Article

Journal of Ethnobiology

Diet During the Late Initial Period (1100–800 BC) in the Chavín Heartland: New Data from Canchas Uckro (North-Central Peru)

Journal of Ethnobiology
1–13

DOI: 10.1177/02780771231176477
journals.sagepub.com/home/ebi
Sage

Jason Nesbitt[1], Sadie L. Weber[2], Eden Washburn[3], Bebel Ibarra Asencios[1], Anne R. Titelbaum[4], Andrew Schroll[1], and Lars Fehren-Schmitz[3]

Abstract

During the late Initial Period (c. 1100-800 BC), the Conchucos region of highland Peru witnessed the formation of the ceremonial and "proto-urban" center of Chavín de Huántar (c. 1000-500/400 BC). An important question regarding Chavín de Huántar centers on the nature of its subsistence economy during the time when it was first founded. In this paper, we present new results from zooarchaeological, starch granule, and stable isotope ($\delta^{13}C$ and $\delta^{15}N$) analyses to reconstruct diet from Canchas Uckro, a settlement located in Chavín de Huántar's heartland region. Founded c. 1100 BC and abandoned just after 800 BC, Canchas Uckro provides insight into socioeconomic processes during the early phases of Chavín de Huántar. Extant faunal remains suggest deer comprised an important component of the diet, while camelids constitute a minor proportion of the assemblage. Starch granules recovered from the pottery indicate that domesticated cultigens (maize, potato, and manioc) were obtained from different highland production zones. $\delta^{13}C$ and $\delta^{15}N$ analysis of a sample of human skeletal remains, coupled with Stable Isotope Analysis in R (SIAR) mixing models, demonstrate that C_3 plants constitute most of the diet, while maize was not intensively consumed. $\delta^{13}C$ and $\delta^{15}N$ further indicate that deer made up 25-50% of the diet. The results of this study add to a growing corpus of data on subsistence practices in the north-central and northern highlands of Peru prior to the widespread adoption of domesticated camelids.

Keywords

Peru, zooarchaeology, stable isotopes, starch granule analysis, bioarcheology, hunting

Introduction

The late Initial Period (or Middle Formative Period; c. 1100-800 BC) was a transformative time in the Central Andes. During this period, numerous civic-ceremonial centers were founded in the Peruvian highlands (Burger 1992) (Figure 1a). One locus of cultural development was the Conchucos region of north-central Peru. By the late second millennium BC, this area witnessed the formation and subsequent florescence of Chavín de Huántar (c.f., Burger 2019; Kembel and Haas 2015; Rick et al. 2010), a large ceremonial and "proto-urban" center (Burger 1984). While much is known about its later occupation during the Janabarriu Phase (c. 800/700 and 500/400 BC), less is understood about the regional socioeconomic processes during the late second millennium BC when the site was first founded. Scholars generally agree that late Initial Period highland populations practiced an agrarian economy in which a variety of cultivated plants were consumed (Burger 1992; Burger and van der Merwe 1990; Sayre 2010). In contrast, analysis of mammalian remains suggests the late second millennium was a transitional period between the hunting of wild game (primarily deer and wild camelids) and the adoption of domesticated camelids that diffused northwards (Miller and Burger 1995; Uzawa 2010) from the south-central and southern Andes where they were first domesticated (e.g., Bonavia 2008; Mengoni Goñalons 2008; Moore 2016; Wheeler 1995, 1999; Wing 1986).

[1]Department of Anthropology, Tulane University, New Orleans, USA
[2]Laboratório de Arqueologia Tropical, Museu de Arqueologia e Etnologia, Universidade de São Paulo, São Paulo, Brazil
[3]Department of Anthropology, University of California, Santa Cruz, USA
[4]Basic Medical Sciences, University of Arizona College of Medicine-Phoenix, USA

Corresponding Author:
Jason Nesbitt, Department of Anthropology, Tulane University, 6823 St. Charles Avenue, New Orleans, Louisiana, 70118, USA.
Email: jnesbitt@tulane.edu

Sadie L. Weber, Labortório de Arqueologia Tropical, Museu de Arqueologia e Etnologia, Universidade de São Paulo, Avenida Prof. Almeida Prado, 14660–Butantã, São Paulo, SP, 05508–070, Brazil.
Email: sadielweber@gmail.com

Eden Washburn, Department of Anthropology, University of California, Santa Cruz, 1156 High Street, Santa Cruz, CA 95064, USA.
Email: ewashbur@ucsc.edu

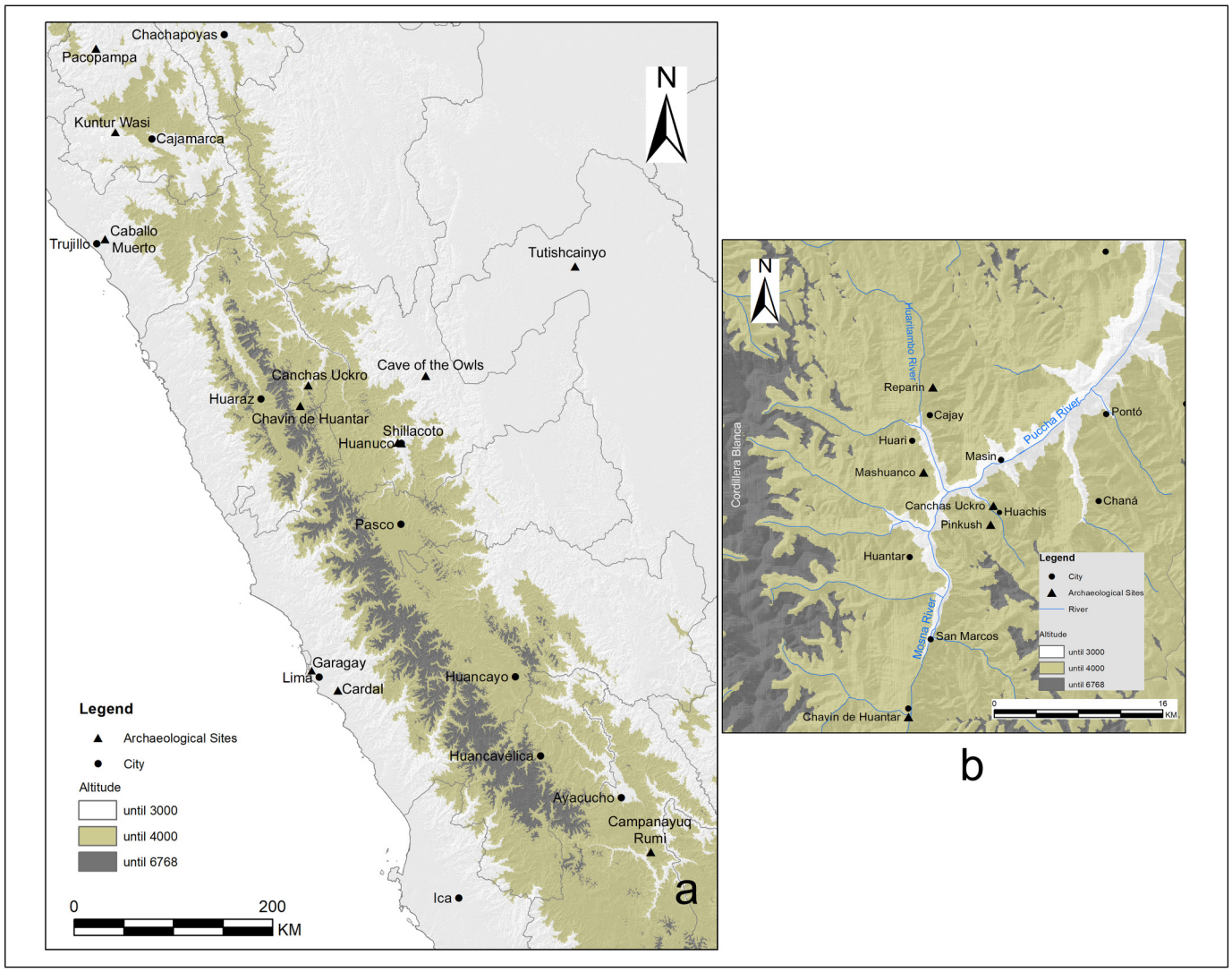

Figure 1. a) Map showing key archaeological sites mentioned in the text, b) map of the Conchucos region with the location of Canchas Uckro.

While the extant data indicates a mixed economy in the northern and north-central highlands, little is known about the precise nature of the diet prior to the adoption of camelids. For instance, was there regional variation in subsistence practices between different sites during this time? Furthermore, what proportion of the diet was comprised of different domesticated plants versus animal protein? If hunting was an important practice what was its approximate dietary contribution?

In this paper, we address these questions through a zooarcheological, starch granule, and stable isotope ($\delta^{13}C$ and $\delta^{15}N$) study from Canchas Uckro, a late Initial Period site situated in the Chavín heartland. Utilizing these methods, we present new data on the role of animals and domesticated plants in the Canchas Uckro subsistence economy. Our results demonstrate that the inhabitants of Canchas Uckro practiced a combination of hunting and farming, as opposed to a fully agrarian or agropastoral system. Based on these findings, we contextualize our results with Chavín de Huántar, as well as other contemporary sites in highland Peru.

Environmental Context of Canchas Uckro

Situated approximately 22 km to the northeast of Chavín de Huántar, Canchas Uckro is one of several sites dating to the late Initial Period and Early Horizon (800-200 BC) in the Conchucos region (Nesbitt 2023). This region consists of multiple intermontane river valley systems in the eastern Andes of north-central Peru that drain into the Marañón River, a tributary of the upper Amazon. Located above the Puccha River, (Figure 1b), Canchas Uckro is positioned near several different vertically stacked production zones (e.g., Brush 1976; Murra 1985; Pulgar Vidal 1970; Tosi 1960) that was favorable to ancient human settlement in the region (Tello 1960: 42).

