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A Bioarchaeological Study of Coca Use and Coca Leaf Chewing at Puruchuco-Huaquerones, Peru

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Introduction

During the Inca imperial expansion and conquest, coca production was reorganized and the ownership of coca plantations was redistributed in some regions (Espinoza Soriano 1963:18-20; Julien 1998; Murra 1980:32, 90-91, 156, 177; Rostworowski 1972:261, 1973). On the central coast, members of the Ychma macroethnic community living in the middle and lower Rímac and Lurín Valleys lost control of their coca plantations to the Yauyos of Huarochiri (Rostworowski 2002:90, 174). Ethnohistorians and scholars have explored and debated access to coca during the Inca empire. Some have argued that the Incas restricted coca use and prohibited its consumption by commoners. Other scholars counter that everyone had access to coca and that Inca control over coca chewing would have been difficult to accomplish (Murra 1986, 1991:575; Parkerson 1983). Few archaeological studies have investigated the practice of coca chewing during the Late Horizon and explored the consequences of Inca re-organization and re-distribution of coca plantations.

The present study explores coca access and use in the Late Horizon community at Puruchuco-Huaquerones. We examine the dental evidence of coca leaf chewing and the mortuary offerings of coca and coca paraphernalia from burials recovered from two spatially distinct cemeteries (Huaquerones and 57AS03) within the archaeological zone of Puruchuco-Huaquerones. Using these bio-archaeological data, we examine who had access to coca, which members of this community chewed coca, and whether or not commoners had access to the plant. The bioarchaeological results are tempered with insights from archaeology, ethnohistory, and ethnography to understand more fully the prehistoric practice of coca leaf chewing, and its biological consequences, among Late Horizon residents of the central coast of Peru.

Archaeological and Ethnohistorical Evidence of Coca and Coca Leaf Chewing

Archaeological evidence demonstrating the presence and importance of coca and coca leaf chewing in the Andean region is extensive, and some of the earliest evidence has been recovered from the western slopes of the Andes (Dillehay *et al*. 1989:744-746). Depictions of individuals chewing coca and preparing a coca quid are known from ceramics, including those from the Nasca, Moche (Donnan 1978:118, figure 183; Donnan and Benn 1990:23; Menzel 1977: figure 146; Moseley 1992: figure 13), and ancient Ecuadorian cultures (Lathrap *et al.* 1975: figure 66). Some scholars have argued that *coqueros*, the ceramic figurines or vessels that depict ritual

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specialists or shamans chewing coca, evince the restricted access of commoners to coca and coca consumption (Calatayud and Gonzalez 2003: 1504; Martin 1970:424-426; Naranjo 1981:163-166). Coca bags, stone sculptures, lime, lime gourd containers, and coca itself have been recovered from coastal and highland sites from Ecuador, Peru, Bolivia, and Chile.[1] Several mummies from coastal sites have been recovered with coca quids in their cheeks (Arriaza *et al.* 1995:39; Aufderheide 2003:157; Cartmell *et al.*1991:161, figure 1). While the archaeological evidence associated with prehistoric coca leaf chewing is diverse and the practice appears ubiquitous before the Late Horizon, few studies have specifically addressed the access to coca and the frequency of coca chewing in different regions during the Inca empire and the bioarchaeological evidence for coca chewing remains largely unexplored.

Much of what we know about coca chewing during the Inca empire comes from ethnohistorical sources, written from both Spanish and indigenous perspectives. However, each written source offers accounts of different experiences, with different agendas, and with different, but pervasive, prejudices about indigenous peoples (Silverblatt 1987:xxii-xxv). Furthermore, many of these accounts of Andean culture were written several decades after the Spanish conquest, and after the devastating effects of depopulation, Christian conversion, and colonial resettlement programs, all of which had severely altered the lives of Andean people. Therefore, scholars caution against the literal reading of these ethnohistorical sources because they are likely to be distorted by the experience of conquest and invasion, as well as the biases of their authors (Julien 1993:187; Urton 1990). Administrative and court documents also contain references to coca consumption and production, but they, too, should be critically questioned because they present static perspectives of what were arguably dynamic and dramatic processes of cultural change and these documents "may just as easily strive to conceal as to reveal" (Julien 1993:178-179).

Several mid- to late sixteenth century accounts describe the high value of coca, its restricted access, and the role it played in religious rites.[2] In his historical examination of coca prohibition, Gagliano reveals that the Inca nobility were not the only people who consumed coca, because the military, *chasqui* (couriers), the elderly, and anyone who received imperial sanction were reportedly permitted to chew it (Gagliano 1994:16). Together, these ethnohistoric sources present a picture of coca chewing as a revered practice that was restricted to the Inca elite or those with their permission, and suggest that coca may have been prohibited for the bulk of the Andean population.

Information contained in regional administrative documents typically describes the ubiquity of coca plants and coca fields (Murra 1986). As a result, coca is interpreted as having been a staple in many highland communities and, therefore, accessible to all (*ibid.*). Citing survey data collected in 1539 from the Pillkumayu Valley in what is now the Huánuco Region of Peru, Murra asserts that every highland village possessed individuals responsible for managing and cultivating tropical products, including coca, and that "these goods were part of the normal peasant repertoire in the Andes" (*ibid.*: 51). Furthermore, in 1572, for Sonqo, north of modern La Paz, Bolivia, ethnohistorical docu-

[1] Cassman *et al.* 2003:151; Engel 1963:77; Hastorf 1987; Indriati 1998:17-19; Kolata 1993:146; Lathrap 1973:180-181; Lathrap *et al.*1975: figures 61, 62, items 434-466; Menzel 1977: figure 128; Murphy 2004:119.

[2] Acosta 2002 [1590]:210-211; Betanzos 1996 [1557]:42-53, 56; Cobo 1964 [1653]: 473-474, 1990 [1653]:64, 65-66, 94, 119, 128, 137; Matienzo 1967 [1567], chapter 44, p. 163; Pizarro 1969 [1571]:262, 265.

ments report that everyone had access to food and to coca fields (*ibid*.; Murra 1991:572). However, Juan de Matienzo, a Spanish administrator familiar with coca production around Cusco and nearby regions, asserts that the Incas permitted only the nobility and members of the military access to coca and commoners were proscribed from using it (Julien 1998:129; Matienzo 1967 [1567]:163).

With variable strategies, the Inca assumed control of, and regulated, the numerous coca plantations that were widely distributed along some of the middle and upper reaches of the Peruvian coastal valleys (*e.g.* Chillón, Chancay, and Ica) and in the highlands (*e.g.* Chuquioma, a lowland valley on the eastern slopes of the Andes northeast of Pocona, Bolivia, and southeast of modern Cochabamba (Julien 1998; Murra 1980:32, 90-91, 144, 156, 177; Netherly 1988:263-265; Rostworowski 1973:203-204). While Inca imperial control of coca production and cultivation was well organized and maintained in some regions (Cieza de León 1984, *Señorio de los Incas* [1553]: Chapter 18, pp. 166-168), restrictive access and coca use prohibition were more difficult to enforce in the northern coca fields and in the *yungas*, the warm, low-lying valleys on the eastern slopes of the Andes (Gagliano 1994:17; Murra 1975:61-65; Parkerson 1983:120; Rostworowski 1999:63-67). In a regional administrative survey (*visita)* document from 1558-1570 (Archivo General de Indias Justicia 413), the ownership of the Quivi coca fields in the Chillón Valley on the central coast of Peru was the subject of a dispute among several different ethnic communities after the Spanish conquest (Marcus and Silva 1988; Rostworowski 2004:131, 286-300, 308-310). Shortly after Inca expansion onto the central coast, the coca plantations in the middle region (*chaupiyunga*) of the Lurín Valley were annexed by Tupac Yupanqui and presented to the Yauyos of Huarochiri (Rostworowski 2002:174).

