years, and males 3.2 years (see Eerkens and Bartelink 2013). Figure 6 plots the estimated age at which the weaning process was terminated against the $d^{15}N$ value of the diet during early childhood (i.e., the post-weaning diet). This figure highlights the two burials with extra skulls as outliers from the rest of the population. While some girls had $d^{15}N$ values as low as the two burials with extra skulls (i.e., the two data points in the lower right of Figure 6), they were fully weaned at a significantly later age. The reasons why these individuals experienced such an unusual childhood dietary history, with an abrupt weaning at an early age, and the relationship of this dietary history to an unusual burial treatment, with an extra skull, are considered in greater detail below.

Discussion

In other research (Eerkens, Mackie, and Bartelink 2013; Eerkens, Barfod, Jorgenson, et al. 2014), we have shown significant geographic partitioning of stable isotope signatures within Central California. Indeed, the isotopic data from CA-CCO-548 suggests that some individuals who were buried at the site were born and raised in other locations (i.e., were immigrants; Jorgenson 2012). However, all the individuals missing their skulls, as well as those buried with an extra skull and the modified calotte interred with Burial 137, appear

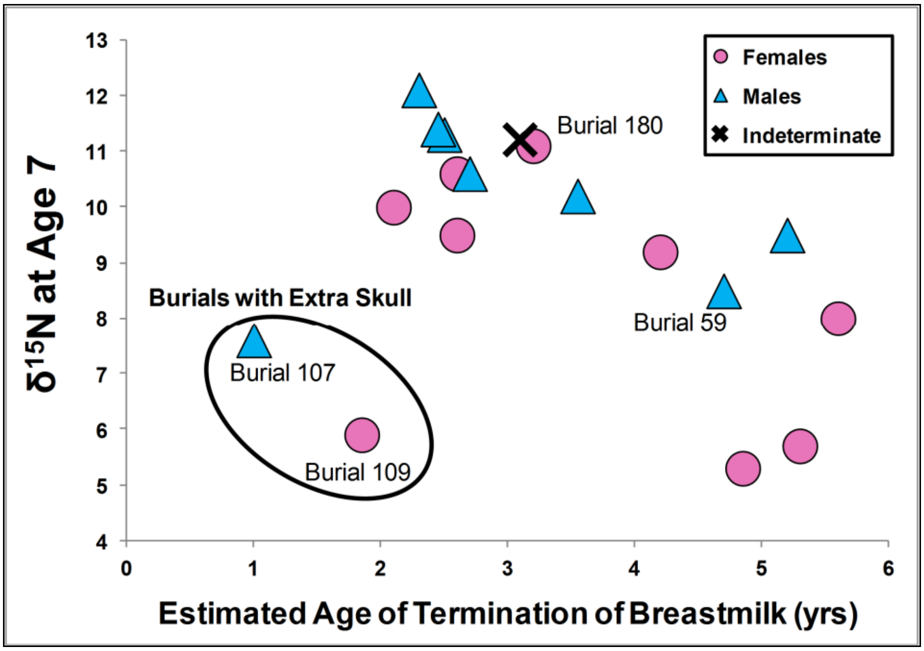

Figure 6. Comparison of the estimated age at which breastmilk input ceased (x-axis) and d15N during the post-weaning diet (y-axis), for boys and girls at CA-CCO-548.

to have lived at CA-CCO-548 during, at minimum, the last several years of their lives. That is, they lived near the site long enough to acquire a local isotopic signature in their bone tissues. For individuals in this sample that had teeth, those teeth also show isotopic patterns consistent with having been born in the immediate area, if not at CA-CCO-548. In short, none of the headless remains or extra heads can be shown to have derived from another location.

