Reports

Origins of Prehispanic Camelid Wool Textiles from the North and Central Coasts of Peru Traced by Carbon and Nitrogen Isotopic Analyses

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Carbon and nitrogen isotopic compositions of wool textiles from the north (Virú, Early Intermediate Period) and central (Chancay, Late Intermediate Period) coasts of Peru were used to reconstruct the diet and habitat of the camelids (llamas and alpacas) from which they were produced in order to better understand the regional political economies. The Chancay textiles were derived from camelids primarily raised on high-altitude C_3 grasslands. Similarly, isotopic data from Virú textiles assembled in north-coast styles are consistent with the importation of highland camelid wool. For both Virú and Chancay, imported raw materials were crafted in local styles, serving as an effective means of materializing corporate power. Stylistically foreign (noncoastal) Virú textiles were characterized by carbon isotopic compositions similar to those for camelids recovered from Early Intermediate Period sites in the Virú Valley and suggest that these textiles originated in the *yungas* (1,000–2,300 m asl) or the low sierra (2,300–3,500 m asl). Accordingly, although highland camelid wool was imported to the coast, a simple model of exchange involving the movement of wool textiles exclusively from the *puna* or the *altiplano* to the coast is untenable.

Textiles were of great economic and symbolic significance in the prehispanic Andes. They were consumed locally, extensively traded, and in some cases produced to fulfill tribute obligations (Costin 1998). They were both utilitarian items and markers of prestige (Boytner 2004). Although discussions of social and ethnic identity have focused primarily on ceramic vessels, it is quite possible that textiles were the most important material manifestations of personal and/or corporate identity in the region (Costin 1998; Millaire 2009; Oakland Rodman 1992). Andean textiles were typically composed of camelid wool (from llamas and alpacas), cotton, or a combination of these two materials. Because llamas produce coarser and less homogenous wool than alpacas, it is generally held that alpacas were raised principally as wool producers while llamas were used for meat, transport, and dung (Bonavia 2008). Nevertheless, both alpacas and llamas were and continue to be used in wool production, and the probable existence of a breed of llama with finer fleece in ancient times further underscores this point (Wheeler, Russel, and Redden 1995).

In the traditional model of Andean human ecology, where vertically delineated zones are characterized by distinct classes of resources, cotton is a coastal product, whereas camelid herding and wool production have been associated with the high-altitude grasslands of the *puna* or the *altiplano*, ∼3,500–4,800 m asl (Boytner 2004; Murra 1980 [1955]). Some authors have suggested, however, that camelids (especially llamas) were raised in some of the coastal river valleys (Dufour et al. 2014; Shimada 1982; Shimada and Shimada 1985; Szpak et al. 2014*b*) or in the intermediate zones between the coast and the *puna* (Finucane, Agurto, and Isbell 2006; Thornton et al. 2011).

Textiles have been recovered from many Andean sites, especially along the coast, where arid conditions facilitate excellent organic preservation (Boytner 2004). Most coastal textiles are composed of cotton, but wool textiles also occur (Boytner 1998*a*; Millaire 2009). On the basis of the presumption that camelids were herded exclusively at high altitudes, it is generally held that wool textiles recovered from coastal sites were acquired through trade with highland groups (Boytner 2004; Rowe 1980).

Control over the production, distribution, and exchange of goods is often cited as a driving force behind the emergence of local elites in chiefdoms and archaic states or as a means of consolidating and materializing elite power (Brumfiel and Earle 1987). From a broad perspective, studying craft production, distribution, and exchange is crucial to better understanding the development of sociopolitical complexity and the emergence of states in the Andean region (Vaughn 2006). Craft production is a complex activity consisting of many parts (artisans, means of production, organization and social relationships of production, objects, relationships of distribution, and consumers; following Costin 2001) that are situated within broader environmental, political, and social contexts. Material objects are inscribed with meaning at different stages in their "life histories" (production, distribution/exchange, consumption) as they become tied to particular peo-