This brief review of the ethnohistorical literature reveals different perspectives on the consumption of, and access to, coca during and after the Inca empire, with variability by region in the type and exertion of Inca control of coca cultivation, distribution, and access possible. After the Spanish conquest, some accounts of Inca coca use were colored by the controversial colonial dialogues over whether or not the stimulant should be eradicated because of its association with indigenous religious practices, or promoted because of the economic opportunities it provided in trade, and in its role in the exploitation of Andean farmers and the miners at Potosí (Cieza de León 1984, *La crónica del Perú* [1553]: Chapter 96, p. 121; Gagliano 1994; Murra 1991:566; Parkerson 1983). Coca production and consumption grew dramatically in conjunction with the Spanish intensification of agriculture and silver mining (Stern 1982:37).

Background on Coca Chewing

Before presenting the data and analyses from Puruchuco-Huaquerones, a brief review of coca chewing and oral health is in order. According to modern accounts, coca is usually chewed three to five times per day for approximately 15-45 minutes (Allen 2002:105; Fuchs 1978: 281; Indriati 1998:12; Plowman 1984:129). Although the frequency and distribution of coca chewing vary by age, sex, and geographic region, both men and women have been observed chewing coca, and children are first exposed to coca during family rituals (Allen 2002:112; Carter and Mamani 1986:141, 143, 156-57, 257; Fuchs 1978:279; Hamner and Villegas 1969: 289). Adolescent silver miners in Potosí have been observed chewing coca and preparing ritual offerings of coca for the "devil" that resides in the mine (Davidson and Ladkani 2005).

Research in human biology has focused on the physiological effects of coca, but little has

been reported about the effects of coca chewing on the oral health of regular chewers. Through the examination of human dental remains, several possible characteristics were believed to be associated with the practice of coca leaf chewing including unusual types of carious lesions, brown staining on teeth, heavy calculus formation, and alveolar recession/periodontal disease (Klepinger *et al.* 1977; Langsjoen 1996; Leigh 1937; Turner 1993). It was recently concluded that calculus deposition is more likely the result of overall poor dental health, rather than coca leaf chewing (Ubelaker and Stothert 2006). Most of these dental consequences can occur in the absence of coca leaf chewing, and none of these studies examined the effects of the practice on living chewers. Cartmell *et al.* (1991) pioneered an alternative technique to the examination of dental remains by using a radioimmunoassay of hair samples from a sample of mummified human remains to detect cocaine and/or its metabolic product benzoylecgonine (BZE). Unfortunately, the radioimmunoassay test requires the preservation of hair, a situation that is not always encountered in many geographic areas and across all time periods in the Central Andes.

Currently, the dental technique is the only other method to detect coca use in human remains (Indriati 1998; Indriati and Buikstra 2001). Indriati conducted the first large scale investigation of dental health of chewers by examining the teeth of modern peoples from the highlands of Peru, Bolivia, and Chile and interviewing them about their coca leaf chewing practices (Indriati 1998). Based on her dental exams and interviews, she concluded that the strongest indicator of coca leaf chewing among the modern day samples was the presence of large and wide cervical-root caries on the buccal surface of mandibular molar teeth accompanied by root exposure (*ibid.*; Indriati and Buikstra 2001:245). Mild and weak indicators included cervical-root caries on maxillary molars, antemortem loss of molars, cervical-root caries on the buccal surface of premolars accompanying the antemortem loss of adjacent molars, the presence of molar roots only, and interproximal caries (Indriati 1998:117; Indriati and Buikstra 2001:245). Testing these dental characteristics on archaeological samples of human remains, Indriati identified individuals based upon the degree of likelihood that they were coca leaf chewers (definite, probable, possible, or nonchewer; Indriati 1998). The dental method for the identification of coca leaf chewing is particularly valuable because teeth are often preserved in archaeological samples of human remains.

There are slight methodological differences between Indriati (1998) and Indriati and Buikstra (2001). We choose to follow the latter because it is published in a peer-reviewed journal and is a more recent statement. However, when applying the Indriati and Buikstra method, we found that individuals who possessed 1-2 strong indicators, lacked mild indicators, and possessed weak indicators (or just 2 strong indicators and no other indicators, as was the case with HP01-116) were not classified and they fell between categories. In the absence of the strongest indicators, we agree with Indriati and Buikstra that these individuals should be classified as either nonchewers, or depending on the number of mild indicators and the number of molars, as possible chewers. We have confidence in Indriati's assessment of modern coca chewers and the correlation of the strongest indicators with these individuals (as a consequence of coca leaf chewing). For consistency, we were comfortable classifying individuals with 1-2 of these strong indicators in the most conservative category, possible chewer. Because there are several individuals who possessed strong indicators, but lacked the requisite number of mild or weak indicators, we think that the presence of 1-2 cervical-root carious lesions on the buccal surface of the mandibular molars (alone or with

several weak indicators) is sufficient to classify them as possible chewers.

The etiology of cervical-root caries is not entirely understood. However, Indriati and Buikstra hypothesize that the anesthetic qualities of the cocaine metabolites released during coca leaf chewing act to suppress the activity of the salivary glands around the location of the coca quid (Indriati and Buikstra 2001:243). The reduction of the salivary flow results in dry mouth, or xerostomia, which is correlated with a higher frequency of carious lesions in modern clinical contexts, particularly on the cervical and root surfaces (Epstein and Scully 1992; Guggenheimer and Moore 2003; Indriati and Buikstra 2001; Närhi *et al.* 1999; Neville *et al.* 2002:346-346).

To evaluate the different perspectives on coca access and consumption during the Inca empire, we can turn to the evidence for coca chewing and use from Puruchuco-Huaquerones.

The Archaeological Context of Puruchuco-Huaquerones

Tupac Yupanqui and his troops arrived on the central coast circa A.D.1470, when they assumed control of Pachacamac and the Rímac and Lurín Valleys, part of the Ychma macroethnic community (Cobo 1964[1653]: Book 2:299-302; Rostworowski 2002:174). Recent work in nearby sites in the Rímac and neighboring valleys has begun to identify the archaeological correlates of the Inca presence on the central coast of Peru and the sociopolitical organization of this region during the Late Intermediate Period.[3] Preliminary findings suggest a pattern of Inca sociopolitical control in which pre-existing administrative centers were modified and utilized by the Inca state (Eeckhout 2004; Wallace 1998). It is likely that future work will contribute to the emerging picture of the altered social and political landscapes after Inca colonization, and of the variable strategies that were applied in different regions (Covey 2000; D'Altroy 2002:248-262, 2005; Dillehay 1977, 1979; Malpass 1993; Menzel 1959; Morris 1998; Sandweiss 1992).

The archaeological zone of Puruchuco-Huaquerones is 11.5 kilometers east of the modern city of Lima as measured from the city center, on the southern side of the lower middle Rímac Valley. It contains architecture and several cemeteries (Figures 1, 2; Cock Carrasco 1999, 2001, 2006; Cock Carrasco and Goycochea Díaz 2004). One of the structures, the palace at Puruchuco, may have been involved in Inca administration of the region, based on the presence of imperial Inca architectural influences (Tabío 1965; Villacorta 2004:553). However, others have suggested that it was an elite residence or that it may have served as the center for the local polity (Lati), which was part of the Ychma macroethnic group (Rostworowski 2002:220-221). Recent mathematical decoding of 21 khipus from Puruchuco revealed hierarchical accounting information passing between the local elites and the provincial Inca lord, which bolsters the assertion that the site may have played a role in Inca administration of the region (Urton and Brezine 2005:1067).