At an elevation of approximately 3170 m.a.s.l., the site is situated within the *quechua* production zone. This area is surrounded by extensive contemporary agricultural terracing for a variety of crops that are supported by both irrigation and rainfall agriculture. In antiquity, the *quechua* could have been used

for maize production and other mid-elevation crops (Brush 1976; Pulgar Vidal 1970).

Above Canchas Uckro are the *jalca* and *puna* grasslands. In the *jalca* (c. 3300-3800 m.a.s.l.), highland crops such as quinoa (*Chenopodium quinoa*), potatoes (*Solanum tuberosum*), as well as other high-elevation tubers like *oca* (*Oxalis tuberosa*) can be cultivated. At altitudes exceeding 3800 m.a.s.l. lies the extensive grasslands known as the *puna*. This region serves as pasturelands for domesticated camelids herds (e.g., Flores-Ochoa 1979) and is also the preferred habitat of taruca (*Hippocamelus antisensis*), a species of Andean deer.

Below Canchas Uckro lies the Puccha valley floor which is located at ~ 2500 m a.s.l. and lower. Sometimes referred to as *quebrada* by local populations, it is better known as the *yunga*, a hot, dry production zone found in the intermontane valleys on the eastern side of the Andes (Onuki 1985). In the areas around the town of Masin, roughly 3 km from Canchas Uckro, are narrow strips of agriculturally productive lands in which a diversity of tropical cultigens are farmed, including manioc (*Manihot esculenta*), avocado (*Persea americana*), achiote (*Bixa orellana*), and other fruits.

Excavations of Canchas Uckro

Canchas Uckro is a two-tiered stone platform that measures 60 (N-S) m x 35 (E-W) m and is approximately 3 m in height (Figure 2). On the summit of the platform are a cluster of circular buildings that probably functioned as houses (Nesbitt et al. 2021). Excavations focused on the main platform to ascertain its chronology and relationship with Chavín de Huántar. These investigations determined that Canchas Uckro functioned as a small ceremonial center and village settlement that was built in two principal construction phases dated between c. 1100 and 800/750 BC (Nesbitt 2023; Nesbitt and Ibarra Asencios 2023; Nesbitt et al. 2021) (Supplemental Figure S1). The age of Canchas Uckro is significant because it was contemporary with the first phases of monument building (Kembel and Haas 2015; Rick et al. 2010) and residential settlement (Burger 1984, 2019; Mesía-Montenegro 2022) at Chavín de Huántar. Furthermore, Canchas Uckro was abandoned around 800-750 BC (Nesbitt and Ibarra Asencios 2023) and coincides with the florescence of Chavín de Huántar during the Janabarriu Phase (c. 800/700-400 BC) (Burger 1984, 2019).

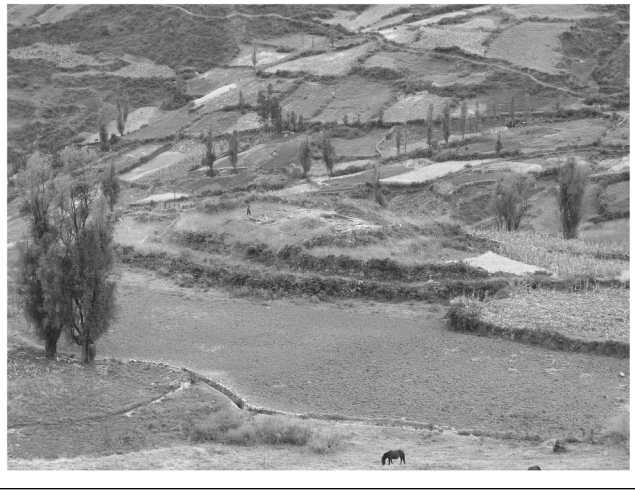

Figure 2. Photograph of the Canchas Uckro platform.

The organic remains discussed in this paper were recovered from fill deposits associated with the construction of the main façade on the northwest side of the platform and the lateral revetment walls on the southeast side (Figure 3). Sediments from these contexts were carefully troweled and screened through 3 mm mesh. Limited flotation of soil samples was also conducted but did not yield identifiable macrobotanical remains due to acidic soils. On the other hand, abundant faunal remains were recovered consisting mainly of mammals and small quantities of marine mollusks. In addition, human remains were found within these deposits.

On the northwest side of the platform, a 5 × 5 m excavation unit revealed two horizontally superimposed walls that correspond to two separate building phases. These walls probably functioned as retaining walls for the upper part of the platform. The earliest of these walls (Wall 2) was covered over by a fill deposit consisting of quarried boulders and dark, artifact-rich soils. Within these layers, abundant faunal remains and other organic remains were recovered. Wall 1 was constructed immediately following the interment of Wall 2. The space in front of Wall 1 also consisted of a thick refuse layer.

Like the northwest part of the platform, the excavations on the southeast façade yielded evidence for two building phases in which the original wall (Wall 3) was covered by a second (Wall 4). Excavations behind Wall 3 exposed a large section of the fill of the platform. The fill was approximately 1.25 m in depth and contained dozens of large boulders. The matrix of this fill consisted of dark brown organic-rich soils with charcoal, animal bone, and marine shell. Wall 3 was covered over by an intentional fill layer that measures some 50 cm in thickness and is characterized by boulders within a dark soil matrix with abundant artifacts and faunal remains. This deposit was also utilized as the fill over which a later platform wall (Wall 4) was built. Wall 4 was covered with a deep, organic, and artifact-rich layer with pottery and animal bone.

Materials and Methods

Zooarchaeology

The zooarchaeological analysis was conducted by Sadie Weber and builds off a larger project that is investigating the intensification of camelid use and the transition to agropastoralism in the late second and early first millennia BC (Weber 2019). Faunal remains included mammal bone (Number of Identified Specimens [NISP] = 625), as well as marine and terrestrial mollusks (NISP = 109). While this may seem to represent a small

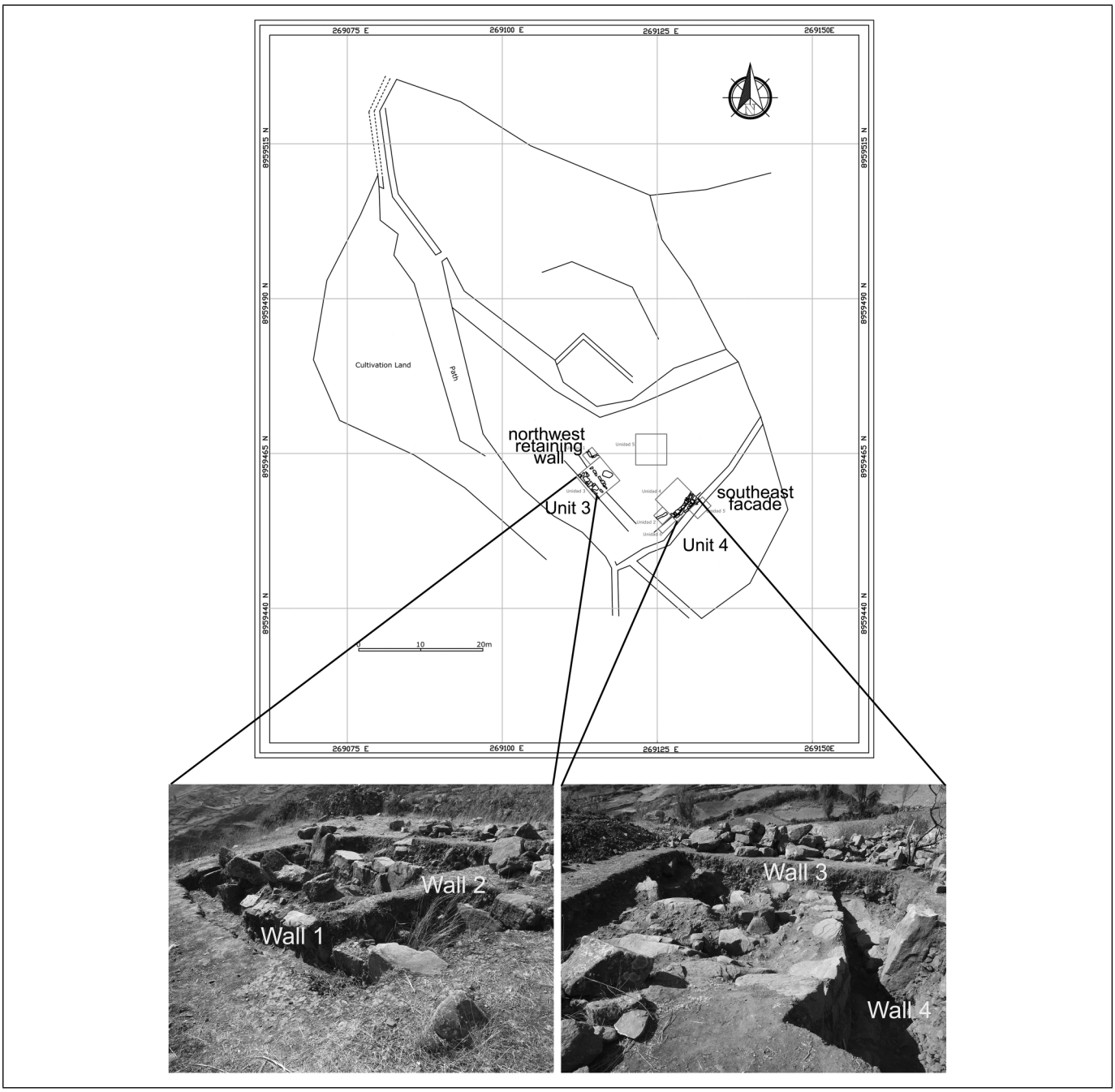

Figure 3. Image of the excavations of the northwest and southeast façade walls.

sample, it is of comparable size to other contemporary highland contexts (e.g., Miller and Burger 1995). Animal bones and mollusks were identified with the aid of published guides (e.g., Altamirano Enciso 1983; France 2008; Torres et al. 1979 for animal bone; Alamo and Valdivieso 1997; Keen 1971; Osorio 2002 for mollusks) and photographs of collections from the Harvard University Museum of Comparative Zoology. The category "artiodactyl" was used in cases of unclassifiable elements of the axial skeleton (vertebrae and ribs), cranial, and long-bone fragments to avoid skewing the analysis toward a specific taxon. Consequently, a lower number of specifically classified faunal remains were identified.

