



# Isolation of the Channel Island Group: Paleopathology Confirms Linguistic and DNA-Derived Perspectives of Costal California

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## Abstract

Assessment of prior claims and specific identification of the presence or absence of treponemal disease and its specific variety (syphilis versus yaws versus bejel) in costal California and adjacent islands were reassessed for evidence of interactions. Although previous interpretations were flawed, this new assessment identified the specific variety of treponemal disease as yaws and its geographic distribution in prehistory. The appearance of yaws in costal California suggests a contamination, one which spared the islands. Population isolation, linguistics and DNA perspectives all support the perspective of isolation of the channel island group.

**Keywords:** Treponemal disease; yaws; taphonomy; California, paleopathology; caries sicca; segregation; bejel; epidemiology

## Introduction

Santa Rosa Island is special. As part of the Channel Islands off the coast of California, it shares with Mediterranean islands a special isolation, one that begot major morphotypic variation – development of dwarfism, most notable in proboscidea, specifically elephants and, in the case of Santa Rosa Island, dwarf Columbian mammoths [1]. The isolation noted when the sea levels were lower (during more massive glaciation) [2], compared with greater isolation today with sea level elevation. This ecosystem is referred to as the North American Galapagos [1]. Thus, it is parsimonious that similar human isolation begot not a new species, but a similar segregation from the mainland, an isolation which protected the inhabitants from a disease that ravaged the mainland. Both island and mainland peoples were free of this disease, a virginity lost when mainland inhabitants were subject to incursions from Mexico and/or what became the southwest United States. The disease in question has been clearly identified in Mexico 1000 years before present [3] and in the southwest, as far back as 9,000 years [4].

## Methods

Sites in and around Santa Barbara were assessed and compared with previously reported North American sites and

with a previously unpublished eastern site to assess consistency of disease manifestations. Skeletal remains were subjected to visual macroscopic examination of all available cortical surfaces—to identify periosteal reaction and map the distribution of occurrences in each skeleton. Sample size (denominator) was determined on the basis of sufficient tibial preservation for assessment, as the tibia is the sentinel bone for recognition of treponemal disease as a population phenomenon [5-6]. Mescalitan Island was a 0.35 km<sup>2</sup> land mass in a lagoon 400 meters inland from the coastline [7]. The Mescalitan Island CA-SRI-46a site has two calibrated carbon dates of 675-970 CE (average 808) and 588-915 CE (average 743) [8]. Tecolote Point CA-SRI-3a, on the northwest coast of Santa Rosa Island, has two carbon dates of 5000-6000 BCE [9-10] believed that they were from the “Dune Dweller” culture, supporting a deep cultural and genetic regional Chumash continuity [11]. The Skull Gulch SRI-2b site (Braje et al., 2010) [11], also located on the northwest coast is dated as 1030-1390 CE (Cybulski, 1980) [12]. Cañada Verde CA-SRI-41a is dated at 4000 ybp (Erlandson, 1999) [13]. Skeletons were examined to establish the pattern of periosteal reaction, distinct for each treponemal disorder (i.e., syphilis, yaws and bejel) [14]. Given that that yaws is polyostotic (> or = 3

bone groups affected), that bejel and yaws have high population penetration and that hand and foot involvement are uncommon in syphilis and bejel, these characteristics were utilized to identify the specific treponematoses. The reproducibility of this approach has been repeatedly documented when ability to recognize periosteal reaction has been verified [15]. Failure to validate diagnostic skills [16-17] explains reported deviant assessments [18]. Each skeletal element was considered as a bone group, with the exception of hands and feet, wherein carpals, tarsals, metacarpals, metatarsals and phalanges were not counted individually. Presence of tibia was utilized to establish minimal site number of skeletons. Chi square and Fisher exact tests were utilized to assess the costal versus island prevalence of periosteal reaction patterns.