Burials from two of the cemeteries at Puruchuco-Huaquerones, Huaquerones and 57AS03, are the subject of this study (Figure 2). Previous work uncovered an area where additional burials may be located, but this area has not been systematically studied or scientifically excavated (Tabío 1965). It is believed that the majority of burials in both cemeteries are Late Horizon and date from the early presence of the Inca in the Rimac Valley until shortly after the

[3] Cornejo Guerrero 1999; Eeckhout 2004; Farfan Lobatón 2004; Feltham and Eeckhout 2004; Makowski and Vega Centeno 2004; Marcone Flores 2004; Shimada *et al.* 2004; Vallejo Berrios 2004; Villacorta 2004.

arrival of the Europeans, or from approximately A.D. 1475 to 1540, based on the ceramic chronology, the presence of Inca aryballos, and stylistic patterns and details on textile bags (Cock Carrasco 2006; Cock Carrasco and Goycochea Díaz 2004:185).

The burials range in their preservation from large textile bundles containing mummified individuals with soft tissue preservation to completely skeletonized individuals. Several factors affected the degree of preservation of the burial bundles, including type of bundle fill, presence or absence of textiles, and location within the cemeteries. Individuals who possessed considerable textiles in their bundles were more likely to be mummified because the textiles drew and absorbed the decomposition fluids, as well as some of the moisture that may have seeped into the burial pit. Several types of burial fill were observed, including cotton, cotton with cottonseeds, and cotton with other organic materials (*ibid.*). Those bundles that were filled with a large amount of cotton were usually better preserved because the raw cotton also absorbed any moisture in the bundle. Bundles that contained bundle fill of cotton and cottonseeds were often the most deteriorated and individuals in these bundles were more likely to be skeletonized.

In the Huaquerones cemetery, some areas were more affected by recent human activities than others, which contributed to differential preservation of the bundles. For example, some areas were used for gray water disposal. Other areas were more protected because human occupation had not occurred in these areas. Several areas were leveled for construction, which caused the underlying burials to be closer to the modern surface. Those burials from greatly modified areas were more likely to contain skeletonized individuals (versus mummified or partially mummified individuals) and fewer organic offering (*e.g.* gourds, textiles, food offerings) in a pristine state of preservation. The burials from 57AS03 were affected by different activities, specifically the use of the area for animal grazing (sheep), the construction of Avenida Javier Prado, the use of a drainage channel next to the cemetery, and the increasing encroachment of the neighborhoods and buildings in the area.

Despite the potential for postdepositional modification, the majority of the mortuary contexts are extraordinarily well preserved. Cock and Goycochea (2004:187-193) classified the burials by their fill type, whether or not they possessed a false head, and their size, but they caution that there is considerable variability in the burial preparation, elaboration, and quantity and quality of the funerary offerings. For summary purposes here, we will describe some of the common characteristics of a typical burial. The principal individual was usually arranged in a seated or flexed position within the bundle and was accompanied by internal offerings, such as weaving implements, beans, corn, gourds, *Spondylus* or scallop shells, textile bags, and metal tweezers. A textile layer typically surrounded the individual and these internal offerings and, depending on how elaborate the burial was, additional offerings were sometimes placed within the bundle, but outside of this layer . The next layers in the bundle were the bundle fill and any additional textiles. An outer textile layer surrounded the bundle fill and maintained the integrity of the bundle. Additional offerings, such as ceramic vessels, weaving baskets, wooden heddles, and other weaving implements, were placed outside of the bundle, but within the burial pit (Cock 2002; Cock and Goycochea 2004). Some of the burials from Puruchuco-Huaquerones contain internal offerings of coca leaves, gourds containing lime, and coca bags, suggesting these individuals may have been coca chewers during their lifetimes.

SAMPLE AND METHODS

This study analyzes dental evidence of coca leaf chewing, the mortuary treatment of these individuals, and the mortuary offerings of coca and/or coca paraphernalia in order to understand who had access to, and chewed, coca in this community. To explore the dental evidence of coca leaf chewing, we conducted a dental survey of the maxillary and mandibular dentition of 209 individuals from the Huaquerones and 57AS03 cemeteries. The sample included both males and females from different age categories and a small sample of late adolescents (Table 1).

	57AS03	Huaquerones	Total
Total adults	87	122	**209**
Males	50	67	**117**
Females	37	50	**87**
Indeterminate	0	5	**5**
Young adults (YA)	33	57	**90**
Middle adults (MA)	43	58	**101**
Older adults (OA)	8	7	**15**
Adults*	3	0	**3**

Table 1. Sample composition by age and sex.

*Individuals who could not be categorized into the young, middle, or older adult category were classified simply as adults.

Individuals were excluded if they did not possess crania or they were still mummified and possessed textile headdresses, because a dental examination was impossible. Because teeth must be present to document the frequency of carious lesions and dental indicators of coca leaf chewing, individuals with fewer than six teeth were excluded from the analysis of these dental stigmata. Individuals younger than eighteen years of age were excluded due to the age progressive nature of the development of carious lesions and antemortem tooth loss. Epidemiological studies of living human populations and bioarchaeological investigations have demonstrated that the severity and frequency of carious lesions is strongly correlated with age and that the lesions progress over a period of years.[4] Although it would be interesting to examine the presence and frequency of coca leaf chewing among subadults from Puruchuco-Huaquerones, we cannot reliably document these phenomena by using dental data.

Adult age estimation was based upon age-related changes to the pubic symphysis morphology, auricular surface morphology, and sternal rib endmorphology.[5] Sex determination was based upon characteristics of the pelvis and the cranium (Buikstra and Ubelaker 1994:16-21; Meindl *et al.* 1985; Murail *et al.* 1999; Phenice 1969).

In this investigation, we scored the following variables using established standards of data collection in dental anthropology and following Indriati and Buikstra's method (Indriati and Buikstra 2001; Hillson 2000, 2002; Kelley and Larsen 1991; Larsen *et al.* 1991; Turner 1979): antemortem tooth loss, postmortem tooth loss, location of carious lesions by tooth surface, root exposure, and degree of calculus formation. Carious lesions were recorded by tooth and surface location, by severity, and when possible, by site of initiation. Antemortem tooth loss was recorded in the absence of the tooth with the presence of healed or partially remodeled osseous activity on the mandibular or maxillary alveolus. Postmortem tooth loss was based upon the absence of the tooth and no apparent osseous response on the alveolus. Root exposure was measured to the nearest tenth of a millimeter using dental calipers. The presence of calculus was scored by tooth location and the amount

[4] Buikstra and Ubelaker 1994:55; Hillson 2002:280-283; Langsjoen 1996:476-478, 484; Larsen 1997:65-75; Reich *et al.* 1999; Sapp *et al.* 1997:61-74.

[5] Bass 2005:134-142; Buikstra and Ubelaker 1994:21-32; Iscan *et al.* 1984, 1985; Lovejoy *et al.* 1985; McKern and Stewart 1957; Suchey and Katz 1998.

and severity of the calculus (Dobney and Brothwell 1987).

