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Research Article

On head lice and social interaction in archaic Andean coastal populations

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ABSTRACT

Archaic mummies from northern Chile were examined for the presence of *Pediculus humanus capitis*. The excellent preservation of mummies and louse nits/eggs permitted a study of the degree of head lice infestation. We studied 63 Chinchorro mummies (ca. 5000–3000 years B.P.) from the Arica-Camarones coast. An area of 2 cm × 2 cm on each mummy's head was systematically inspected for louse nits/eggs. Hairs with nits/eggs and lice were collected and analyzed using optic and scanning electronic microscopy. About 79% (50/63) of the mummies resulted positive for pediculosis, with an average of 2.1 nits/eggs/cm^2 per positive individual. Microscopic analyses revealed the micromorphology of all developmental stages, including eggs/nits, nymphal instars and adults. Chinchorro people lived in small huts increasing the transmission of ectoparasites. Considering that head lice thrive in crowded conditions, their prevalence could be used as an bioindicator to assess and debate cultural behavior (e.g., degree of crowdedness and sedentism) and to study paleoepidemiology in prehistoric populations.

1. Introduction

Head lice, *Pediculus humanus capitis* De Geer (1767), have been a part of mummy studies for decades. Zinsser (1935) presented the importance of lice in mummy studies in his classic publication *Rats, Lice and History* (republished in 2007). Previously, Ewing (1924) had published the discovery of lice from Peruvian mummies. Both authors pointed out the comparative value of mummy louse studies in documenting the intra-population variation of lice as they adapted to different hair morphology in diverse human populations. Although Zinsser and Ewing highlighted the potential of population-based studies, such potential went unexplored for decades. Recently, a series of case reports have been published, drawing on small, or single mummy samples (Araújo et al., 2000; Arriaza et al., 2012a,b; Raoult et al., 2008; Rivera et al., 2008). Most studies were not quantitative, but were successful in painting a general picture of the arrival of head lice in the New World. Araújo et al. (2000) reported head lice from hair associated with an archaic human skeleton in northeastern Brazil. The finding was radiocarbon dated to more than 10,000 years ago indicating that the introduction of lice into the New World probably occurred with the earliest migrants. Based on molecular analysis of Chiribaya head lice (960 B.P. Peru) from two individuals, Raoult et al. (2008) showed that pre-conquest head lice populations likely had haplotype links to the Old World, pointing to ancestral migrations of host and parasite into the New World. Rivera et al. (2008) found louse nits/eggs on six of seven 4000-year-old mummies from Camarones, on the coast of northern Chile, however they did not report nit/egg density. This small sample hinted that high levels of head lice infestation were reached in archaic coastal Andean populations.

Levels of infestation of 44% were documented in mummies from Canyon de Chelly, Arizona, dating to 800–900 years ago (El-Najjar et al., 1998). In general, louse infestation was relatively rare in the Southwestern United States in prehistory. These case studies have been important in documenting louse distribution through time and space.

The first ancient population-based study on head lice infestation was performed by Reinhard and Buikstra (2003), who analyzed 146 Chiribaya culture mummies from the Moquegua valley of southern Peru. They found that 92 of the mummies were sufficiently preserved for analysis. They then assessed the distribution of parasites in host populations, searching for a pattern

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of over-dispersal—which means that a very small percentage of hosts harbor the majority of parasites. In parasitological terms, this phenomenon is best described by a negative binomial distribution (Anderson, 1993), or "wormy hosts", in the case of intestinal parasites, when few hosts carry a great number of parasites who contribute to continuing transmission dynamics in endemic communities (Croll and Ghadirian, 1981). This phenomenon has been observed with other ectoparasitic diseases such as tungiasis, where a small number of individuals carried most of the parasites in a community (Heukelbach et al., 2007). In order to validate the paleoepidemiological value of parasite data, this characteristic distribution had to be demonstrated with archaeological remains. Reinhard and Buikstra (2003) were able to quantify infestations on an individual basis by calculating the maximum number of eggs and nits cemented to hair shafts on the scalps of the 92 Chiribaya mummies. The infestation of nits and eggs on Chiribaya hosts reflected the negative binomial distribution. This supports the statistical value of louse parasitological data when large numbers of human remains can be evaluated.