The assemblage was quantified according to NISP, Minimum Number of Elements (MNE), and Minimum Number of Individuals (MNI) (Grayson 1984; Lyman 2008). For both MNE and MNI calculations fusion state, size, orientation (distal/proximal, cranial/caudal), and side were considered. While MNI calculations generally underestimate the overall number of individuals represented, they offer a conservative estimate of the individuals necessary to account for all remains recovered. Pathology,

burning, breakage, and mechanical modification were also recorded. Age determination, when possible, of cervids (Harlow and DeFoor 1962; Mena 1992; Purdue 1983; Severinghaus 1949) and camelids (Wheeler 1982; 1999) was undertaken to create survivorship profiles. Furthermore, for the purposes of aging the cervids represented here, epiphyseal fusion stages of white-tailed deer (*Odocoileus virginianus* [see Purdue 1983]) were used to produce an approximate survivorship curve.

Starch Granule Analysis

Forty sherds were subjected to starch granule analysis using field extraction procedures and slide preparations outlined in Weber (2019:181) (Supplementary Data: Field Extraction and Slide Preparation for Starch Granule Analysis). Identification of the starches was completed at Harvard University through microscopic analysis under cross-polarized light. Starches from the archaeological samples were compared to modern reference assemblages and published images to confirm the identifications (e.g., Pagán-Jiménez 2015).

$\delta^{13}C$ and $\delta^{15}N$ Analysis

Human remains from Canchas Uckro were relatively rare and consisted of secondary interments that were frequently associated with animal bone (Supplementary data: Human Remains; Supplemental Figures S2 to S4). In this study, we selected bone from 5 different individuals for $\delta^{13}C$ and $\delta^{15}N$ analysis. Individuals were identified based on duplicate skeletal elements and genetic analysis (not reported in this text). Sex was estimated for three of the five individuals using morphological observations of the pelvis (Buikstra and Ubelaker 1994). Assessment of sex for three of the five individuals was determined using ancient DNA analysis (not reported in this text).

In addition to the human bone, four cervid teeth were sampled for $\delta^{13}C$ and $\delta^{15}N$ analysis and used in combination with $\delta^{13}C$ and $\delta^{15}N$ data from additional possible dietary resources (see Supplementary Data: $\delta^{13}C$ and $\delta^{15}N$ Analysis; Supplemental Table S1). Data for the mixing models for determining human diet was compiled from the following references: Colonese et al. 2020; DeNiro and Hastorf 1985; Finucane et al. 2006; Takigami et al. 2020; Turner et al. 2010; Tykot et al. 2006; Washburn et al. 2020.

Table 1. Summary of Main Taxonomic Groups from the Canchas Uckro Faunal Assemblage.

Taxonomic group	NISP	MNI
Artiodactyl (not further identifiable)	366	-
Cervidae (not further identifiable)		
Hippocamelus antisensis Odocoileus virginianus	192	
11 2	7	
Camelidae	22	2
Cavia sp.	25	8
Carnivorae (not further identified)	4	-
Aves (not further identified)		
Total	3	
625	-	

Results

Zooarcheology

Faunal remains from Canchas Uckro were highly fragmented, a characteristic common to contemporary animal bone assemblages from the Peruvian highlands (e.g., Miller and Burger 1995; Rosenfeld and Sayre 2016; Sawyer 1985; Shimada 1982, 1985; Uzawa 2019; Wing 1972). The assemblage is dominated by artiodactyls (Table 1) (NISP = 593), which in pre-Hispanic Andean contexts are deer and camelids. Of those bones that can be more specifically identified, the majority are cervids (taruca and white-tailed deer), with a NISP of 205 and an MNI of 7. However, because of the fragmentary nature of the assemblage, the actual quantity of cervids was probably greater. For cervids, nearly all identifiable skeletal elements are present, excluding ribs and certain vertebrae, which were abundant in the overall assemblage, but could only confidently be identified to the artiodactyl level. All cervids were prime-aged adults, save for two young individuals. The survivorship pattern represented here reflects an expected age distribution of a normal cervid social group (Barrio 2010; Merkt 1987) (Figure 4).

In contrast, camelids form a small component of the assemblage and are represented by an NISP of 22 and an MNI of 2. All camelids were of adult age. While few camelid remains were complete enough to be measured, those bones that could be measured fall within the size ranges of domesticated llama or wild guanaco (Kent 1982; Le Neün et al. 2023; Supplementary Data: Identification of Camelids; Supplemental Tables S2 to S4). Moreover, given that the natural range of guanacos overlaps with llamas (González et al. 2006), determining whether the bones

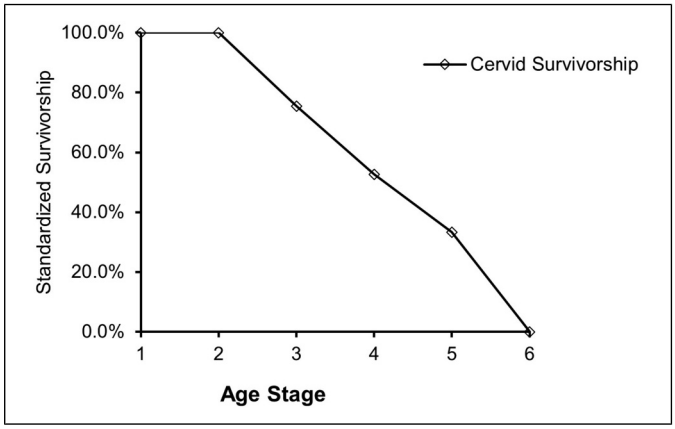

Figure 4. Survivorship curve for all cervids at Canchas Uckro. Age stages are as follows: 1 = fetal; 2 = 0-12 months; 3 = 13-20 months; 4 = 20-29; 5 = 29-38 months; 6 = >38 months.

represent domesticated or wild camelids is difficult to ascertain with our small camelid bone sample.

Evidence for butchery (cutting, chopping, and marrow cracking) appeared within all artiodactyl categories (cervid, camelid, and unidentified artiodactyl) and on 28% (n = 174) of all analyzed faunal remains. There was a high frequency of shattered long bones, and while in many cases they were assigned to skeletal element, they could not be specified to the genus or species level. As such, a general artiodactyl pattern of butchery marks is represented. Cut marks from stone tools are common, appearing on 20% (n = 125) of the artiodactyl remains, including cervids and camelids, and are primarily located at standard disarticulation or bleeding locations including the cervical vertebrae, pelvis, long bone articulations, and the axial skeleton. Cut marks appear on the ventral aspects of two of the cervid cervical vertebrae, as well as on a single cervid atlas, possibly indicating *in situ* slaughtering and field preparation of the carcass (Miller 1979: 27).

Butchery mark locations are consistent with carcass disarticulation and processing. A pattern of forcibly opening the animal's ribcage is evident in green fractures that are located on the transverse processes of the thoracic and lumbar vertebrae (Miller 1979: 44). Shattering of long-bone shafts and the splitting and shattering of metapodials was also common throughout the assemblage and is likely indicative of marrow cracking and fat processing (e.g., Binford 1981; Morin 2020; Rick and Moore 1999; Yacobaccio 2007). Rare evidence for burning (n = 31) probably indicates that animal carcasses were de-fleshed, the meat cooked, or entire elements were boiled, and the long bones were subsequently processed for marrow.

In addition to the artiodactyls, 25 guinea pig (*Cavia* sp.) bones (NISP = 25; MNI = 8) were recovered from the excavations. Guinea pig bones are quite small and for taphonomic reasons are often underrepresented in faunal assemblages (Osborn 2019: 360–361; Valdez and Valdez 1997). As a result, the dietary contribution of this species is difficult to ascertain from animal bone alone.

Marine Mollusks

A total of 109 marine mollusk fragments were recovered and are tabulated in Supplemental Table S5 according to NISP and MNI. Five marine mollusk species are represented in the assemblage from Canchas Uckro. Four species pertain to the cold waters of the central or north-central Peruvian coast, including *Choromytilus chorus,* which was the most common. Other species include *Aulacomya ater, Donax obesulus,* and the marine gastropod *Concholepas concholepas*. Finally, two parts of a *Spondylus* sp. shell bead fragment were also recorded.

Starch Granule Analysis

Of the 40 sherds, 6 yielded starch granules. In some cases, the starch forms were too ambiguous or too damaged to bespecifically identified. As such, the identifications made here are conservative. Three plants were identified from our assemblage including potato (*Solanum tuberosum*), maize (*Zea mays*), and manioc (*Manihot esculenta*), as well as unidentified grasses (Poaceae) (Supplemental Figure S5; see also Supplemental Figure S6 for modern comparative starches).