Following the methodology of Indriati and Buikstra (2001:246), we identified the presence, absence, and frequency of the strong, mild, and weak indicators of coca chewing. Accordingly, the strongest indicator of coca leaf chewing is the presence of cervical-root caries on the buccal surface of the mandibular molars with severe root exposure equal to or more than three mm. from cemento-enamel junction. Mild indicators include cervical-root caries on the buccal surface of the maxillary molars, cevical-root caries on the mesial, distal, and lingual surfaces of the maxillary and mandibular molars, cervical-root caries on the premolars when adjacent molars are lost, and buccal-pit caries. Weak indicators were the presence of interproximal caries, the presence of molar roots only, and antemortem tooth loss. Individuals were then classified as definite, probable, and possible chewer or nonchewer according to the presence and frequency of the strong, mild, and weak indicators (after Indriati and Buikstra 2001). Definite chewers possessed at least two strong indicators and two other mild or weak indicators. Probable chewers possessed one strong indicator and one mild indicator. Possible chewers possessed one strong indicator, or at least one mild indicator, or several weak indicators.

Dental data were compared by age, sex, and mortuary treatment. Because a description of all of the variables scored and analyzed is beyond the scope of this study, we will only summarize the results of the variables relevant to the practice of coca leaf chewing.

The objectives of the mortuary analysis were twofold: 1) to investigate the presence or absence of coca and or coca paraphernalia in the funerary contexts of the individuals in the dental survey and 2) to classify the different burials as elite, intermediate, commoner, or indeterminate based on their mortuary treatment to explore whether or not coca was restricted to those individuals with elaborate mortuary treatment. This burial typology did not specifically identify Inca royalty, provincial lords or chiefs, but the mortuary variability present suggests that a degree of social differentiation existed in the cemetery. While it is unlikely that these social strata were the same as those identified and recognized by members of the community interred at Puruchuco-Huaquerones or even those recognized by Inca nobility, the differentiation between the elites and the non-elites (intermediate and commoner) is the best attempt we can make to capture differences among high and low status individuals, if they existed.

For the present study, these burials were categorized into different social status groups (elite, intermediate, and commoner) by inspection of their mortuary treatment and on the basis of the presence of metal, ceramics, *Spondylus*, and scallop shells (Table 2). Artifacts made of perishable or organic materials, such as weaving baskets, textiles, and food, were excluded from the burial typology due to their differential preservation.

	57AS03	Huaquerones	Total	% total (N= 209)
Elite	0	22	22	9.5
Intermediate	14	23	37	17.7
Commoner	15	60	75	35.8
Atypical	50	0	50	23.9
Indeterminate	8	17	25	12.0

Table 2. Sample composition by burial classification.

Following Cock Carrasco and Goycochea Díaz (2004:190-193), the largest of the adult burials with false heads and the highest quality and quantity of mortuary offerings were classified as elite individuals because they possessed the most elaborate mortuary treatment. The false heads are not naturalized or anatomical representa-

tions of faces, such as those from other Andean sites on the central coast (Fleming *et al.* 1983:149-150, see Uhle 1903 for context; Kaulicke 1997), but the presence of a false head may indicate a different social identity and perhaps a more elaborate means of memorializing the deceased. Intermediate burials possess *Spondylus* shell and usually both ceramic and worked metal offerings, but they lack a false head and they are smaller in size than the false head burials (<1 meter in height approximately). Commoner burials possess few, if any, burial offerings, and typically the offerings are only small pieces of unworked metal and/or ceramic vessels. A subsample of burials from 57AS03 resembled the commoner burials in their mortuary treatment; however, the orientation of the burials and the position of the bodies departed from the Late Horizon pattern observed, so these burials were classified as atypical burials. Some burials could not be classified because they were in a poor state of preservation or because they were fully or partially disturbed, so they were categorized as indeterminate. The presence of coca, gourd lime containers (*caleros)*, and specific textile bags (*chuspas)* accompanied by either coca or lime gourds were considered as mortuary offerings of coca or coca paraphernalia.

RESULTS

In the total sample, 4,705 teeth and 6,398 sockets were examined. Approximately 882 teeth were lost antemortem. Of the total teeth examined from the two cemeteries, 14.7% possessed carious lesions, and 84.1% of the individuals examined possessed carious lesions. Individuals averaged 4.1 carious lesions each (Tables 3, 4).

	57AS03	Huaquerones	Total
Number of teeth observed	2080	2625	**4705**
Number of sockets observed	2677	3721	**6398**
Antermortem tooth loss (AML), by teeth	314	568	**882**
Number of sockets/ AML (%)	8.5%	6.6%	**7.3%**
AML by individual (at least one tooth)	50	87	**137**
AML by individual (%)	57.5%	71.3%	**65.6%**
Average AML per individual	3.6	4.7	**4.2**
Males with AML (%)	26 (52.0%)	44 (50.6%)	**70 (52.2%)**
Females with AML (%)	24 (48.0%)	40 (46.0%)	**64 (46.7%)**
Indeterminate with AML (%)	0%	3%	**3%**

*Table 3: Comparison of dental health indicators between 57AS03 and Huaquerones.**

*Note: this comparison includes the full adult sample listed in Table 1.

	57AS03	Huaquerones	Total
Total adults	85	116	**201**
Males	49	65	**114**
Females	36	47	**83**
Indeterminate	0	4	**4**
Number of caries	276	416	**692**
Teeth with caries (%)	13.2%	15.8%	**14.7%**
Total individuals with caries	68/85	101/116	**169/201**
Individuals with caries (%)	80%	87.1%	**84.1%**
Average caries per individual	4.0	4.2	**4.1**
Males with caries (%)	38 (55.9%)	55 (54.5%)	**93 (55.0%)**
Females with caries	30 (44.1%)	42 (41.6%)	**72 (42.6%)**
Indeterminate with caries	0	4	**4**
Anterior caries (% total caries)	48 (17.4%)	97 (23.3%)	**145 (21.0%)**
Posterior caries (% total caries)	228 (82.6%)	320 (76.9%)	**548 (79.2%)**

Table 4. Comparison of carious lesions between 57AS03 and Huaquerones.

In the total adult sample, more males than females possessed antemortem tooth loss (52.2% versus 46.7%) and the number of males with carious lesions was higher than the number of females with carious lesions (55% versus 42.6%; Table 4). Approximately 87.1% individuals from the Huaquerones cemetery exhibited at least one carious lesion and individuals averaged 4.1 lesions each. The frequency of carious lesions

between Huaquerones males and females was very similar (54.5% and 41.6% respectively) and chi-square tests reveal that there are no statistically significant differences between males and females ($p>.05$). In the adults from 57AS03, approximately 80% possessed carious lesions and individuals averaged 4.1 carious lesions (55.9% of the males and 44.1% of the females), but these differences are not statistically significant ($p>.05$). The frequency of posterior caries is much greater than the frequency of anterior caries, which is not unexpected given the greater number of posterior teeth (molars and premolars) and the greater likelihood that the fissures and cusp morphology on the occlusal surfaces of the posterior teeth will contribute to the growth of cariogenic bacteria and carious lesions.

Approximately 57.5% of the individuals from 57AS03 experienced antemortem tooth loss and 71.3% of the individuals from Huaquerones experienced antemortem tooth loss. In both cemeteries, males and females experienced antemortem tooth loss in nearly equal numbers (Table 3) and these differences are not statistically significant (57AS03 $p>.05$, Huaquerones $p>.05$). Individuals buried in 57AS03 averaged 3.6 teeth lost antemortem and those buried in Huaquerones lost an average of 4.7 teeth antemortem. As expected, due to the age-progressive nature of tooth decay, the middle adult and older adult categories from both cemeteries show higher frequencies of carious lesions and antemortem tooth loss (Table 5).

	57AS03	Huaquerones	Total
YA with caries	26	40	**66**
MA with caries	31	54	**85**
OA with caries	8	7	**15**
Adults with caries	3	0	**3**
YA with AML	12	29	**41**
MA with AML	30	51	**81**
OA with AML	7	7	**14**
Adults with AML	1	0	**1**

Table 5. Dental health by age category.