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ple, places, and events (Thomas 1991). The wool that was used to manufacture textiles is particularly significant in this context. While the most salient aspects of the finished fabrics were likely the stylistic and iconographic representations on the finished pieces, the use of distinct types of raw materials (e.g., wool, cotton, maguey) tied to particular places or groups of people may also have been significant. For instance, Boytner (1998*b*) reports the exclusive use of camelid wool in burial contexts at the coastal site of El Algodonal in the lower Osmore Valley on the south coast of Peru, despite the fact that cotton was widely available in the region and artifacts associated with processing cotton for use in textiles were recovered. In this case, camelid wool was clearly imbued with certain properties that made it the ideal, perhaps the only, substrate appropriate in mortuary contexts.

Textile research in the Andes has often been significantly influenced by ethnohistoric and ethnographic studies of weaving and textile production (e.g., Murra 1962, 1980 [1955]). While this strategy may be effective in studies of Inka cloth production (e.g., Costin 1993, 1996, 1998), an approach that relies predominantly on these data applied to earlier and distinct political entities or cultural groups is problematic (Wylie 1985). We approach the issue of textile production on the north and central coasts of Peru by carefully evaluating material evidence and relying less on ethnohistoric analogy. This report seeks to address aspects of the production of raw material (camelid wool) used in textiles from two contexts in coastal Peru (Virú and Chancay), using carbon and nitrogen isotopic analyses in concert with technological and contextual analysis of the fabrics. More generally, it provides further insight into our still-developing understanding of the production and management of animal resources on the Peruvian coast.

Methodological Context

Traditionally, strontium, oxygen, and hydrogen isotopes have been used to assign provenance. These isotope systems tend to vary in a systematic way across landscapes at regional and continental scales, strontium being influenced by local geology and oxygen and hydrogen being influenced by climate and hydrology. Thus, they have the capacity to establish whether an object or organism is local in origin (Hobson 1999). Carbon and nitrogen isotopic compositions of soils, plants, and animals are generally less sensitive to systematic geographic variation at relatively small spatial scales, and the interpretation of such data may be problematic within the context of determining specific source areas for organic materials (e.g., Hedges, Thompson, and Hull 2005), particularly where baseline variation in source isotopic compositions is low. Conversely, where there is substantial variability in baseline isotopic compositions, carbon and nitrogen isotope systems better enable the assessment of "local" origin (e.g., Guiry et al. 2012). These approaches have been used to verify or determine where modern animal products (e.g., meat, ivory, honey, milk, butter, cheese) were produced (reviewed by Gonzalvez, Armenta, and de la Guardia 2009).

As with all isotopic studies of biological materials, an especially important consideration for textiles is the temporal period that is represented by the sample being analyzed. The textiles analyzed in this study are composed of hair (wool) derived from camelids. These samples are not internally homogenous in the way that other tissues, such as bone collagen, are. Individual samples consist of small portions of large, complex tapestries or, in other cases, isolated yarns. Thus, although the entire sample (which ranges from a small fragment of a much larger piece to a yarn that effectively represents 100% of the material that could be sampled) can be homogenized, we cannot ascertain (1) what temporal period is represented (e.g., season), (2) the length of the temporal period represented (e.g., a single season, multiple seasons, multiple years), or (3) how many animals provided the wool used in a given sample. Because of this, with the exception of samples with extreme isotopic values (those at the absolute low or high end of the possible range), any single sample is not likely to provide a useful provenance assignment, even in a general sense, and we would not advocate that the methods employed in this report be used in this manner. Instead, the approach taken here utilizes collections of samples from different contexts to make more general statements about larger groups of samples, rather than individual samples.