Results of the $\delta^{13}C$ and $\delta^{15}N$ Analysis

Bone collagen samples from the five human individuals and collagen from four individual cervid teeth were subjected to $\delta^{13}C$ and $\delta^{15}N$ analysis, and the results are presented in Figure 5 and Table 2. Atomic C/N ratios calculated for all samples range between 2.9 and 3.6, suggesting bone and tooth collagen was well preserved (Ambrose and Norr 1993; DeNiro and Hastorf 1985). The $\delta^{13}C$ values of the human individuals range from −19.1‰ to −18.4‰ with an average value of −18.7‰. Human $\delta^{15}N$ values range from 7.1‰ to 7.8‰ with a mean of 7.4‰. Based on these values, the diets of individuals from Canchas Uckro appear to represent a predominantly C_3 plant diet supplemented by terrestrial herbivore protein. In addition, $\delta^{15}N$ values fall within the expected range of terrestrial protein thus ruling out the consumption of marine protein, including shellfish.

Raw $\delta^{13}C$ and $\delta^{15}N$ data were further analyzed using dietary mixing models (Supplementary Data: Statistical Data Analysis of Dietary Resources; Supplemental Table S6; Supplemental Figures S7 and S8), which were applied to estimate the contributions of different foods in the diets of individuals from Canchas Uckro (Delgado 2021; Kennett et al. 2020; Washburn et al. 2020). Our mixing models suggest that all individuals found at Canchas Uckro had diets consisting of either the direct or indirect consumption of predominately C_3 plants and terrestrial grazers with a mostly C_3 plant diet. While there is some inter-individual variation in the proportions of each dietary source modeled, we estimate that C_3 plants constituted between 25 and 45% (75% credibility interval) of the diet. Conversely, C_4 and leguminous plants were only consumed in small amounts. In the Central Andes, the only major domesticated C_4 plants are maize and amaranth (or Kiwicha; *Amaranthus caudatus*), a plant that is cultivated at higher altitudes. Of the two plants, maize was the most commonly eaten and scholars have generally assumed that C_4 values are an indicator of the intensity of its consumption (but see Cadwallader et al. 2012). According to our dietary mixing models, C_4 plants (probably maize) formed less than 10% of the diet (75% credibility interval).

In addition to the consumption of C_3 plants, the diet also included significant contributions from terrestrial meat protein from animals that grazed on C_3 plants (Figure 5). In our model, terrestrial meat protein sources were separated based on $\delta^{13}C$ and $\delta^{15}N$ allowing us to determine the separate dietary contributions of camelids (with C_3 and C_4 diets respectively), guinea pigs, and deer (Supplemental Table S6). It is important to note that while camelids and deer with a predominantly C_3 plant diet overlapped in their $\delta^{13}C$ values, they were distinguishable based on an approximately 2.5‰ difference in their $\delta^{15}N$ values

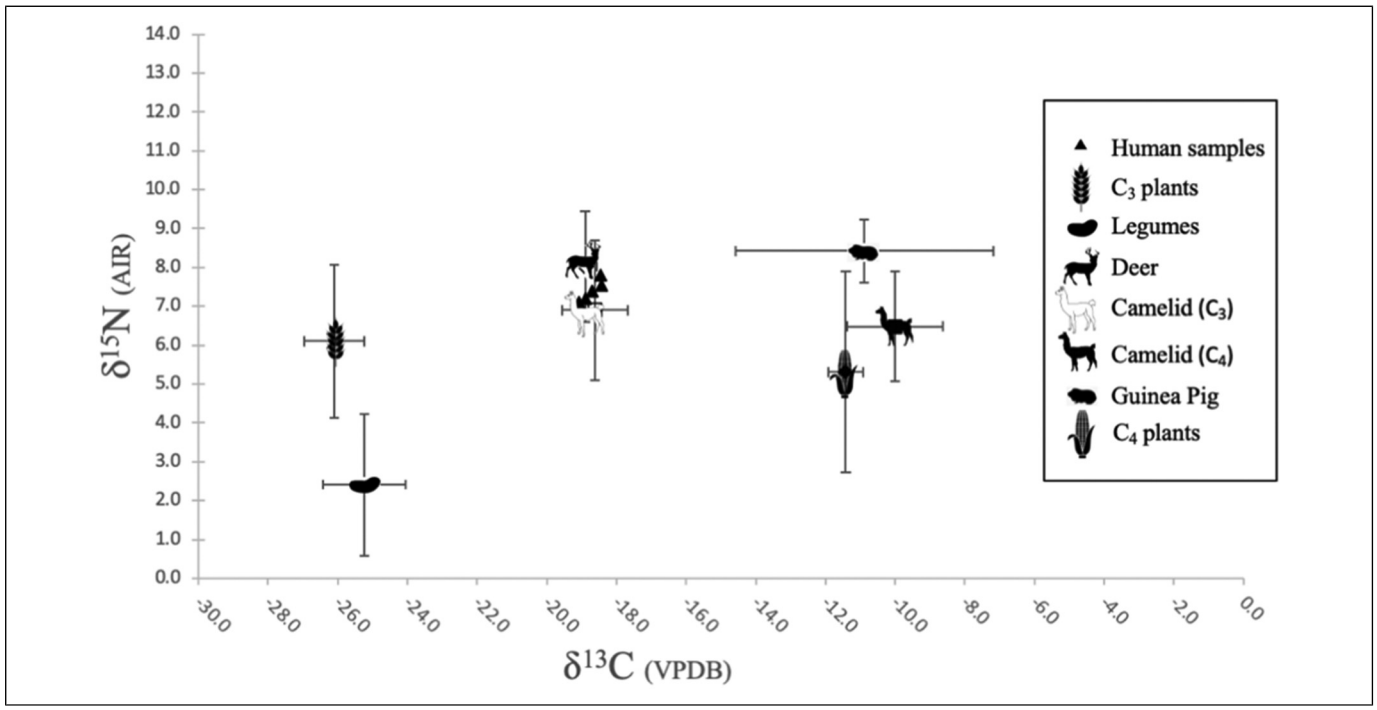

Figure 5. Scatter plot showing the human $\delta^{13}C$ and $\delta^{15}N$ values from Canchas Uckro along with mean ($\pm 1\sigma$) isotope values for potential food sources. See Table S6 for the dietary source data used.

Table 2. Archeological Context, Sex Estimates (Based on a DNA and Morphological Observation When Possible; *Both Assessments Made) and $\delta^{13}C$ and $\delta^{15}N$ Values from Human Samples from Canchas Uckro.

Sample	Context	Element	Sex	$\delta^{13}C$ (‰)	$\delta^{15}N$ (‰)	C/N
CUO 69	U.4 C.1 St1	Proximal hand phalanx (right)	M*	−18.4	7.5	3.2
CUO 70	U.4 C.2 Platform 1	proximal foot phalanx (right)	F	−19.1	7.1	3.2
CUO 71	U. 3–4	1st proximal foot phalanx (right)	M	−18.5	7.8	3.2
CUO 8	Unit 7B layer 2A	proximal foot phalanx (right)	M*	−18.7	7.4	2.9
CUO 15	Unit 8D layer 2	5th metatarsal (left)	F*	−18.9	7.2	2.9

(Supplemental Table S6). Based on our dietary simulations, we conclude that deer was the major source of meat protein making up 25–50% of the modeled diet (75% credibility interval) for the individuals from Canchas Uckro. This finding is congruent with the prominence of deer in the faunal assemblage.

The results of our model also suggest guinea pig (*Cavia porcellus*) was a limited source of dietary protein constituting 3–5% of the diet. As dependent scavengers, guinea pigs have diets that represent the food provided over the lifetime of the animal (Finucane et al. 2006). As a result, the range of $\delta^{13}C$ and $\delta^{15}N$ values observed in the reference data collection of guinea pigs is relatively large.

Discussion

Diet at Canchas Uckro was a combination of domesticated plants and wild game. While these findings fit broadly within what is known about subsistence practices in other parts of the north-central and northern Peruvian highlands, our utilization of isotopic data and mixing models enables us to make more refined conclusions about the relative proportion of different food sources.

Hunting Practices

Seventy-nine percent of the identified fauna pertain to two species of deer: taruca and white-tailed deer. The dietary importance of deer is further demonstrated by the mixing models that show that cervids comprise between 25 and 50% of the modeled diet. Along with the paucity of domesticated camelids, we assert that hunting, rather than herding, was an important activity. The role that cervids played prior to and during the intensification of camelid pastoral systems merits further exploration.

White-tailed deer inhabit all highland ecological zones (Emmons 1990: 162–163), while taruca is typically found in the *puna* at elevations ranging from 3500 to 5000 m asl (e.g., Barrio 2010, 2013; Flannery et al. 1989: 19–20; Lynch 1980:

12–13; Pinto et al. 2015). Based on these distributions, it is likely that the inhabitants of Canchas Uckro hunted within the immediate catchment of the site. This conclusion is supported by strontium isotope analysis of teeth (n = 4) from 4 different deer recovered from the excavations at Canchas Uckro. The strontium values (Supplemental Table S7) of these deer match closely with the bioavailable strontium in the area immediately surrounding Canchas Uckro (Washburn et al. 2021).

Supporting evidence for the importance of hunting includes the high number of chipped stone and ground slate projectile points (n = 18) that were recovered from Canchas Uckro (Supplemental Figure S9). Projectile point size suggests that they were likely part of atlatls, a hunting weapon that is depicted in some of the stone sculptures at Chavín de Huántar (Burger 1992: 164). Atlatl hooks have been recovered from Early Horizon contexts at Huacaloma (Terada and Onuki 1982: Plate 51) and Campanayuq Rumi (Matsumoto 2012: 754). If atlatls were used at Canchas Uckro, then hunting strategies probably included stalking or ambushes (Custred 1979), perhaps at distances between 10 and 30 m, which is the range at which this weapon is most effectively utilized (Hutchings and Brüchert 1997; Whittaker 2010). Apart from a single neonate, the age profile demonstrates that the Canchas Uckro inhabitants hunted prime-age adult deer (Figure 4), a practice that is documented at other sites in the northern highlands such as Kuntur Wasi (Uzawa 2019; see also Tomczyk and Grávalos 2022 for later time periods).