**Results**

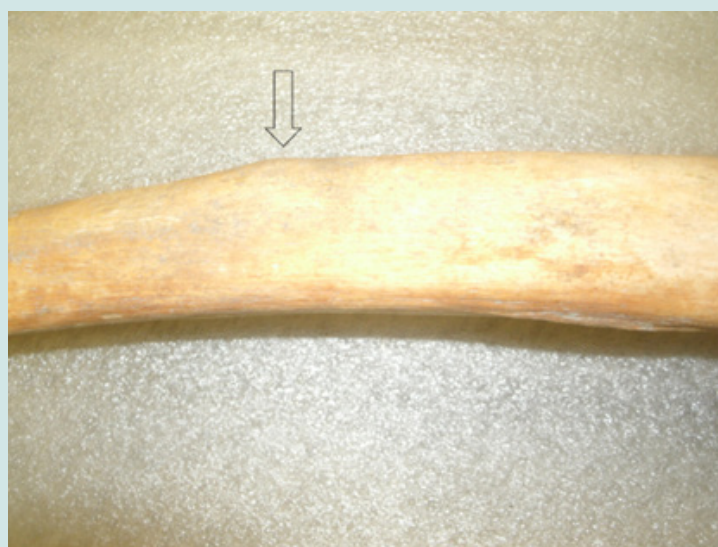
Tecolote Point CA-SRI-3a had 11 individuals in whom tibia were preserved. None had periosteal reaction. Cañada Verde CA-SRI-41a had 21 individuals. One had a subperiosteal hematoma (Figure 1), but none with any other even minimal periosteal reaction. CA-SRI-2b had 15 individuals, none of whom had periosteal reaction, despite the claim. Examination of these 47 skeletons (number determined on the basis of sufficient tibial preservation) from the Channel Islands, revealed no periosteal reaction, with the exception of one individual with a focal subperiosteal hematoma (Table 1). There was no sabre shin reaction. This pristine pattern contrasted

with that in the individuals from Mescalitan Island CA-SRI-46a, in whom periosteal reaction was common. Mescalitan Island CA-SRI-46a had 13 individuals, one with a focal tibial bump and two individuals with polyostotic (> 3 bone groups affected) periosteal reaction. Individual designated 12-10 had involvement of tibiae, fibulae, femorae, radii, ulnae, calcaneus and metacarpals. Individual 12-24 had tibial, calcaneal metacarpal and metatarsal involvement (Table 1). Disease was poly-ostotic and hands and feet were affected in the individuals with periosteal reaction. The pattern (Table 1) was indistinguishable from that noted sites with confirmed yaws [19-20]. Two individuals from CA-SRI-2b, dated at 1260-1390 CE (average 1340) and 1030-1190 CE (average 1100), had been previously diagnosed as having treponemal disease on the basis of skull changes [12], but had no post-cranial evidence of periosteal reaction – despite the claims of Walker et al., 2005. Examination of the skulls from that site revealed a subtle cranial suture in one, that may have been mistaken for caries sicca [21] and healing non-specific skull lesions in a second (Figure 2). The latter pathologic alteration can be the result of skin and subjacent cranial infection by a variety of microorganisms. Diagnosis in the first case was also based on nasopalatine destruction, but we could not distinguish those alterations from changes taphonomically-derived. Thus, there was no evidence of periosteal reaction and therefore of treponemal disease in 47 individuals from the island sites.

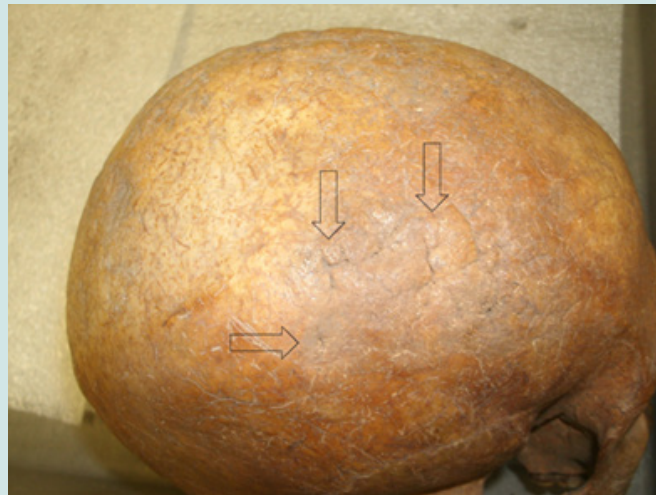
**Table 1:** Distribution of periosteal reaction\* in examined California site.

Site	Skeleton number	Femur	Tibia	Fibula	Tarsal	Metatarsal	Humerus	Radius	Ulna	Metacarpal	# of bone groups affected
SRI-46a	10-Dec	U	U	U	U			U	U	U	7
	24-Dec		B		U	U				U	5

\*Unilateral (U) versus bilateral (B)



**Figure 1:** Lateral view of proximal section of tibia. Slight bump (arrow) from subperiosteal hematoma.



**Figure 2:** Postero-lateral view of cranium. Healing non-specific defects (arrows) that previously mistaken for (misdiagnosed as) caries sicca.