Environmental and Isotopic Context

The Andean region of Peru is one of marked environmental diversity. As one moves from the coastal desert to the high-altitude grasslands, there are large-scale changes in annual precipitation (increases with altitude), temperature (decreases with altitude), and floral community composition (Molina and Little 1981). These large coastal-highland environmental differences produce three trends in plant carbon and nitrogen isotopic compositions with increasing altitude: on average, (1) plant nitrogen isotopic compositions decrease, (2) the relative abundance of C_4 plants decreases, and (3) the overall isotopic variability in plants decreases (Szpak et al. 2013). With respect to camelids in particular, some of these effects may be mediated by the consumption of agricultural products or by-products, which has been observed in modern camelids (e.g., McCorkle 1987) and suggested for archaeological camelids (Dufour et al. 2014; Finucane, Agurto, and Isbell 2006; Szpak et al. 2014*b*). This is significant because wild coastal plants are characterized by significantly higher $\delta^{15}N$ values than highland plants on average (Szpak et al. 2013), but cultigens grown on the coast with the aid of irrigation do not display unusually high $\delta^{15}N$ values (Szpak et al. 2012*a*). Nevertheless, the paucity of C_4 vegetation (both wild and domestic) at high altitudes still holds (Szpak et al. 2013), and carbon isotopic compositions are thus a better indicator of low- and high-altitude grazing. This isotopic variation in plants is not specific enough to enable the definitive assignment of individual samples to particular ecological zones, but it does provide a framework with which to assess the likelihood that a group of samples (but not any particular sample in isolation) originated in one ecological zone or another.

Archaeological Context

Textiles analyzed in this study come from two contexts: the Virú River valley on the north coast of Peru and the Chancay area (Huaura, Chillón, and Chancay River valleys) on the central coast of Peru (fig. 1*A*). The Virú textiles (fig. 2) are derived from two sites: Huaca Gallinazo (V-59) and Huaca Santa Clara (V-67; fig. 1*B*), both associated with the Virú polity, which flourished during the Early Intermediate Period (EIP, ~100 BC–AD 700). The Virú polity is defined by a distinctive type of corporate black resist-painted ceramics (Gallinazo Negative) that was initially classified as part of a larger tradition known as Gallinazo, which was associated with unburnished, incised, and appliquéd domestic wares (Bennett 1950; Millaire and Morlion 2009). Virú is one of several political entities that emerged on the north coast during the EIP, including the better-known Moche polity. The organization of the Virú polity is consistent with that of an archaic state (Millaire 2010*b*) and is characterized by a four-tiered settlement system (Willey 1953). A small portion of the textile sample is derived from Huaca Gallinazo (V-59), the largest mound of the larger Gallinazo Group, a string of structures located approximately 4 km from the coast, believed to have been the Virú capital (Millaire 2010*b*; Millaire and Eastaugh 2011, 2014; Willey 1953). Huaca Gallinazo was occupied for at least 7 centuries, beginning at 50 BC, and contains substantial residential and ceremonial structures (Millaire 2010*b*). Most of the textiles in this study are from Huaca Santa Clara (V-67), a midsized site that was likely one of several Virú regional administrative centers (Millaire 2010*a*). The isotopic compositions of camelid skeletal material have been previously analyzed from EIP contexts at both Huaca Gallinazo and Huaca Santa Clara (Szpak et al. 2014*b*).

The second set of textiles is associated with the Late Intermediate Period (LIP, AD 1000–1400) Chancay culture, located on the central coast of Peru (fig. 3). The Chancay culture is characterized by black-on-white ceramics and poured and rammed adobe (*tapia*) corporate architecture, and it is recognized for its spectacular textiles (Boytner 2004; Jiménez Díaz 2006). The nature of Chancay and its relation with other LIP groups are poorly understood. Believed to have its origins in the Chancay Valley (fig. 1*A*), the Chancay culture may have flourished relatively early in the LIP, possibly integrating nearby valleys (Huaura and Chillón) before either extensively interacting with the expansionist Chimú state (Brown Vega 2009) or being conquered by it (Mackey 1987).