In contrast, camelids are scarce at Canchas Uckro, comprising 4% (n = 22) of the identifiable assemblage in terms of NISP. A limited number of metrics from these bones indicates that these could be either domesticated or wild camelids.

The observed patterns at Canchas Uckro are somewhat divergent from the faunal composition of nearby Chavín de Huántar (Miller and Burger 1995) during the Urabarriu Phase (950-800 B.C.) (Burger 2019), which is roughly contemporary with Canchas Uckro. During this time, cervids at Chavín de Huántar consist of between 9.8 and 30.8% (depending on method of quantification) of the faunal assemblage (Miller and Burger 1995). However, Miller and Burger acknowledge that the proportion of cervids might be greater because of the highly fragmented nature of the Urabarriu faunal remains (Miller and Burger 1995: 428). Nevertheless, the same study demonstrated that camelids make up as much as 53% of the assemblage (Miller and Burger 1995). Miller and Burger (1995: 435) further estimate that of the camelid bones (NISP = 356, MNI = 7) recovered from Urabarriu contexts 55% were probable llamas and the remaining 45 % were vicuñas (*Vicugna vicugna*), a species of wild camelid. Based on this, "wild game comprised 60–70 percent of the meat, with the remaining 30–40 percent coming from llamas" (Miller and Burger 1995: 448) during the Urabarriu Phase. The importance of hunting during this early phase of Chavín de Huántar is also indicated by the high number (n = 26) of projectile points recovered from Urabarriu contexts (Burger 1984: 189).

It is unclear why there is a discrepancy in the relative proportion of camelids (wild or domesticated) between Canchas Uckro and Urabarriu Phase Chavín de Huántar. One possibility is the low sample sizes for both sites during the late Initial Period. Alternatively, the differences between the two sites could be rooted in variations in long-distance interaction and relationships with other regions. Since its inception, Chavín de Huántar was connected to distant places (Burger 1984, 1992; Lumbreras 1993), including the south-central highlands (Burger et al. 2006; Matsumoto et al. 2018; Young 2020) where domesticated camelids appear much earlier. On the other hand, Canchas Uckro was involved in only limited long-distance connections (Nesbitt et al. 2021). It is therefore possible Chavín de Huántar's population had more access to domesticated camelids as part of these networks.

The composition of the faunal assemblage at Canchas Uckro most closely resembles contemporary phases of centers of the central and northern highlands. Zooarchaeological studies from late Initial Period contexts at Kotosh, Huaricoto, Huacaloma, Kuntur Wasi, Pacopampa, and Pirincay (in Ecuador) all show that deer constituted most of the identified fauna (Miller and Gill 1990; Moore 2016: Figure 3.3; Sawyer 1985; Shimada 1982, 1985, 1988; Takigami et al. 2020; Uzawa 2010, 2019; Uzawa et al. 2021; Wing 1972). It was not until the period after c. 800 BC that domesticated camelids became major components of the highland economies at Chavín de Huántar and regions to the north. Two studies of the fauna from Chavín de Huántar demonstrate that in the Janabarriu Phase (c. 700–400 BC) camelid utilization intensifies markedly to more than 90% of the fauna (Miller and Burger 1995; Rosenfeld and Sayre 2016). Osteological measurements and age profiles determined that these camelids were clearly domesticated llamas and alpacas. At the same time, there is a significant decline in cervids, suggesting the waning of hunting as an important subsistence practice. This pattern is apparent at sites such as Pacopampa, Kuntur Wasi, Huacaloma, and Huaricoto suggesting the diffusion of domesticated camelids into the northern highlands in the early and middle part of the first millennium B.C. (Sawyer 1985; Shimada 1985, 1988; Takigami et al. 2020; Uzawa 2010, 2019) that replaced a widespread hunting lifeway in the second millennium BC.

Other Animals in the Diet

Guinea pigs played a minor role in the Canchas Uckro diet. Ancient and contemporary Andean cultures used guinea pigs as a feasting food that was consumed during specific times of the year (Bolton 1979; Gade 1967; Rosenfeld 2008). Based on ethnographic research in a highland community in southern Peru, Bolton (1979: 240) estimated that guinea pigs made up ~3–4% of dietary protein. Our mixing model results suggest that guinea pig was consumed in similar quantities (2–5% of diet) at Canchas Uckro.

The Role of Domesticated Plants

The full range of plants in the subsistence economy is more difficult to discern because of poor macrobotanical preservation. Isotopic data shows that C_3 plants was a major component of the diet. Pilot starch granule analysis identified potato (n = 1) and manioc (n = 1), both of which are C_3 plants. Potatoes are typically farmed at elevations between 3300 and 3800 m.a.s.l. It has been suggested that potatoes, along with other high-elevation tubers, were possible dietary staples at Chavín de Huántar and elsewhere in the highlands (Burger and van der Merwe 1990).

The documentation of manioc starch is notable. Manioc is one of several tropical plants depicted on the Tello Obelisk, a stone sculpture from Chavín de Huántar (Lathrap 1973) and is also represented on imported pottery reported from the Gallery of the Offerings (Lumbreras 1993: Laminas 12 and 204). Manioc's iconographic prominence suggests the ritual, and perhaps dietary, importance of this plant. Because it is a tropical root crop, manioc cannot be grown in the immediate vicinity of Canchas Uckro. However, it could be acquired from the *yunga* production zone in the Puccha valley floor at elevations lower than 2500 m.a.s.l. This part of the *yunga* is only 3 km from Canchas Uckro. We suspect that the manioc consumed by the inhabitants of Canchas Uckro was probably acquired from this area. While manioc is present at Canchas Uckro, there is insufficient data to indicate its relative dietary importance.

More can be said about the dietary contribution of maize to the inhabitants of Canchas Uckro. Maize starch granules were present in a single sherd. In the highlands, maize is cultivated in the *quechua* production zone immediately surrounding Canchas Uckro. Details about the intensity of maize consumption are provided by stable carbon isotope analysis of the five individuals from Canchas Uckro, combined with mixing models. $\delta^{13}C$ values range between −19.1‰ and −18.4‰ suggesting that maize was not intensively consumed. Mixing model results suggest that maize comprised around 10% of the diet.

These results conform to a growing dataset from different parts of the Central Andes that indicates that prior to c. 700 BC maize was not a dietary staple. Though maize is present in the Peruvian highlands by 4000-3600 BP (Perry et al. 2006) and on the coast by c. 6700-6500 BP (Grobman et al. 2012), isotopic studies from Andean highland and coastal sites dating between the third and early first millennia BC indicate that human populations relied primarily on C_3 plants, rather than maize (Burger 2012; Burger and Van der Merwe 1990; Miller et al. 2021; Pezo-Lanfranco et al. 2022; Seki and Yoneda 2005; Turner et al. 2018; Tykot et al. 2006; Washburn et al. 2020; c.f., Finucane 2009; Tung et al. 2020). Mean $\delta^{13}C$ values from Canchas Uckro (−18.9‰) are virtually identical to those from a sample of burials from the Urabarriu (n = 4) and Janabarriu Phases (n = 1) at Chavín de Huántar, as well as Huaricoto (−18.5‰) (Burger and van der Merwe 1990). Furthermore, burials dating to the late Initial Period from centers located in the northern highlands such as Pacopampa and Huacaloma also have yielded similar $\delta^{13}C$ measurements (Seki and Yoneda 2005; Takigami et al. 2021; Tykot et al. 2006). In other words, the Peruvian data indicate that there was a long temporal lag between the domestication and diffusion of maize and its conversion to a dietary staple in the Andean region. In the Peruvian highlands, part of this lag is likely rooted in the availability of a diverse array of crops that contributed to a varied plant diet dominated by C_3 cultigens.

Maize may also have been a component of the ritual economy. Some archeologists have posited that during the late Initial Period, maize was used to brew *chicha*, an alcoholic beverage widely consumed in the Andes (Burger and van der Merwe 1990; Ikehara et al. 2013; Weber and Young 2023). Other evidence for the ritual importance of maize comes from bottles from the Ofrendas Gallery at Chavín de Huántar (Lumbreras 1993: Lamina 79, 618–619) and Kotosh (Izumi and Terada 1972: Plate 100. 12–14) that exhibit maize iconography. For these reasons, it is possible that maize was a special purpose crop that was utilized in ceremonial events, rather than as a nutritional staple (e.g., Burger and van der Merwe 1990).

Conclusions

At the local level, the data presented in this paper indicate that Canchas Uckro was an economically self-sufficient community. Identified animal and plant resources consumed at the site were acquired from the local highland *quechua* and *puna* production zones that are found within the site's immediate vicinity. The presence of manioc also indicates that the lower *yunga* zone was exploited. Thus, the inhabitants of Canchas Uckro were utilizing a compressed type of Andean zonation (Brush 1976), acquiring hunted, and cultivated resources available within a catchment area of approximately 3–4 km.

Our analysis benefited from the utilization of multiple dietary proxies to create a more nuanced picture of subsistence practices at Canchas Uckro. We argue that the inhabitants of Canchas Uckro employed a mixed hunting and agrarian economy. $\delta^{13}C$ and $\delta^{15}N$ and SIAR mixing model analysis leads us to estimate that roughly 50–60% of the diet came from plants. Within the plant diet, C_3 plants made up the vast majority, while maize utilization was more limited. Evidence for limited maize consumption adds to a larger dataset that this crop was not a trigger for the development of early complexity in highland Peru (e.g., Burger 2012; Burger and van der Merwe 1990; Washburn et al. 2020). This data indicates that while farming was important, it is unlikely that any specific crop formed a dietary staple during the late second millennium BC in highland Peru.