Several individuals exhibited distinctive carious lesions on the buccal aspect of the cervical root region of the mandibular molars, considered the strongest indicator of coca leaf chewing. The buccal cervical root carious lesions ranged in severity from incipient lesions to large, wide lesions extending down the root of the molars (Figures 3, 4). Typically, the cervical root carious lesions were accompanied by several of the mild and weak indicators of coca chewing (Indriati and Buikstra 2001). Following Indriati and Buikstra's framework for identifying coca chewing in skeletal samples, 32 individuals (32/201; 15.9%) were identified as definite chewers, probable chewers, and possible chewers of coca on the basis of presence and frequency of the strong, mild, and weak indicators of coca leaf chewing (Tables 6, 7).

	57AS03	Huaquerones	Total
Total chewers (%)	11/85 (12.9%)	21/116 (18.1%)	**32/201 (15.9%)**
Male chewers	3	8	**11**
Female chewers	8	12	**20**
Indeterminate chewers	0	1	**1**
Definite	5	4	**9**
Probable	3	4	**7**
Possible	3	13	**16**
Individuals with offerings	1	8	**9**
Chewers with offerings	0	2	**2**
Chewers - Elite	0	4	**4**
Chewers - Intermediate	2	1	**3**
Chewers - Commoner	5	13	**18**
Chewers - Atypical	1	0	**1**
Chewers - Indeterminate	3	3	**6**

Table 6. Comparative summary of coca leaf chewers by cemetery.

Individual	Assessment	# Strong indicators	# Mild indicators	# Weak indicators	Age (years)	Sex	Burial type
HP01-122	Definite	2	2	2	35-49	M	Elite
HP01-89	Definite	4	1	1	20-34	F	Commoner
HP02-184	Definite	4	1	1	35-49	M	Elite
HP01-64	Probable	1	2	2	35-49	F	Elite
HP02-156	Probable	1	6	2	35-49	F	Elite
HP02-190	Probable	1	2	1	35-49	F	Commoner
HP01-100	Probable	1	2	3	35-49	F	Commoner
HP01-116	Possible	2	0	0	20-34	F	Commoner
HP02-173	Possible	0	2	3	20-34	M	Commoner
HP01-17	Possible	0	1	2	35-49	F	Commoner
HP01-24	Possible	1	0	9	35-49	M	Commoner
HP01-44	Possible	1	0	2	35-49	M	Commoner
HP02-186	Possible	1	0	1	35-49	M	Commoner
HP02-166	Possible	1	0	2	35-49	F	Intermediate
HP02-172	Possible	1	0	3	35-49	M	Intermediate
HP01-120	Possible	0	1	2	35-49	F	Commoner
HP01-71	Possible	0	1	2	35-49	M	Commoner
HP02-145	Possible	0	3	2	50+	I	Indeterminate
HP02-157	Possible	0	1	2	35-49	F	Commoner
HP02-192	Possible	0	0	7	35-49	F	Indeterminate
HP02-194	Possible	0	1	6	35-49	F	Commoner
57AS03E 125	Definite	3	1	7	35-49	F	Commoner
57AS03E 307	Definite	3	2	5	20-34	F	Commoner
57AS03E 392	Definite	2	0	2	35-49	F	Commoner
57AS03E 442	Definite	2	0	9	35-49	F	Indeterminate
57AS03E 471	Definite	2	2	2	35-49	M	Indeterminate
57AS03E 149	Probable	1	2	6	50+	F	Commoner
57AS03E 190	Probable	1	1	7	20-34	M	Intermediate
57AS03E 298	Probable	1	27	19	50+	F	Commoner
57AS03E 018	Possible	1	0	5	50+	F	Intermediate
57AS03E 477	Possible	1	0	3	20-34	F	Indeterminate
57AS03E 073	Possible	0	1	3	20-34	M	Atypical

Table 7. Coca leaf chewers from Puruchuco-Huaquerones.

Of these 32 individuals, eight were identified as definite coca leaf chewers, seven were identified as probable coca leaf chewers, and 17 were identified as possible coca chewers. Eleven of the total coca chewers were males, 20 were females and one was of indeterminate sex. These differences are not statistically significant ($p>.05$). More individuals were identified as coca chewers from the Huaquerones cemetery than from 57AS03 (21 versus 11; 18.1% and 12.9%, respectively). Nine individuals were interred with mortuary offerings of coca and/or coca paraphernalia (Figure 5, Table 8). Most of these individuals were classified as nonchewers and only two chewers possessed coca or coca paraphernalia among their mortuary offerings. The majority of individuals with offerings of coca or coca paraphernalia were male (six males, three females) and eight of them were interred in the Huaquerones cemetery and one was interred in 57AS03.

Individual	Age, yrs	Sex	Coca leaf chewer?	Type of offering	
HP01-122	35-49	M	Definite	Textile bag, lime gourd container	Elite
HP02-157	35-49	F	Possible	Textile bag, lime gourd container	Intermediate
HP01-40	35-49	F	Non-chewer	Textile bag, four lime gourd containers	Intermediate
HP01-70	20-34	M	Non-chewer	Textile bag, lime gourd container, coca	Elite
HP01-88	35-49	M	Non-chewer	Textile bag with lime	Intermediate
HP01-125	35-49	M	Non-chewer	Lime gourd with container	Intermediate
HP02-206	50+	M	Non-chewer	Textile bag with lime gourd container inside	Elite
HP01-14	35-49	F	Non-chewer	Coca leaves	Commoner
57AS03E 081	25-49	M	Non-chewer	Coca leaves	Atypical

Table 8. Individuals with mortuary offerings of coca and/or coca paraphernalia

When we examine the mortuary treatment of the chewers, most of the individuals with dental evidence of coca leaf chewing were classified as commoner burials (18 individuals; Table 7). Three intermediate burials and four elite burials possessed dental evidence of coca leaf chewing. One chewer was classified as an atypical burial and the poor preservation of the funerary contexts of six chewers did not allow for classification (indeterminate). Only two of the coca chewers possessed mortuary offerings of coca or coca paraphernalia and they were both from the Huaquerones cemetery. Indriati's (1998) study found evidence of coca chewing in 40-80% of her sample, which is significantly higher than was found in this study (15.9%, Table 9).

However, the majority of the samples were from the southern coastal and southern highland regions (Indriati 1998). Using the radioimmunoassay technique, the individuals who tested positive for coca use in the samples analyzed by Cartmell and colleagues (1991) ranged from zero percent to close to 69%, with the highest frequency of coca use detected in their provincial Inca sample (69.2%; Table 9). A similar low prevalence was reported from hair samples of non-elite Lambayeque burials from the coastal site of El Brujo that were analyzed by radioimmunoassay and only tested positive for coca use in 17% (4/23) of the cases sampled (Verano 2000).

Site/Cultural phase	Approximate date	N	Coca use %	Author(s)[1]
Puruchuco-Huaquerones	AD 1475-1535	201	15.9	Present study
Huaquerones	AD 1475-1535	116	18.1	Present study
57AS03	AD 1475-1535	85	12.9	Present study
Chinchorro	3000-2000 BC	23	0.0	Cartmell *et al.* 1991
Quiani	3000-1250 BC	3	0.0	Cartmell *et al.* 1991
El Laucho	560 BC	49	44.9	Indriati 1998
Alto Ramirez	350-250 BC	3	33.3	Cartmell *et al.* 1991
Tiwanaku	AD 300-1000	51	49.0	Indriati 1998
Maytas	AD 750-950	69	71.0	Indriati 1998
Cabuza	AD 400-1000	16	62.5	Cartmell *et al.* 1991
Gentilar	AD 650-950	23	52.2	Indriati 1998
Chiribaya Alta	AD 650-1100	26	69.2	Indriati 1998
Yaral	AD 650-1100	9	55.5	Indriati 1998
El Brujo	AD 900-1100	23	17.0	Verano 2000
Maytas Chiribaya	AD 1100-1250	97	55.7	Cartmell *et al.* 1991
San Miguel	AD 1200-1350	8	25.0	Cartmell *et al.* 1991
Inca[2]	AD 1400-1500	13	69.2	Cartmell *et al.* 1991

Table 9. Comparison of the prevalence of coca use.