Camelid bone from the highland (3,850 m asl) site of Chinchawas in the Department of Ancash (fig. 1*A*) serves as a useful isotopic baseline for high-altitude camelid manage-

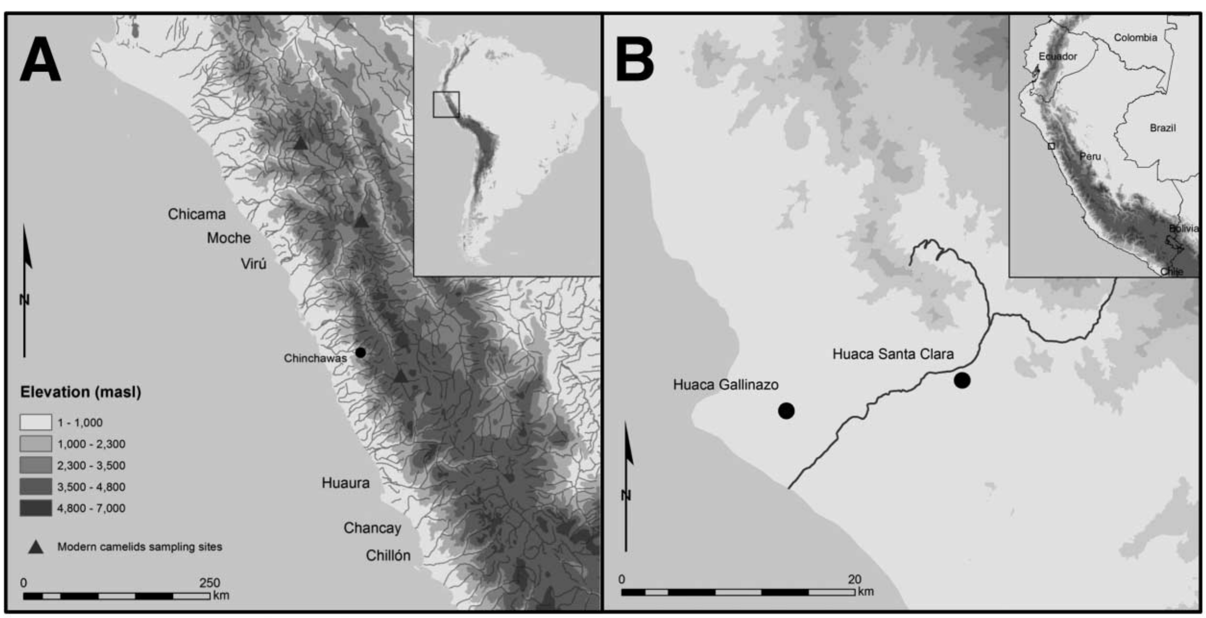

Figure 1. *A*, Map showing Peruvian coastal river valleys relevant to the materials analyzed in this study as well as the high-altitude site of Chinchawas and the locations where modern camelid samples used for comparative purposes were collected (Szpak et al. 2014*b*). *B*, Map of the Virú Valley showing the two sites from which textiles were sampled. A color version of this figure is available online.