This result is unlike isotopic data from mass burial pits recorded at other sites in Central California (Eerkens, Barfod, Jorgenson, et al. 2014; Eerkens, Bartelink, et al. 2014; Gardner 2013). In those situations, contextual data indicate that they were victims of violence (e.g., embedded points, perimortem cranial trauma), and the isotopic data demonstrate that they are distinct from the rest of the burial population, suggesting that they were not native to the site where they were buried. Even the modified calotte associated with Burial 137 at CA-CCO-548, purported to have been a trophy of warfare (Van Buren and Wiberg 2011), appears to have been fashioned from the skull of a local individual. Thus, if the extra skulls at CA-CCO-548 are, in fact, trophies, they are unlikely to be the result of inter-group warfare, but instead result from intra-group violence.

However, we argue that additional contextual and isotopic information suggest that the extra skulls are not trophies of war at all, even intra-group warfare. First, both males and females are represented in the headless and extra-skull categories at CA-CCO-548. In most societies, it is primarily males that carry out warfare, both within and between groups (Adams 1983; Goldstein 2003; Wrangham and Peterson 1996). This pattern holds in the ethnographic record of Central California, where males differentially engaged in warfare, and raiding was generally conducted to avenge poaching and previous murders (James and Graziani 1975; Jorgensen 1980). In other archaeological cases with clear evidence for warfare and/or trophy-taking in California, it is nearly always males that are represented (Andrushko et al. 2005, 2010; Eerkens, Bartelink, et al. 2014; Schwitalla et al. 2014; Wiberg 2002). Likewise, a recent survey in Central California shows that 78 percent of trophy-taking subjects and 58 percent of sharp-force trauma victims (e.g., embedded projectile wounds) are male (Schwitalla et al. 2014). This is not to say that females were not victims of interpersonal violence. Indeed, Schwitalla et al. (2014) record many examples of skull depressions, ulnar fractures (speculated to represent "parry fractures"), and projectile wounds among females that could have been the byproduct of violence.

Second, evidence for interpersonal violence at CA-CCO-548 is very low, based on a comprehensive osteological examination of nearly 500 individuals from the site (Wiberg 2010). Only one burial (.2 percent of all individuals) is reported to have a projectile point directly embedded in bone (Burial 182). Moreover, osteological analyses reveal only 11 forearm fractures of the ulna (3.5 percent of all individuals with at least one ulna; three females, five males, three indeterminate sex), six cranial fractures (1.5 percent of all individuals with cranial vault elements present; three females, two males, one indeterminate sex), and just four mandible/maxilla fractures (1.0 percent of individuals with at least part of the mandible or maxilla present; three females, one male). While accidents can contribute to such fractures, interpersonal violence is a common source. By comparison, later archaeological sites in Central California typically contain much higher rates of such trauma or, in some cases, evidence of perimortem removal of body parts, such as forearms (Andrushko et al. 2005; 2010; Bartelink et al. 2013; Jurmain 1991, 2001; Jurmain and Bellifemine 1997; Jurmain et al. 2009; Schwitalla et al. 2014). For example, at CA-ALA-329, an earthen mound located near the Coyote Hills along the southeast San Francisco Bayshore, 9 percent of adult individuals showed evidence of craniofacial trauma (3.3 percent of which represented cranial vault trauma), 4.4 percent of individuals showed evidence of embedded projectile point injury, and forearm fractures of the ulna affected over 5 percent of individuals (Bartelink et al. 2013). CA-ALA-329 shows patterns similar to many other sites in the region, suggesting that the low prevalence of violence indicators at CA-CCO-548 reflects low levels of interpersonal aggression and violence. Such a situation is consistent with the notion that population densities were much lower between 3,000 and 4,000 years ago in Central California, as indicated by the relatively small number of sites known from that interval (Rosenthal et al. 2007), and that competition over land and resources was a major factor behind prehistoric warfare (Bettinger 2015).