Yet farming was only one component of the diet at Canchas Uckro. Deer hunting was clearly a central activity and of seeming greater importance than typically ascribed to Initial

Period societies. In other words, the inhabitants of Canchas Uckro practiced a mixed hunting-farming (Smith 2001) or "middle ground" strategy in which people spent 15% or more of their time hunting and cultivating (Denham and Donohue 2022). It is perhaps premature to extend the mode of subsistence we describe from Canchas Uckro to other regions in highland Peru in the late Initial Period but given the growing body of data for this time we should consider axes of variation (Plucinnek, 2001) in subsistence practices between regions.

Canchas Uckro represents the time immediately predating intensive use of domesticated camelids after 800/750 BC (Miller and Burger 1995; Rosenfeld and Sayre 2016). Crucially, it was at this time of socioeconomic change at Chavín de Huántar and elsewhere that Canchas Uckro was abandoned (Nesbitt and Ibarra Asencios 2023). Agropastoral lifeways during the period after 800/750 BC signal the transition toward a radically different political economy in highland Peru (Lau 2021; Tomczyk and Grávalos 2022). In this sense Canchas Uckro, along with its highland contemporaries of the late second/early first millennia B.C. represent the last vestiges of a hunting lifestyle.

Acknowledgments

We would like to thank Alina Álvarez Larrain, Richard Burger, MinJoo Choi, Rachel Johnson, Yuichi Matsumoto, Richard Meadow, Julia Sjödahl and two anonymous reviewers for commenting on an earlier draft of this paper. We also benefitted from conversations with Yuji Seki, Mai Takigami, and Kazuhiro Uzawa about their research on the spread of camelids in northern Peru. Finally, Michael Sawyer provided a copy of his unpublished M.A. thesis for which we are most grateful. Research at Canchas Uckro was supported by research grants from the Roger Thayer Stone Center for Latin American Studies, the Committee on Research, and the Tulane-Xavier Center for Bioenvironmental Research.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Supplemental Material

Supplemental material for this article is available online.

References

Alamo, V., and V. Valdivieso. 1997. *Lista sistemática de moluscos marinos del Perú.* Lima: Instituto marino de Perú, Multiformas S.A.

Altamirano Enciso, A. J. 1983. *Guía Osteológica de los Cérvidos Sudamericanos*. Universidad Nacional Mayor de San Marcos, Lima.

Ambrose, S. H., and L. Norr. 1993. "Experimental Evidence for the Relationship of the Carbon Isotope Ratios of Whole Diet and Dietary Protein to those of Bone Collagen and Carbonate." In *Prehistoric Human Bone*, edited by J. B. Lambert, and G. Grupe, 1–37. Berlin: Springer.

Barrio, J. 2010. "Taruka, *Hippocamelus Antisensis* (D'Orbigny, 1834)." In *In Neotropical Cervidology: Biology and Medicine of Latin American Deer*, edited by J. M. B. Duarte, and S. González, 77–88. Jaboticabal: FUNEP and IUCN.

Barrio, J. 2013. "*Hippocamelus Antisensis* (Artiodactyla: Cervidae)." *Mammalian Species* 45: 49–59. https://doi.org/10.1644/901.1.

Binford, L. R. 1981. *Bones: Ancient Men and Modern Myths*. New York: Academic Press.

Bolton, R. 1979. "Guinea Pigs, Protein, and Ritual." *Ethnology* 18: 229–252. https://doi.org/10.2307/3773376.

Bonavia, D. 2008. *The South American Camelids*. Los Angeles.: Cotsen Institute of Archaeology Press, University of California.

Brush, S. B. 1976. "Man's Use of an Andean Ecosystem." *Human Ecology* 4: 147–166. https://doi.org/10.1007/BF01531218.

Buikstra, J. E., and D. H. Ubelaker. 1994. "*Standards for Data Collection from Human Skeletal Remains*." Arkansas Archaeological Survey Research Series No. 44. Fayetteville, Arkansas.

Burger, R. L. 1984. *The Prehistoric Occupation of Chavín de Huántar, Peru*. Berkeley.: University of California Press.

Burger, R. L. 1992. *Chavín and the Origins of Andean civilization*. London.: Thames and Hudson.

Burger, R. L. 2012. "Central Andean Language Expansion and the Chavín Sphere of Interaction." *Proceedings of the British Academy* 173: 133–159. https://doi.org/10.5871/bacad/9780197265031.003.0006.

Burger, R. L. 2019. "Understanding the Socioeconomic Trajectory of Chavín de Huántar: A New Radiocarbon Sequence and its Wider Implications." *Latin American Antiquity* 30: 373–392. https://doi.org/10.1017/laq.2019.17.

Burger, R. L., G. F. Lau, V. M. Ponte, and M. D. Glascock. 2006. "The History of Prehispanic Obsidian Procurement in Highland Ancash." In *La Complejidad Social en la Sierra de Ancash: Ensayos Sobre Paisaje, Economía y Continuidades Culturales*, edited by A. Herrera, C. Orsini, and K. Lane, 103–120. Lima: PUNKU Centro de Investigacion Andina.

Burger, R. L., and N. van der Merwe. 1990. "Maize and the Origin of Highland Chavín Civilization: An Isotopic Perspective." *American Anthropologist* 92: 85–95. https://doi.org/10.1525/aa.1990.92.1.02a00060.

Cadwallader, L., D. Beresford-Jones, O. Whaley, and T. O'Connell. 2012. "The Signs of Maize? A Reconsideration of What δ13C Values Say About Palaeodiet in the Andean Region." *Human Ecology* 40: 487–509. https://doi.org/10.1007/s10745-012-9509-0.

Colonese, A. C., R. Winter, R. Brandi, T. Fossile, R. Fernandes, S. Soncin, K. McGrath, M. Von Tersch, and A. Marques Bandeira. 2020. "Stable Isotope Evidence for Dietary Diversification in the pre-Columbian Amazon." *Scientific Reports* 10: 16560. https://doi.org/10.1038/s41598-020-73540-z.

Custred, G. 1979. "Hunting Technologies in Andean Culture." *Journal de la Société des Américanistes* 66: 7–19. https://doi:10.3406/jsa.1979.2168.

Delgado, M. 2021. "Patterns of Dietary Diversity in Holocene North-West South America: New Insights from Bayesian Stable Isotope Mixing Models." *Antiquity* 95: 1027–1042. https://doi.org/10.15184/aqy.2021.56.

Denham, T., and M. Donohue. 2022. "Mapping the Middle Ground Between Foragers and Farmers." *Journal of Anthropological Archaeology* 65: 101390. https://doi.org/10.1016/j.jaa.2021.101390.

DeNiro, M. J., and C. A. Hastorf. 1985. "Alteration of $^{15}N^{14}N$ and $^{13}C^{12}C$ Ratios of Plant Matter During the Initial Stages of Diagenesis: Studies Utilizing Archaeological Specimens from Peru." *Geochimica et Cosmochimica Acta* 49: 97–115. https://doi.org/10.1016/0016-7037(85)90194-2.

Emmons, L. H. 1990. *Neotropical Rainforest Animals: A Field Guide*. Chicago: The University of Chicago Press.

Finucane, B. C. 2009. "Maize and Sociopolitical Complexity in the Ayacucho Valley, Peru." *Current Anthropology* 50: 535–545. https://doi.org/10.1086/599860.

Finucane, B. C., P. M. Agurto, and W. H. Isbell. 2006. "Human and Animal Diet at Conchopata, Peru: Stable Isotope Evidence for Maize Agriculture and Animal Management Practices During the Middle Horizon." *Journal of Archaeological Science* 33: 1766–1776. https://doi.org/10.1016/j.jas.2006.03.012.

Flannery, K. V., J. Marcus, and R. G. Reynolds. 1989. *The Flocks of the Wamani: A Study of Llama Herders on the Puna of Ayacucho, Peru*. San Diego: Academic Press.

Flores-Ochoa, J. 1979. *Pastoralists of the Andes: The Alpaca Herders of Paratía*. Philadelphia.: Institute for the Study of Human Issues.

France, D. 2008. *Human and Nonhuman Bone Identification: A Color Atlas*. Boca Raton: CRC Press.

Gade, D. W. 1967. "The Guinea Pig in Andean Folk Culture." *Geographical Review* 57: 213–224. https://doi.org/10.2307/213160.

González, B., R. E. Palma, B. Zapata, and J. C. Marín. 2006. "Taxonomic and Biogeographical Status of Guanaco *Lama Guanicoe* (Artiodactyla, Camelidae)." *Mammal Review* 36: 157–178. https://doi.org/10.1111/j.1365-2907.2006.00084.x.

Grayson, D. K. 1984. *Quantitative Zooarchaeology: Topics in the Analysis of Faunal Remains*. Orlando: Academic Press.

Grobman, A., D. Bonavia, T. D. Dillehay, D. R. Piperno, J. Iriarte, and I. Host. 2012. "Preceramic Maize from Paredones and Huaca Prieta." *Peru. Proceedings of the National Academy of Sciences* 109: 1755–1759. https://doi.org/10.1073/pnas.1120270109.

Harlow, R., and M. DeFoor. 1962. "How to Age White-Tailed Deer." *Florida Wildlife* 16: 18–21.

Hutchings, W. K., and L. Brüchert. 1997. "Spearthrower Performance." *Ethnographic and Experimental Research. Antiquity* 71: 890–897. https://doi.org/10.1017/S0003598X00085580X.

Ikehara, H. C., J. Fiorella Paipay, and K. Shibata. 2013. "Feasting with *Zea mays* in the Middle and Late Formative North Coast of Peru." *Latin American Antiquity* 24: 217–231. https://doi.org/10.7183/1045-6635.24.2.217.