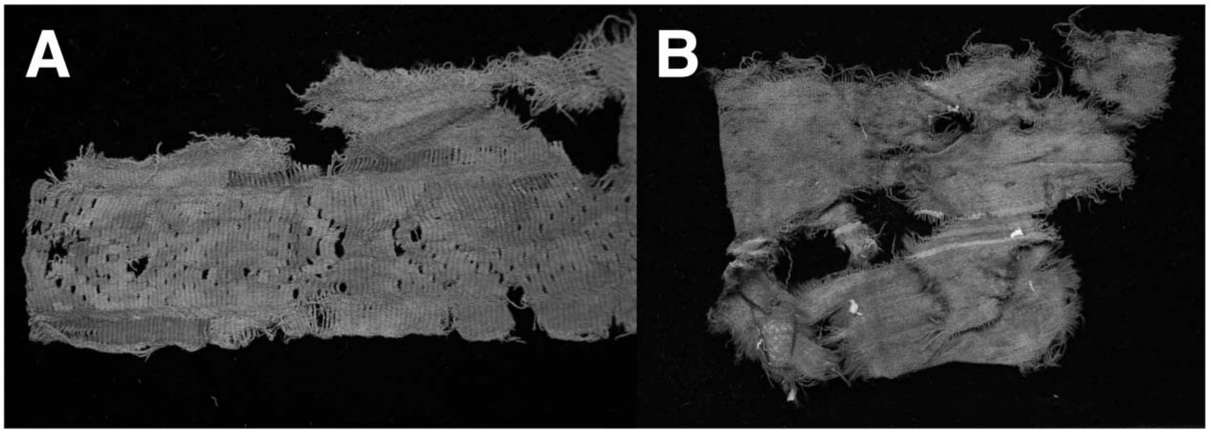

Figure 2. Examples of textiles from Huaca Santa Clara. *A*, Slit tapestry; lab ID AIS 672, artifact no. SC-162k. *B*, Warp-face fabrics; lab ID AIS 665, artifact no. SC-139b. A color version of this figure is available online.

ment, because alpaca herding appears to have been one of the principal activities at the site (Lau 2007). Located near high-altitude pasturelands on the western flanks of the Andes, Chinchawas was occupied most intensively between AD 500 and 900 and features late developments of the Recuay culture (Lau 2001, 2002*a*, 2002*b*, 2005, 2007). Abundant camelid remains were found in the residential sector of Chinchawas, including dense deposits associated with feasting episodes and ritual enclosures (Lau 2007). Camelid bones analyzed in this study were sampled from several different contexts and include refuse associated with domestic and feasting activities.

Details on sample preparation, isotopic methodology, analytical accuracy and precision, data treatment, and statistical methods are presented in CA+ supplement A.

Textile Classification

Where possible, textiles were classified according to spinning and weaving styles and, for the Virú samples, were characterized as "local" (north coast) or "foreign." The Chancay textiles were similarly classified, but the lack of relevant literature for textile styles on the central coast of Peru makes classification of individual samples as local or foreign problematic. In textile production, spinning is the process of drawing out fiber to a desired thickness and applying a twist to either the right (S-spun) or the left (Z-spun). These singles can then be plied in the opposite direction to form plied yarns (fig. 4). Weaving is a process in which two distinct sets of yarns (warps and wefts) are interlaced at right angles to form a fabric. In the Andean region, weavers traditionally used the back-strap loom to create cloths following a number of techniques, some of which were prevalent in a particular region or time period but rare or absent in another. Textiles on the Peruvian north coast were traditionally woven with S-spun yarns (Bororó technique), whereas in the highlands and the midelevation *yungas* (~1,000–2,300 m asl) area, fabrics were typically Z-spun (Bakaïrí technique; Millaire 1997; Nordenskiöld 1924).

Virú textiles were recovered during excavations at Huaca Santa Clara and Huaca Gallinazo. The vast majority of the wool analyzed in this study is derived from Huaca Santa Clara ($n = 88$), with a few additional samples from Huaca Gallinazo ($n = 6$). Given their contemporaneity (Millaire 2010*a*, 2010*b*), the similarities in camelid-herding practices at the two sites (Szpak et al. 2014*b*), and the small sample size for Huaca Gallinazo, the two groups were pooled as "Virú textiles" for the purpose of this analysis. Most of the Virú textiles recovered were cotton, but 17% featured some camelid wool. The majority of camelid wool yarns ($n = 64$)

Figure 3. Chancay textile with bird design executed with camelid fiber supplemental wefts. Canadian Museum of History catalog no. XIX-G-451. A color version of this figure is available online.