Note: All of the samples and their approximate dates, except for the sample from Puruchuco-Huaquerones, were the dates provided by the authors in the original citations.

1. The studies reported by Verano 2000 and Cartmell *et al.* 1991 used the radioimmunoassay test to detect coca use.

2. The Inca sample analyzed by Cartmell and colleagues is from the Camarones Valley, south of Arica, Chile and the authors believe that it is a local group with "an administrative relationship to the Imperial Inca" (Cartmell *et al.* 1991:264).

Discussion and Conclusions

The overall prevalence of coca leaf chewing found at Puruchuco-Huaquerones is low in comparison with that of other studies of the practice. This evidence suggests limited access to coca, but we believe access was unrelated to social status and not restricted to the elite members of the community. The coca plantations in the upper Lurín Valley were annexed by Tupac Yupanqui and given to the Yauyos of Huarochiri during the Inca expansion onto the central coast (Rostworowski 2002:90, 174). Therefore, members of the Ychma macroethnic group living in the middle and lower Rimac and Lurín Valleys and, specifically, people from Puruchuco-Huaquerones, lost control of their coca plantations and may have experienced a reduction in access to the plant. It is unclear how local elites or Inca administrators in the region distributed the available coca, but it may have been distributed as part of mit'a labor obligation (Hastorf 1991:151-152; Murra 1982). A high number of the identified coca chewers were female (20/32, 62.5%) and it is conceivable that coca may have been distributed to these women during mit'a labor, such as weaving or chicha production. This pattern is particularly interesting because the frequency of carious lesions is higher in males than in females in the entire sample (93 males versus 72 females), but more females than males were identified as coca chewers (20 females, 11 males, one indeterminate). There is a significant difference in carbon isotope composition of dietary protein between males and females at Puruchuco-Huaquerones, indicating that males had differential access to animal protein fed C4 fodder, or that males may have consumed higher quantities of chicha (Williams 2004: 157, 160). Differential consumption of food and coca could have occurred for male and female participants as a result of a gendered division of labor (Hastorf 1991:149-151; Murra 1982:256), where males may have received meat and chicha, and females received coca, which may explain the higher number of female coca chewers. Other studies have reported higher numbers of coca chewing among females than males, but the results were not statistically significant (Cartmell *et al.* 1991: 265; Indriati and Buikstra 2001:255).

The patterning of offerings of coca and coca paraphernalia contrasts with the dental evidence of coca chewing. Mortuary offerings of coca, lime gourds, and textile bags, although present, were uncommon (nine individuals) and were recovered more among the burials of adult males than females (six males, three females). Most of these individuals were also classified as elite or intermediate burials, so they also received a more elaborate mortuary treatment that included a higher quantity and quality of offerings (Table 8). Only two individuals with coca or coca paraphernalia were identified as coca chewers. In the absence of dental evidence of the practice, these offerings likely highlight the symbolic importance of coca and paraphernalia, particularly for men in this community. Dental evidence of the practice of coca leaf chewing at Puruchuco-Huaquerones indicates that males and females chewed coca, but that mortuary offerings were usually reserved for males. Although the sample size of individuals with offerings of coca or coca paraphernalia is small in the present study, it is known that during seventeenth and eighteenth century Andean funerary rites, mourners and family members of the deceased reportedly offered coca and coca paraphernalia (Doyle 1988), so the objects could simply reflect ceremonial offerings that say little about the practice of coca chewing by the deceased. Contrary to what we would expect based on some ethnohistorical sources (Acosta 2002 [1590]; Cobo 1964 [1653]; Matienzo 1967 [1567]; Pizarro 1969 [1571]), this study of coca leaf chewing demonstrates that access to coca was not restricted to the elite individuals from Puruchuco-Huaquerones. Only four chewers were classified as elite individuals (4/32, 12.5%).

Individuals identified as possible, probable, or definite coca chewers were not correlated with one particular burial type, nor were these individuals found only among the more complex mortuary contexts and treatments. Rather, individuals identified as coca chewers were interred in all of the different burial contexts and most of the identified coca leaf chewers were from commoner burials in the typology used in this study (18/32, 56.3%).

A higher frequency of coca leaf chewing has been observed in archaeological samples from highland regions and south coastal regions (Table 9; Cartmell *et al*. 1991; Indriati 1998; Indriati and Buikstra 2001). Some of the coca leaf chewers from Puruchuco-Huaquerones may have possessed some highland affinities, either through intermarriage, trade, or ethnicity. It is possible that the chewers were members of communities or an ethnic group or groups relocated to this area of the central coast, possibly from the highlands, who continued to chew coca in this coastal region. Dental metric data indicate that the community from Puruchuco-Huaquerones is characterized by considerable phenotypic variability and the samples from Huaquerones and 57AS03 show similar levels of phenotypic similarity (Murphy *et al*. 2008). In the future, we will investigate residence and migration patterns through the analysis of oxygen and strontium isotope ratios, which may help reveal if these chewers have highland affinities.

Unfortunately, the results of this study cannot address the ceremonial use of coca, its infrequent use, or differential susceptibility to the dental consequences. Individuals who seldom or rarely chewed coca, only participating in occasional sacred rituals, may not evince the dental consequences of the practice. For example, individuals who were interred with coca and coca paraphernalia, but who lack dental evidence of coca leaf chewing, may have been infrequent chewers, may have died too young to develop the pathological conditions, and/or may have possessed a higher resistance to the distinctive dental pathologies. These issues will be explored through the analysis of hair of individuals from Puruchuco-Huaquerones through radioimmunoassay tests. These findings will further clarify the frequency of the practice of coca leaf chewing for members of this coastal community during the Late Horizon.

The bioarchaeological data from Puruchuco-Huaquerones do not indicate that coca use was widespread in this region during the Late Horizon or that the practice of coca chewing was restricted only to elites. Despite the low prevalence, its association with individuals from elite, intermediate, and commoner burials supports the view that everyone had access to the leaf (Murra 1986, 1991). In comparison to other Andean archaeological populations, the population at Puruchuco- Huaquerones exhibited a relatively low incidence of the practice, and few individuals were interred with offerings of coca or coca paraphernalia. These results may reflect a change in access to coca resulting from the loss of coca plantations to the Yauyos when the Incas arrived on the central coast. However, access to the leaf was sufficient for a sample of individuals to chew it frequently and for coca and coca paraphernalia to be included as offerings during the funerary rites of some individuals. If Inca imperial control was exercised through diplomacy and alliance building with local elites and/or indirect measures in the lower middle Rimac Valley, as suggested by Villacorta (2004) and others, then coca use at Puruchuco-Huaquerones may reflect less restrictive strategies of control and access to coca by the local elites in this region than what was experienced by other regions. Another possible explanation is that the low frequency of coca chewers and coca use may reflect a coastal pattern that was less frequent among people living at sea level and some of these identified chewers may

actually represent highlanders living in the heterogeneous community of Puruchuco-Huaquerones. Finally, the debate over access to coca may have been slightly overstated due to the overemphasis on those ethnohistorical sources that are removed from the daily realities of provincial life. Additional data from Late Intermediate and Late Horizon coastal sites and bioarchaeological samples would greatly illuminate whether or not coca availability shifted after the Inca established a presence on the central coast, as well as the prevalence of coca leaf chewing and coca access from different regions of the north and central coasts.