## Discussion

Pathology can provide valuable clues to population origins and migrations [22]. Observation of population prevalence of periosteal reaction in SRI-46a was statistically indistinguishable from what has been previously observed in yaws and bejel, but statistically distinct from that of syphilis (Chi square = 1.102, ns). The pattern observed, polyostotic and affecting hands and feet was indistinguishable from that observed both clinically and on macroscopic skeletal evaluation of individuals with documented yaws [23-26]. It is clearly at variance with pauci-ostotic syphilis and bejel (in which hands and feet are typically spared [27-28]). No disorder other than those of treponemal derivation produce skeletal changes affecting more than a single bone with a prevalence exceeding four percent of the population [29]. Yaws and bejel have substantial bone involvement as a population phenomenon, with lesions found in 20-40%, in contrast to periosteal reaction recognizable on macroscopic examination of bone in only two to 13% of those with syphilis. [18] examined SBA-52, located on the mainland coast and dated 4350 and 4200 (calibrated) ybp. They reported tibial involvement and a polyostotic pattern in 34% of 41 individuals from that site, as well as similar patterns in other mainland sites SBA-1 and Ven-110. Based on the criteria described above, those three sites also are diagnosed as yaws-afflicted. Yaws has been previously documented in a contiguous distribution from eastern Florida to the Cascade Mountains, extending over 9 millennia. Several geographically peripheral exceptions (Canadian) have been noted: The Northwest territories, Atlantic Provinces and Ontario, prior to invasion by the Iroquois [30]. These document that yaws spread into coastal California at least five millennia before present. [31] suggested that spread of treponemal disease from central Mexico was through US southwestern trade routes across the Mojave Desert. While he suggested syphilis, the evidence actually supports the diagnosis of yaws. We concur that the treponemal disease afflicting the California coast in the vicinity of Santa Barbara

likely was derived from the southwest, but consider his suggestion of a Mexican origin, unlikely. The California coastal appearance of the disease preceded its documentation in Mexico, while it was clearly present in the southwest for several prior millennia. The timing of its presence in coastal California is of interest, as it had not penetrated Texas as recently as 6000 ybp. As the Baha region was afflicted with a different treponematosis (bejel) at the same time as yaws was recognized in coastal California, it is suspected that yaws entered the Santa Barbara area through Arizona. It is intriguing that two different treponemal disorders are identified in coastal North America. The presence of bejel confirmed linguistic analyses, suggesting that the inhabitants represented a migration separate from that which populated more interior regions of North America (Rothschild and Rogers, 2010). Herein, we similarly confirm linguistic perspectives of population isolation and interactions [32-33]. Presence of any one treponemal disorder appears to protect populations from the others. Thus, one must be eliminated before another can take its place, as previously documented in Mexico. It is of interest that the Santa Barbara area was spared contraction of bejel, in contrast to other west coast regions.

Analysis of Santa Barbara area prehistory also reveals an additional unique perspective:

Observations of individuals from the Channel Islands portray a very different scenario from that on the mainland. Total absence of periosteal reaction from the 4000-6000 ybp island sites in the current study and previous observations by [18] document the virginity of that population, at least for those disorders that commonly produce periosteal reaction as population phenomenon, specifically treponemal diseases. Absence of periosteal reaction in those sites reaches statistical significance, compared to its presence in SRI-46 (Fisher exact test,  $p = 0.029$ ). Appearance of yaws in coastal California suggests a contamination, one which spared the islands. Population isolation, linguistics and DNA perspectives (Fig

4.1), all support the perspective of isolation of the channel island group. Scientific analyses are enhanced with interdisciplinary efforts, especially when interpretations are reinforced by disparate methodologies. Herein, macroscopic examination of skeletons reinforces perspectives derived from both linguistic and DNA studies and raises thought-provoking questions. Island isolation is an intriguing phenomenon, with significant impact on evolution, allowing unique phylogenetic variation and also providing virgin populations related to contamination by environmental hazards (e.g., infectious disease) from which mainland inhabitants are not protected. This has several implications:

1. Virgin populations derive from areas in which the disease did not exist.
2. Virgin populations arrived earlier in geologic time than the disease that afflicts individuals outside their catchment areas.

Epidemiologic approaches often consider modern geographic distribution of disease and contemporary exposures related to endemic area travel. The latter is especially important in modern times with facile access to long distance transportation, but the former may be somewhat misleading when applied to ancient times. Environments (e.g., refugia) containing residual islands of disease are not necessarily responsible for the current distribution of that disease. Such hypotheses require independent validation, a seldom applied approach [33]. In the populations analyzed in the current study, application of multiple approaches lead to recognition of the pattern of spread of disease. Availability of more sites should allow us to refine the time course of entry of the contamination (yaws) into the Santa Barbara area.

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