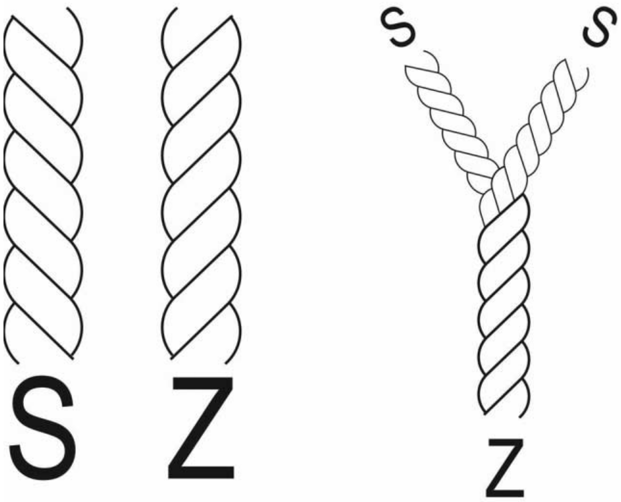

Figure 4. Representations of S and Z spinning techniques and the 2S/Z technique.

are Z-spun (foreign), and 28 are S-spun (local). Several of the yarns consist of unspun wool or isolated fibers and cannot be classified as local or foreign. Accordingly, they are included in the larger "Virú textiles" sample but excluded from the local and foreign subgroups for both spinning and weaving. The majority of woven Virú samples ($n = 64$) were manufactured with a technique (warp-faced) that is associated with the highland and midvalley *yungas* areas (see Rowe 1977). Many of these appear to have been bags, perhaps used to carry commodities from one region to another. Unlike tapestry pieces, which generally employed dyed camelid yarns, these bags were made from naturally colored wool yarns, spun Z/2S. They were made in a consistent style, with densely packed warps and a center panel of stripes in two or more colors, framed by larger fields of plain warp-faced fabric, then folded over and sewn along the sides to create simple bags. The remaining samples classified as "local" were made with characteristically coastal techniques (plain weave, mesh, twill, tapestry).

Chancay textiles were sampled from private collections donated to the Canadian Museum of History, and precise contexts for individual samples are absent; however, their iconographic elements enable them to be confidently associated with the LIP Chancay culture (Anders 1987). The collection includes partial and complete objects made from plain-weave, warp-faced cloth tapestry, as well as double cloth in cotton and wool. Most are decorated with techniques such as painting, embroidery, and supplemental wefts (brocade). The collection also includes several individual Chancay "dolls" and those arranged in tableaus. All of the Chancay yarns are 2Z/S, consistent with spinning styles in high-altitude regions. A complete list of the Virú and Chancay materials sampled is presented in CA+ online supplement B.

Results

Carbon and nitrogen isotopic compositions for the Virú and Chancay textiles and Chinchawas camelid bone collagen are summarized in table 1. For comparative purposes, contemporaneous Virú camelid bone collagen carbon and nitrogen isotopic compositions are also presented in table 1 (Szpak et al. 2014*b*). Isotopic and elemental compositions for all individual textile and bone collagen samples analyzed in this study are presented in CA+ supplement B. Individual carbon and nitrogen isotopic compositions for these materials are presented in figure 5, along with the calculated standard ellipse areas corrected for sample size (SEA_c; Jackson et al. 2011). The textile data from Huaca Santa Clara and Huaca Gallinazo are pooled as "Virú textiles." Isotopic data from camelid bone collagen from contemporaneous (EIP) Virú occupations (Huaca Gallinazo and Huaca Santa Clara) and the Middle Horizon occupation at the high-altitude site of Chinchawas are presented alongside the Chancay and Virú textiles as SEA_c (fig. 6). There are substantial differences between the Virú and Chancay textile groups. There is almost no overlapping area (<0.1%) between the two ellipses for Virú and Chancay textiles, which demonstrates markedly different diets and/or habitats for the camelids that produced the wool used in these textiles.