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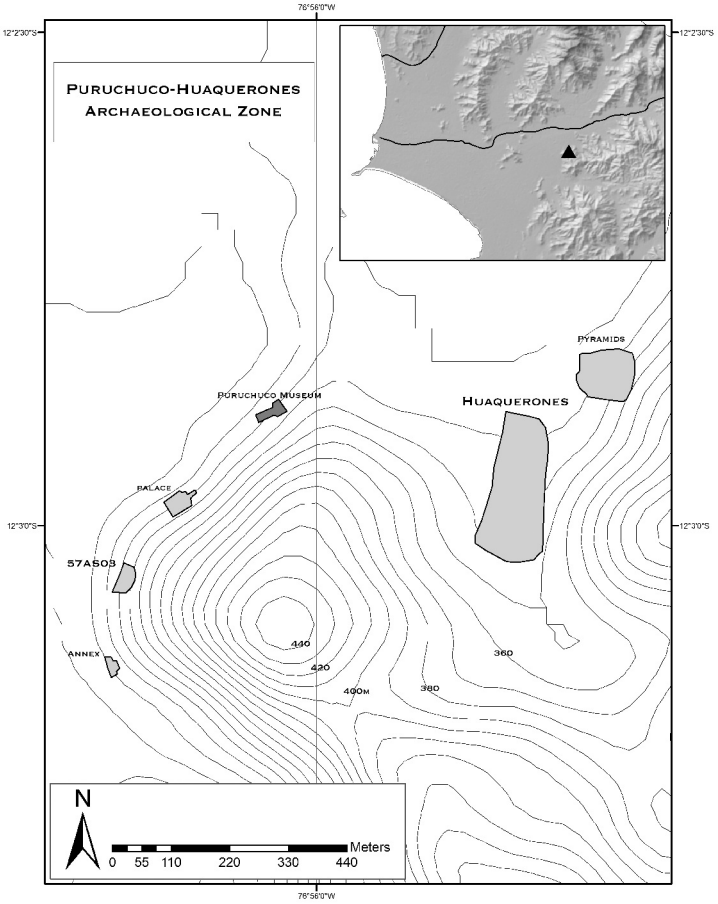

Figure 1: Location of the cemeteries of Huaquerones and 57AS03 relative to the Puruchuco Museum, the Pyramids, and the Palace within the archaeological zone of Puruchuco-Huaquerones. Inset: location of Puruchuco-Huaquerones in the Rímac Valley.

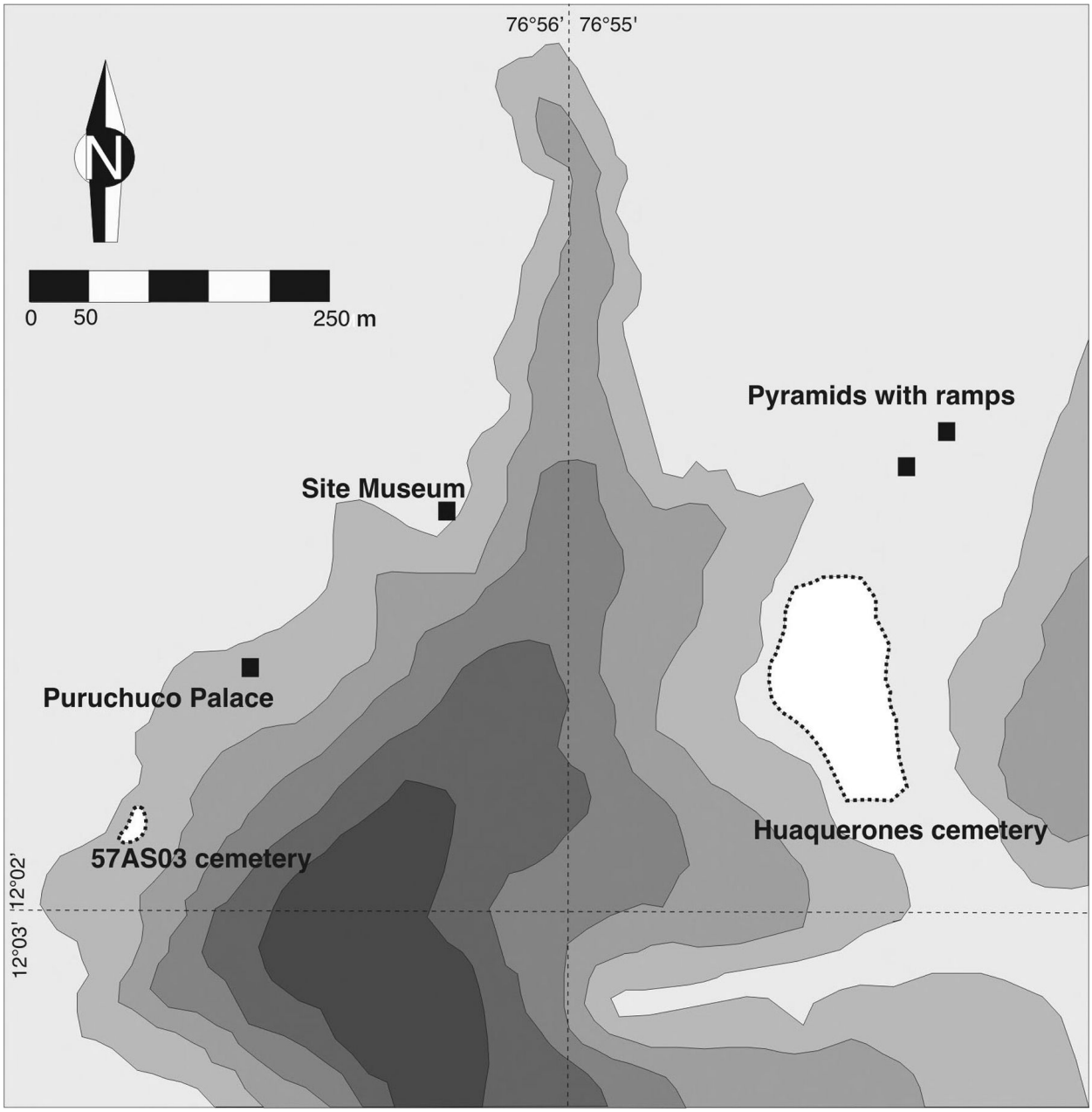

Figure 2: Location of 57AS03 and the Huaquerones cemetery within the archaeological zone of Puruchuco-Huaquerones and relative to the Puruchuco Site Museum, the Pyramids with Ramps, and the Puruchuco Palace

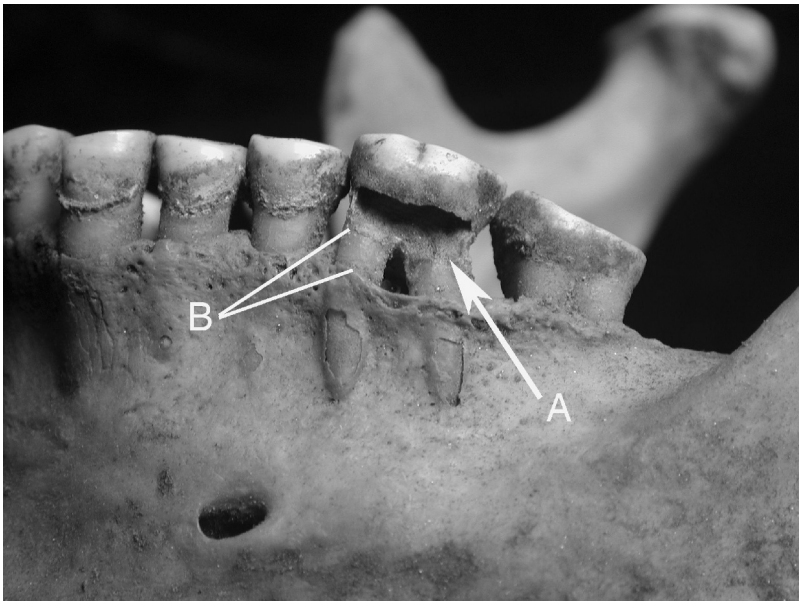

Figure 3: An adult individual (HP01-17) exhibits a deep and wide cervical root carious lesion on the buccal aspect (A) with root exposure of the left mandibular first molar (B). These dental characteristics are considered the strongest indicators of coca leaf chewing.