Following this population-based approach, we have studied several hundred mummies from all cultural phases of the Arica region in northern Chile. In this paper, we focus on the presence of *Pediculus humanus capitis* (*P. humanus capitis*) in Chinchorro populations (5000–3000 years B.P.; $n = 63$ individuals) that inhabited the arid coastal region of the Atacama Desert. The Chinchorro were fishers and hunter-gatherers who lived along the dry but fertile coast at the fringes of the Atacama Desert in northern Chile and southern Peru (Arriaza, 1995; Aufderheide et al., 1993; Santoro et al., 2012). They are known for their elaborated mortuary practices, including artificial mummification (Arriaza, 1995; Arriaza et al., 2012c; Marquet et al., 2012; Rivera, 1991; Standen, 1997). The Chinchorro were expert morticians who transformed the corpses of the dead into polychromous preserved bodies (mummies). They used various techniques and mummification styles that changed through time to preserve individuals of both sexes and all ages, including fetuses. Even though there were regional and chronological variations, two types of artificially prepared mummies stand out: the *black* and the *red style* (Arriaza, 1995). The black mummies were the earliest (ca. 7000–5000 years B.P.) and are basically clay modeled or reconstructed bodies. They have an inner structure of bones, sticks, clay and reeds. Clay masks and short black wigs made of human hair adorn the heads. Externally, the bodies are completely painted black, including the face, using manganese pigments. The red mummies (ca. 5000–4000 years B.P.), in contrast, have incisions for organ removal, stuffing of cavities and externally are fully painted with red ocher, except the face mask which is painted with manganese. These red mummies have long wigs of black human hair. In addition to these types of mummies, there are also Chinchorro bodies with natural mummification, especially after the red style period. Independent of mummification procedures, most bodies were wrapped in reed matts and buried lying on their back with a few grave goods (fishhooks, harpoons and net bags) in the sands of the Atacama Desert. In general, mummification techniques faced cultural changes, but the maritime subsistence and technology for fishing and gathering remained the same. Also, later Chinchorro populations (ca. 3500 years B.P.) no longer practiced complex artificial mummification, annular skull deformation increased, heads were adorned with colored threads (headbands), and fine basket weaving and horticultural products appeared (Rivera, 1991; Standen, 1997).

Scholars have studied many aspects of Chinchorro ways of life and endoparasitism, but ectoparasite studies and their cultural relevance have been minimally addressed so far. Rivera et al. (2008), at the Camarones-15 site, found 98 operculated *Pediculus capitis* eggs and 265 non-operculated eggs. Arriaza et al. (2008, 2012a,b) also reported three positive cases of pediculosis in ten pre-Columbian mummies of different periods from Arica and Iquique (northern Chile) and a heavily infested late agropastoral Chiribaya mummy (ca. 1280–960 years B.P.). Likewise, Reinhard and Buikstra (2003) reported pediculosis in three Chiribayan sites from Peru, with prevalence ranging from 20% to 70%.

The general archaeological evidence posits that Chinchorro populations were composed of small bands of hunter-gatherers and collectors who lived in semi-permanent camps along the coast (Núñez, 1983; Muñoz and Chacama, 1982; Rivera, 1991). Based on this information, it is thought that the Chinchorros were highly mobile groups. Using pediculosis as a bioindicator, we provide evidence in this paper that the Chinchorro daily life was more sedentary and that social bonding was likely strong and enduring. Yet, there are still several questions regarding archaic lice infestations: Why is Rivera's reported frequency so high for this Chinchorro site? Is this value unusual, or did all Chinchorro sites have similar infestation rates? What is the social significance of pediculosis in these early populations? To answer these questions we systematically expanded the sample size and chronogeographic framework to describe the extent that archaic coastal populations were affected by pediculosis, in order to discuss its bioarchaeological significance.

2. Materials and methods

The samples studied came from eleven coastal archaeological sites in the city of Arica in northern Chile, ranging from one to twenty-two individuals per site. In total we studied 63 mummies, 41 naturally mummified and 22 artificially prepared bodies. All are housed at the Museum of Archaeology of the Universidad de Tarapacá, Arica, Chile. The latter included the addition of a hair wig as part of the artificial mummification procedures (Arriaza, 1995; Standen, 1997). In artificially prepared bodies of newborns and infants, clearly the wigs were not made from their own hair, but probably from the hair of older relatives (Arriaza, 1995; Standen, 1997). Two broad, main age categories were considered: adults and subadults. The latter includes ages around 15 and younger. Thus, the demographic profile of the total sample can be subdivided into 42 adults and 21 subadults (26 males, 25 females and 12 individuals whose sex it was not possible to determine). A summary of the study sample demographs per site is presented in Table 1.

2.1. Macroscopic analysis

At the Museum of Archaeology, all mummy heads were examined for the presence of head lice (nits or empty egg-shells, embryonated eggs and lice). If heads were detached by previous autopsies, they were carefully deposited on a 60 cm × 60 cm sheet of acid free paper and inspected visually with the aid of a 10× magnification glass. Complete bodies were studied in their storage trays.

Nits/eggs are affixed to the hair shaft, hence they are less sensitive to loss by handling. To determine the presence and amount of nits/eggs on each mummy's head we slightly modified the methodology of Reinhard and Buikstra (2003), gently lifting the hair in the temporal and occipital areas and placing a 2 cm × 2 cm (4 cm^2) cardboard cutout to count nits/eggs on hair shafts within 1 cm of the scalp (Fig. 1). However, to follow conventions, here we are reporting the observations scored as per 1 cm^2 area.

As the mummies' hair is not always clean but may contain dirt and debris, we undertook six independent observations and counts of nits/eggs: three at the temporal area (anterior, superior, and retro-auricular) and three at the occipital area (two lateral and one medial) where lice are frequently found (Borges and Mendes, 2002; Gairí et al., 2007; Heukelbach, 2010). In addition, on mummies