Izumi, S., and K. Terada. 1972. *Excavations at Kotosh, Peru, 1963 and 1966*. Tokyo: University of Tokyo Press.

Keen, A. M. 1971. *Sea shells of tropical West America*. 2nd edition. Palo Alto.: Stanford University Press.

Kembel, S., and H. Haas. 2015. "Radiocarbon Dates from the Monumental Architecture of Chavín de Huántar." *Journal of Archaeological Method and Theory* 22: 345–427. https://doi.org/10.1007/s10816-013-9180-9.

Kennett, D. J., K. M. Prufer, B. J. Culleton, R. J. George, M. Robinson, W. R. Trask, G. M. Buckley, E., et al. 2020. "Early Isotopic Evidence for Maize as a Staple Grain in the Americas." *Science Advances* 6: eaba3245. https://doi.org/10.1126/sciadv.aba324.

Kent, J. D. 1982. "The Domestication and Exploitation of the South American Camelids: Methods of Analysis and their Application to Circum-Lacustrine Archaeological Sites in Bolivia and Peru." Unpublished PhD Dissertation. Washington University.

Lathrap, D. W. 1973. "Gifts of the Cayman: Some Thoughts on the Subsistence Basis of Chavín." In *In Variations in Anthropology*, edited by D. W. Lathrap, and J. Douglas, 91–105. Urbana: Illinois Archaeological Survey.

Lau, G. F. 2021. "Camelids as Food and Wealth: Emerging Political and Moral Economies of the Recuay Culture." In *Andean Foodways*, edited by J. E. Staller, 61–87. New York: Springer.

Le Neün, M., E. Dufour, N. Goepfert, D. Neaux, J. C. Wheeler, H. Yacobaccio, G. L. Mengoni Goñalons, D. Elkin, A. Gasco, and T. Cucchi. 2023. "Can First Phalanx Multivariate Morphometrics Help Document Past Taxonomic Diversity in South American Camelids?" *Journal of Archaeological Science: Reports* 47: 103708. https://doi.org/10.1016/j.jasrep.2022.103708.

Lumbreras, L. G. 1993. *Chavín de Huántar: Excavaciones en la Galería de las Ofrendas*. AVA Materialen 51. Mainz am Rhein: Verlag Phillip von Zabern.

Lyman, R. L. 2008. *Quantitative Paleozoology*. Cambridge.: Cambridge University Press.

Lynch, T. F. 1980. Setting and Excavations. *In Guitarrero Cave: Early Man in the Andes*, edited by T.F. Lynch, 3–28. New York: Academic Press.

Matsumoto, Y. 2012. "Recognising Ritual: The Case of Campanayuq Rumi." *Antiquity* 86: 746–759. https://doi.org/10.1017/S0003598X0004789X.

Matsumoto, Y., J. Nesbitt, M. Glascock, Y. Cavero, and R. L. Burger. 2018. "Interregional Obsidian Exchange During the Late Initial Period and Early Horizon: New Perspectives from Campanayuq Rumi." *Latin American Antiquity* 29: 44–63. https://doi.org/10.1017/laq.2017.64.

Mena, F. 1992. "Mandíbulas y Maxilares: Un Primer Acercamiento a los Conjuntos Arqueofaunisticos del Alero Fontana (RI-22; XI Región)." *Boletín del Museo Nacional de Historia Natural de Chile* 43: 179–191.

Mengoni Goñalons, G. L. 2008. "Camelids in Ancient Andean Societies: A Review of the Zooarchaeological Evidence." *Quaternary International* 185: 59–68. https://doi.org/10.1016/j.quaint.2007.05.022.

Merkt, J. 1987. "Reproductive Seasonality and Grouping Patterns of the North Andean Deer or Taruca (Hippocamelus Antisensis) in Southern Peru." *In Biology and Management of the Cervidae*, edited by C.M. Wemmer, 388–401. Washington, D.C: Smithsonian Institution Press.

Mesía-Montenegro, C. 2022. "Social Complexity and Core-Periphery Relationships in an Andean Formative Ceremonial Centre: Domestic Occupation at Chavín de Huántar." *Antiquity* 96: 883–902. https://doi.org/10.15184/aqy.2022.73.

Miller, G. R. 1979. "An Introduction to the Ethnoarchaeology of the Andean Camelids." PhD Dissertation. Berkeley: Department of Anthropology, University of California.

Miller, G. R., and R. L. Burger. 1995. "Our Father the Cayman, Our Dinner the Llama: Animal Utilization at Chavín de Huántar, Peru." *American Antiquity* 60: 421–458. https://doi.org/10.2307/282258.

Miller, G. R., and A. L. Gill. 1990. "Zooarchaeology at Pirincay, a Formative Site in Highland Ecuador." *Journal of Field Archaeology* 17: 49–68. https://doi.org/10.1179/00934699 0791548510.

Miller, M. G., I. Kendall, J. M. Capriles, M. C. Bruno, R. P. Evershed, and C. A. Hastorf. 2021. "Quinoa, Potatoes, and Llamas Fueled Emergent Social Complexity in the Lake Titicaca Basin of the Andes." *Proceedings of the National Academy of Science* 118 (49): e2113395118. https://doi.org/10.1073/pnas.211339511.

Moore, K. M. 2016. "Early Domesticated Camelids in the Andes." In *The Archaeology of Andean Pastoralism*, edited by J. M. Capriles, and N. Tripcevich, 17–38. Albuquerque.: University of New Mexico Press.

Morin, E. 2020. "Revisiting Bone Grease Rendering in Highly Fragmented Assemblages." *American Antiquity* 85: 535–553. https://doi.org/10.1017/aaq.2020.29.

Murra, J. V. 1985. "El Archipiélago Vertical" Revisited." In *In Andean Ecology and Civilization: An Interdisciplinary Perspective on Andean Ecological Complementarity*, edited by S. Masuda, I. Shimada, and C. Morris, 3–13. Tokyo: University of Tokyo Press.

Nesbitt, J., and B Ibarra Asencios. 2023. "The Radiocarbon Chronology of Canchas Uckro: Implications for Understanding the late Initial Period (1100–800 BC) in the Chavín Heartland." *Senri Ethnological Series* 112: 169–196. http://doi.org/10.15021/ 00010050.

Nesbitt, J. 2023 [in press]. "Archaeological Investigations of the Chavín Heartland: New Perspectives from Canchas Uckro." *In Reconsidering the Chavín Phenomenon in the 21st Century*, edited by R.L. Burger, and J. Nesbitt, pp. 81–106. Washington, D.C: Dumbarton Oaks Research Library and Collection.

Nesbitt, J., R. Johnson, and B. Ibarra Asencios. 2021. "Connections Between the Chavín Heartland and the Upper Amazon: New Perspectives from Canchas Uckro (1100–800 BC)." In *In The Archaeology of the Upper Amazon: Complexity and Interaction in the Andean Tropical Forest*, edited by R. Clasby, and J. Nesbitt, 106–128. Gainesville: University Press of Florida.

Onuki, Y. 1985. "The Yunga Zone in the Prehistory of the Central Andes: Vertical and Horizontal Dimensions in Andean Ecological and Cultural Processes." In *Andean Ecology and Civilization: An Interdisciplinary Perspective on Andean Ecological Complementarity*, edited by S. Masuda, I. Shimada, and C. Morris, 339–356. Tokyo.: University of Tokyo Press.

Osborn, J. 2019. "A Bayesian Approach to Andean Faunal Assemblages." *Latin American Antiquity* 30: 354–372. https://doi. org/10.1017/laq.2019.21.

Osorio, C. 2002. "*Moluscos Marinos en Chile: Especies de Importancia Económica: Guía por su Identificación*." Facultad de Ciencias, Universidad de Chile, Santiago de Chile.

Pagán-Jiménez, J. R. 2015. *Almidones. Guía de material comparativo moderno del ecuador para los estudios paleoetnobotánicos en el Neotrópico*. Aspha Editores, Buenos Aires.

Perry, L., D. H. Sandweiss, D. R. Piperno, K. Rademaker, M. A. Malpass, A. Umire, and P. de la Vera. 2006. "Early Maize Agriculture and Interzonal Interaction in Southern Peru." *Nature* 444: 76–79. https://doi.org/10.1038/nature04294.

Pezo-Lanfranco, L., M. Machacuay, P. Novoa, R. Peralta, E. Mayer, S. Eggers, and R. Shady. 2022. "The Diet at the Onset of Andean Civilization: New Stable Isotope Data from Caral and Áspero, North Central Coast of Peru." *American Journal of Biological Anthropology* 177: 402–424. https://doi.org/10.1002/ajpa. 24445.

Pinto, C. M. J. Ángel Soto-Centeno, Á. M. Núñez Quiroz, N. Ferreyra, F. Delgado-Espinoza, P.W. Stahl, and D. G. Tirira. 2015. "Archaeology, Biogeography, and Mammology do not Provide Evidence for Tarukas (Cervidae: *Hippocamelus Antisensis*) in Ecuador." *Journal of Mammology* 97: 41–53. https://doi.org/10. 1093/jmammal/gyv151.

Plucinnek, M. 2001. "Archaeology, Anthropology and Subsistence." *Journal of the Royal Anthropological Institute* 7: 741–758. https://doi.org/10.1111/1467-9655.00087.

Pulgar Vidal, J. 1970. *Geografía del Perú: Las Ochos Regiones Naturales del Peru*. Lima: Textos Universitarios.

Purdue, J. R. 1983. "Epiphyseal Closure in White-Tailed Deer." *The Journal of Wildlife Management* 47: 1207–1213.

Rick, J. W., C. Mesia, D. Contreras, S. R. Kembel, R. M. Rick, M. Sayre, and J. Wolf. 2010. "Cronología de Chavín de Huántar y sus Implicancias Para el Periodo Formativo." *Boletín de Arqueología PUCP* 13: 87–132.