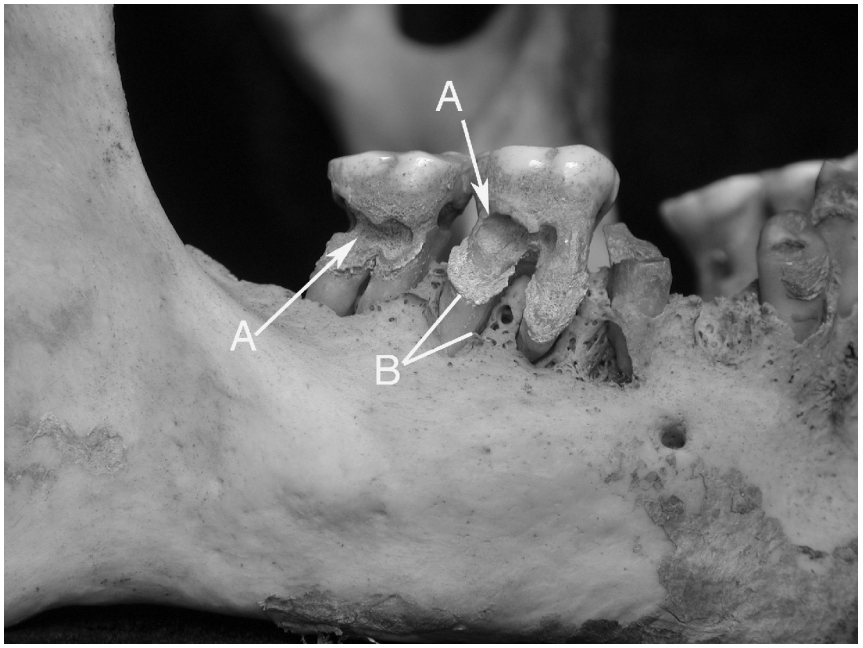

Figure 4: Example of an adult male individual (HP01-184) with two cervical root carious lesions affecting the buccal aspect of his right first and second mandibular molars (arrows labeled A). Root exposure (B) due to alveolar recession is also apparent. The crown of the adjacent premolar has been lost to caries.

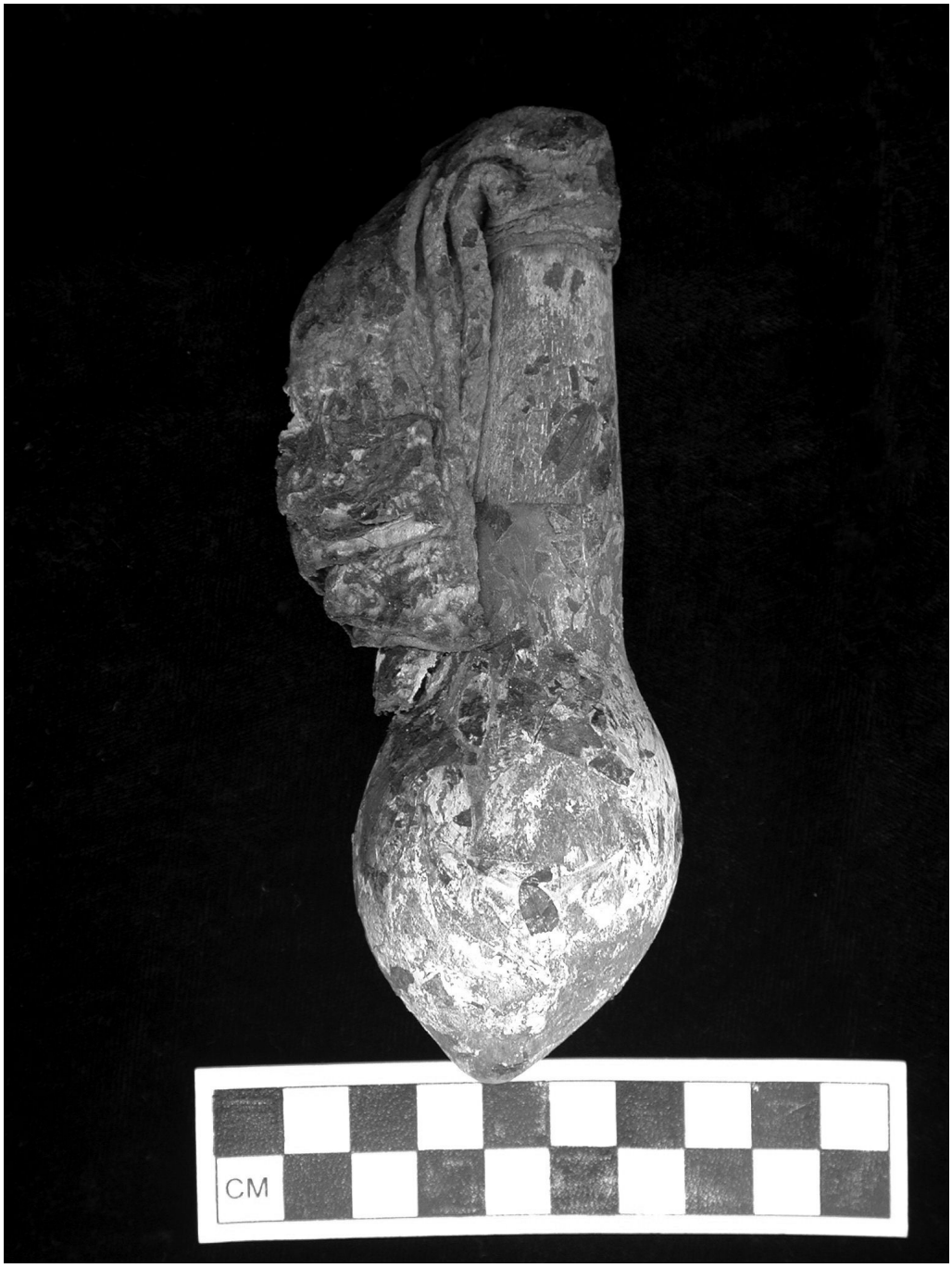

Figure 5: Ten individuals in the present study did not possess dental evidence of coca leaf chewing, but they were interred with coca and coca paraphernalia. This lime gourd container was one of the mortuary offerings accompanying an adult male individual from an elaborate false head mummy bundle. The lime gourd was recovered from inside a coca bag (chuspa) *that also contained a* Spondylus *shell and coca leaves. Some of the coca leaves are still adhering to the exterior of the gourd. The coca bag and its contents were placed underneath the principal individual's left arm.*