Third, 27 percent of the individuals either missing their own skull or containing an extra skull were found in pits with two or more interments (extra skulls not counted as an interment). This rate is slightly higher than the rest of the population (16 percent), and in nearly all cases isotopic data indicate that the other individuals in a grave were living at the site as adults (Jorgenson 2012). As discussed below, we believe that many of these multi-person graves are family plots composed of related individuals buried together. Our previous analyses (Eerkens, Bartelink, et al. 2013) also suggest that some of the social structure and organization among the living, such as clan or religious affiliation, was maintained among the dead within the spatial layout of the cemetery. If headless burials represent the vanquished from other villages, we think it unlikely that they would be expressly interred with unrelated individuals in either family plots or in clan- or religion-affiliated sections.

Finally, two individuals (one male, one female) interred with extra skulls show unusual patterns in childhood diet and seem to have been weaned abruptly and at very early ages, earlier than all other individuals evaluated from our sample. As adults, though, Burials 107 and 109 consumed foods similar to others at the site. While it is possible that these individuals were raised to be warriors beginning at birth, and by virtue of this ascription were weaned early and fed a different suite of foods as children, we believe that this explanation is unlikely for three reasons. First, other than the extra skulls, these individuals were not buried with any other potential implements of war (e.g., projectiles). Second, it is unclear why this special diet would terminate during their adult years, when their diets overlapped with others from the site. Third, ethnographic descriptions in Central California indicate that warfare was practiced on an ad hoc basis, and that there were few, if any, institutional positions that were ascribed at birth relating to war (James and Graziani 1975).

An alternative explanation, one that we favor, is that extra skulls or calottes are not in fact trophies from warfare, but instead relate to ancestor veneration. This is more in line with the low prevalence of osteological evidence of interpersonal violence at the site as a whole. Furthermore, since males are often responsible for undertaking warfare in societies worldwide, it also explains why both males and females are buried with extra skulls in some cases, or lacking skulls in others, at CA-

CCO-548. In other words, both males and females participated in the ritual behaviors that led to burial with an extra (or without a) skull or calotte.

Speculating further, in the cases of Burial 107 and 109, we hypothesize that their mothers may have died during their infancy, before they were fully weaned. This explanation is consistent with the abrupt and early drop in d^{15}N in the M1 serial sections. Both individuals survived well into adulthood, but may have been reunited with skeletal elements from their mothers after death. In some cases, they may have retained a token in the form of an unmodified or shaped skull bowl, from their mother. If this scenario is correct, Burials 107 and 109 may have been adopted by other families at CA-CCO-548 when their mothers died. If the cemetery was structured spatially by kinship or other group membership (e.g., clan affiliation), as we have argued elsewhere (Eerkens, Bartelink et al. 2013), upon their death there may have been conflict about where and how to bury these individuals. This is especially true if an individual had to be interred in a family plot or as part of a multiperson grave. Should such a person be buried with their biological parents or with their adoptive family? Removing elements from the grave of a relative buried in another part of the cemetery (e.g., the skull), and placing it with the newly deceased, may have been one means to resolve such conflicts. Moreover, this explanation also accounts for the presence of only one extra skull per burial, whereas in the case of trophy heads we might expect multiple trophies associated with some of the burials. It also explains why there are nearly equal numbers of headless burials (n = 7) and burials with a single extra skull (n = 8).

Importantly, the hypothesis presented above is testable. We predict, first, that both burial and extra body element are from local individuals. As shown, isotopic data that we have already collected are consistent with this interpretation, but additional testing on other burials and isolated skulls could be undertaken. Second, ancient DNA (aDNA) analyses could establish the genetic relationship, if any, between burial and associated skull. We predict that the skulls represent the mothers or other close biological relatives of the deceased. As a result, aDNA should show identical mitochondrial haplotypes, if they were buried with skulls of their deceased mother or maternal kin, or identical Y-chromosomes, if buried with a close paternal relative.

Unfortunately, we are unable to perform these tests at CA-CCO-548, as all skeletal materials have been reburied. However, if future excavations at nearby sites also reveal burials containing extra skulls, the research design could include isotopic and aDNA analyses as a means to test our hypothesis.