Rick, J. W., and K. M. Moore. 1999. "El Precerámico de la Punas de Junín: El Punto de Vista Desde Panaulauca." *Boletín de Arqueología PUCP* 3: 263–299.

Rosenfeld, S. A. 2008. "Delicious Guinea Pigs: Seasonality Studies and the Use of Fat in the Pre-Columbian Andean Diet." *Quaternary International* 180: 127–134. https://doi.org/10.1016/j. quaint.2007.08.011.

Rosenfeld, S. A., and M. P. Sayre. 2016. "Llamas on the Land: Production and Consumption of Meat at Chavín de Huántar, Peru." *Latin American Antiquity* 27: 497–511. https://doi.org/10. 7183/1045-6635.27.4.497.

Sawyer, M. J. 1985. "An Analysis of Mammalian Faunal Remains from the Site of Huaricoto, PAN 3-35." Unpublished M.A. Thesis. Department of Anthropology, California State University, Hayward.

Sayre, M. P. 2010. "Life Across the River: Agricultural, Ritual, and Production Practices at Chavín de Huántar." Unpublished PhD Dissertation, University of California, Berkeley.

Seki, Y., and M. Yoneda. 2005. "Cambios de Manejo del Poder en el Formativo: Desde el Análisis de la Dieta Alimenticia." *Perspectivas Latinoamericanas* 2: 110–131.

Severinghaus, C. W. 1949. "Tooth Development and Wear as Criteria of Age in White-Tailed Deer." *The Journal of Wildlife Management* 13: 195–216. https://doi.org/10.2307/3796089.

Shimada, M. J. 1982. "Zooarchaeology of Huacaloma: Behavioral and Cultural Implications." *In Excavations at Huacaloma in the* Cajamarca Valley, Peru, 1979, edited by K. Terada, and Y. Onuki, 303–336. Tokyo: University of Tokyo Press.

Shimada, M. J. 1985. "Appendix III: Continuities and Changes in Patterns of Faunal Resource Utilization: Formative Through Cajamarca Periods." *In The Formative Period in the Cajamarca Basin, Peru: Excavations at Huacaloma and Layzón,* 1982, edited by K. Terada, and Yoshio Onuki, 289–305. University of Tokyo Press, Tokyo.

Shimada, M. J. 1988. "Prehistoric Subsistence in the North Highlands of Peru: Early Horizon to Late Intermediate." In *In Economic Prehistory of the Central Andes*, edited by E. S. Wing, and J. C. Wheeler, 131–147. Oxford.: British Archaeological Reports.

Smith, B. D. 2001. "Low-Level Food Production." *Journal of Archaeological Research* 9: 1–43. https://doi.org/10.1023/ A:1009436110049.

Takigami, M., Y. Seki, T. Nagaoka, K. Uzawa, D. Morales Chocano, H. Mukai, and M. Yoneda. 2021. "Isotopic Study of Maize Exploitation During the Formative Period at Pacopampa, Peru." *Anthropological Science* 129: 121–132. https://doi.org/10.1537/ase.210531.

Takigami, M., K. Uzawa, Y. Seki, D. Morales Chocano, and M. Yoneda. 2020. "Isotopic Evidence for Camelid Husbandry During the Formative Period at the Pacopampa Site, Peru." *Environmental Archaeology* 25: 262–278. https://doi.org/10.1080/14614103.2019.1586091.

Tello, J. C. 1960. *Chavín: Cultura Matriz de la Civilización Andina*. Lima: Imprenta de la Universidad Nacional Mayor de San Marcos.

Terada, K., and Y. Onuki. 1982. *Excavations at Huacaloma in the Cajamarca Valley, Peru, 1979*. Tokyo: University of Tokyo Press.

Tomczyk, W., and M. E. Grávalos. 2022. "Changing to Remain the Same: Everyday Animal Use at Ancient Jecosh, North-Central Peru." *World Archaeology* 53: 305–326. https://doi.org/10.1080/00438243.2021.2005676.

Torres, V. R. P., A.J. Altamiriano Enciso, and E. S. Garcia Porras. 1979. *Guía Osteológica de Camélidos Sudamericanos*. Lima: Universidad Nacional Mayor de San Marcos.

Tosi, J. A. 1960. "*Zonas de Vida Natural en el Perú*." Instituto Interamericano de Ciencias Agrícolas de la OEA Zona Andina,

Tung, T. A., T. D. Dillehay, R. S. Feranec, and L. R. G. DeSantis. 2020. "Early Specialized Maritime and Maize Economies on the North Coast of Peru." *Proceedings of the National Academy of Sciences* 117: 32308–32319. https://doi.org/10.1073/pnas.200912111.

Turner, B. L., V. Bélisle, A. R. Davis, M. Skidmore, S. L. Juengst, B. J. Schaefer, R. A. Covey, and B. S. Bauer. 2018. "Diet and Foodways Across Five Millennia in the Cusco Region of Peru." *Journal of Archaeological Science* 98: 137–148. https://doi.org/10.1016/j.jas.2018.07.013.

Turner, B. L., J. D. Kingston, and G. Armelagos. 2010. "Variation in Dietary Histories among the Immigrants of Machu Picchu: Carbon and Nitrogen Isotope Evidence." *Chungara* 42: 515–534.

Tykot, R., R. L. Burger, and N. van der Merwe. 2006. "The Importance of Maize in the Initial Period and Early Horizon, Peru." In *In Histories of Maize: Multidisciplinary Approaches to the Prehistory, Linguistics, Biogeography, and Evolution of Maize*, edited by J. E. Staller, R. Tykot, and B. F. Benz, 187–197. London.: Academic Press.

Uzawa, K. 2010. "La Difusión de los Camélidos Domesticados en el Norte del Perú Durante el Periodo Formativo." *Boletín de Arqueología PUCP* 12: 249–260.

Uzawa, K. 2019. "A Shift in the Utilization of Animals in the Northern Highlands During the Formative Period: The Result of Climate Change or Social Adaptations?" In *New Perspectives on Early Andean Civilization: Interaction, Authority, and Socioeconomic Organization During the 1st and 2nd Millennia BC*, edited by R. L. Burger, Y. Seki, and L. C. Salazar, 97–105. New Haven: Yale University Publications in Anthropology, Yale University.

Uzawa, K., Y. Seki, and D. Morales Chocano. 2021. "Ritual Consumption and Sacrifice of Llama (*Lama Glama*) at the Pacopampa Site in the Northern Highlands, Peru." *Anthropological Science* 129: 109–119. https://doi.org/10.1537/ase.2104111.

Valdez, L. M., and J. E. Valdez. 1997. "Reconsidering the Archaeological Rarity of Guinea Pig Bones in the Central Andes." *Current Anthropology* 38: 896–898. https://doi.org/10.1086/204679.

Washburn, E., J. Nesbitt, R. L. Burger, E. Tomasto Cagigao, V. M. Oelze, and L. Fehren-Schmitz. 2020. "Maize and Dietary Change in Early Peruvian Civilization: Isotopic Evidence from the Late Preceramic Period/Initial Period Site of La Galgada, Peru." *Journal of Archaeological Science: Reports* 31. https://doi.org/10.1016/j.jasrep.2020.102309.

Washburn, E., J. Nesbitt, B. Ibarra Asencios, L. Fehren-Schmitz, and V. M. Oelze. 2021. "A Strontium Isoscape for the Conchucos Region of Highland Peru and its Application to Andean Archaeology." *PLOS One* 16 (3). https://doi.org/10.1371/journal.pone.0248209.

Weber, S. L. 2019. "Pulling Abundance out of Thin Air: The Role of Camelid Pastoralism at 3000 B.P." Unpublished PhD Dissertation. Harvard University.

Weber, S. L., and M. E. Young. 2023. "Eating Local, Drinking Imported: Chicha Recipes, Emulative Desire, and Identity Formation at Atalla, Huancavelica, Peru." In *Foodways of the Ancient Andes: Transforming Diet, Cuisine, and Society*, edited by M. Alfonso-Durruty, and D. E. Blom, 68–88. Tucson: The University of Arizona Press.

Wheeler, J. 1982. "Aging Llamas and Alpacas by Their Teeth." *Llama World* 1: 12–17.

Wheeler, J. 1995. "Evolution and Present Situation of the American Camelidae." *Biological Journal of the Linnean Society* 54: 271–295. https://doi.org/10.1111/j.1095-8312.1995.tb01037.x.

Wheeler, J. 1999. "Patrones Prehistóricos de Utilización de los Camélidos Sudamericanos." *Boletín de Arqueología PUCP* 3: 297–305.

Whittaker, John. 2010. "Weapon Trials: The Atlatl and Experiments in Hunting Technologies." In *In Designing Experimental Research in Archaeology*, edited by J. Ferguson, 195–224. Boulder: University of Colorado Press.

Wing, E. C. 1972. "Utilization of Animal Resources in the Peruvian Andes." In *In Excavations at Kotosh, Peru, 1963 and 1966*, edited by S. Izumi, and K. Terada, 327–351. Tokyo: University of Tokyo Press.

Wing, E.C. 1986. "Domestication of Andean Mammals." *In High Altitude Tropical Biogeography*, edited by F. Vuilleumier, and M. Monasterio, 246–264. New York: American Museum of Natural History, .

Yacobaccio, H. D. 2007. "Andean Camelid Herding in the South Andes: Ethnoarchaeological Models for Archaeozoological Research." *Anthropozoologica* 42: 143–154.

Young, M. E. 2020. "The Chavín Phenomenon in Huancavelica, Peru: Interregional interaction, ritual practice, and social transformations at Atalla." Unpublished PhD Dissertation. Yale University.