Conclusions

Outside of certain specialized occupations (e.g., mortician, pathologist, forensic anthropologist, bioarchaeologist), seeing and handling human remains in Western cultures is not a typical experience for most people. Further, although some people curate the ashes or hair of their ancestors, retaining skeletal body parts is often considered unusual or even deviant (e.g., "skeletons in your closet"), and in fact, is illegal in many countries of Europe and North America. However, in cultures where ancestor worship is accepted, seeing and handling human remains, including skeletal parts, is more common (e.g., Torres Strait Islands, Bonney and Clegg 2011; Melanesia, Bonogofsky and Graham 2011; Marquesas Islands, Valentin and Rolland 2011; Solomon Islands, Walter et al. 2004; Tanzania, Hasu 2009). For example, Martin Weishaupt, a Lutheran missionary who visited the Chagga of Tanzania in 1909–1910, was shown by a chief the burial place of his ancestors. This was a small banana grove where after initial burial and the passage of time, the dead were exhumed and their skulls separated from their body and then buried under stones at a particular place where the clan brings offering to the dead (Hasu 2009). As the ethnographic literature shows, such handling of the dead is not uncommon. Small-scale societies typically lack specialists who prepare and dispose of the dead, such as morticians, and it is the families of the deceased who must handle the remains of their relatives and shoulder the responsibility of their disposition. These activities normalize handling of skeletal remains and may encourage behaviors that lead to the saving of body parts to remember ancestors.

We may never know the exact reasons why people at CA-CCO-548 removed the heads of some individuals and buried extra skulls with others. However, we can test expectations under different hypotheses, rule out some potential factors, provide support for others, and generate new hypotheses to be tested in the future. As we have shown, stable isotope analyses can assist in this process, providing important contextual information on the locations where an individual has lived (e.g., whether local or not) and their dietary history. Contrasting individuals buried with extra skeletal elements, those missing skeletal elements, and/or the extra skeletal elements themselves, with others from a site lacking such associations provides a powerful tool in archaeology.

At CA-CCO-548, the stable isotope data suggest that headless burials, individuals interred with an extra skull, and the extra skulls themselves, all represent people who were living locally. This is inconsistent with the "trophy head" hypothesis, where extra skulls are trophies resulting from intergroup warfare, and headless bodies are the vanquished. Instead, the stable isotope data are more consistent with the ancestor veneration hypothesis. Such an interpretation is also more in line with other information from the site, indicating low levels of interpersonal violence and careful spatial organization of the cemetery. While overlapping with other locals for stable isotopes that record geographic location, the data also show that those buried with extra skulls had unusual childhood dietary histories. From this we suggest a more specific form of ancestor veneration as a possibility. In particular, we speculate that young children who had a mother pass away, yet survived themselves into adulthood, may have been reunited with skeletal elements from their relatives when they too passed. Importantly, this can serve as a new hypothesis to be tested in the future by collecting particular archaeometric data (aDNA and stable isotopes) should similar examples be found in other Early-period sites in Central California.

Acknowledgments. This research was funded by a collaborative grant to JWE and EJB from the National Science Foundation (BCS-0819968 and BCS-0819975). We thank TJ Garibay, Holman and Associates, and California State Parks for facilitating access to the collections prior to reburial. We thank Andy Engilis of the UC Davis Museum of Wildlife Fisheries Biology for access to the freeze dryer. Melanie Beasley, Karen S. Gardner, and Tom Guilderson helped collect and prepare the adult bone samples for collagen and AMS analyses. As well, we thank Rusty van Rossmann for preparing Figure 2, Joy Matthews (Stable Isotope Facility, UC Davis) for assistance with the stable isotope work, and Mark Griffin (SFSU) for age and sex information on the burials. Finally, we thank Valerie Andrushko and three anonymous reviewers for comments on an earlier draft and María Gutiérrez for the Spanish abstract translation.

Data Availability Statement. Primary isotopic and radiocarbon data are available upon request from the authors. All skeletal materials have been reburied at the request of the Most Likely Descendant.

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Submitted November 10, 2014; Revised April 3, 2015; Accepted May 13, 2015.