The relative contributions of C_3 and C_4 plants to the Virú and Chancay textiles are presented in table 2; source proportion histograms (Parnell et al. 2010) are plotted in figure 7. For comparative purposes, data from archaeological camelid bone collagen (Virú and Chinchawas) and modern camelids from northern Peru (collected between 3,182 and 3,595 m asl; fig. 1*A*) are also presented in table 2 and figure 7. Two general patterns are evident in the carbon isotopic compositions of the camelid and textile data sets. In the first, C_3 plants overwhelmingly dominate the diet, and this is the pattern observed for the modern highland camelids, Chinchawas camelids, Chancay textiles, and technologically local Virú textiles. This pattern is consistent with camelids feeding in the highlands, with the mean dietary contribution of C_4 plants ranging between 17.5% and 31.2% (table 2). Although the highlands contain relatively few C_4 plants, several C_4 grass species (particularly *Muhlenbergia* sp.) may be present (in some cases being common, in others present only in trace amounts) and consumed by camelids in high-altitude pastures (Bryant and Farfan 1984). In addition, bringing highland camelid herds to graze fallow maize fields at lower altitudes (<3,500 m asl) on a seasonal basis is a common practice among recent Andean herders (e.g., McCorkle 1987). The relative importance of such practices may add to the variability observed among the highland camelid samples analyzed in this study. In addition, the isotopic phytogeography of highland pastures in the Andes has not been explored in detail, and so it is not clear to what extent variable distribution and abundance of C_4 taxa in these pastures may be responsible for the differences in C_4 plant consumption observed for high-altitude camelids. In

Table 1. Summarized carbon and nitrogen isotopic compositions for Virú and Chancay textiles and the Chinchawas camelid bone collagen

Context	*n*	$\delta^{13}C$ (‰, VPDB)	$\delta^{15}N$ (‰, AIR)
Textiles:			
Virú (all)	94	−17.5 ± 1.7 (−20.8 to −12.2)	7.1 ± 1.1 (4.9–10.5)
Huaca Gallinazo	6	−18.8 ± 1.4 (−20.6 to −16.9)	7.5 ± .5 (7.0–8.5)
Huaca Santa Clara	88	−17.4 ± 1.7 (−20.8 to −12.2)	7.1 ± 1.1 (4.9–10.5)
Chancay	60	−20.2 ± 1.4 (−22.3 to −14.4)	7.9 ± 1.4 (5.1–10.7)
Bone collagen:			
Chinchawas	13	−19.3 ± 0.6 (−20.2 to −17.9)	7.0 ± 1.6 (4.9–9.9)
Huaca Gallinazo[a]	43	−15.7 ± 3.0 (−20.0 to −9.9)	6.6 ± 1.2 (4.7–9.7)
Huaca Santa Clara[a]	43	−15.6 ± 2.2 (−21.9 to −10.9)	6.7 ± 1.3 (4.1–11.8)

Note. $\delta^{13}C$ and $\delta^{15}N$ are reported as mean ± SD, with the range in parentheses. AIR = atmospheric nitrogen; VPDB = Vienna Pee Dee belemnite.
[a] Data are from Szpak et al. (2014*b*).

the second (technologically foreign Virú textiles, Virú camelids), camelids consume more variable proportions of C_3 and C_4 plants, but on average C_4 plants constitute approximately 50% of the diet.

Discussion

Although local populations of camelids almost certainly existed on the north coast during the EIP, the carbon isotopic compositions of technologically local Virú textiles indicate that they were manufactured principally from wool originating in high-altitude grasslands, a result that supports previous assertions that wool used in coastal textiles originated in these environments (Boytner 1998*a*, 1998*b*; Rowe 1980). This may have been because highland wool was of higher quality (Webster 1973) and possibly derived from alpacas rather than llamas, the latter of which are poorly suited to habitats outside of the highlands (Topic, McGreevy, and Topic 1987). The wider variety of camelid breeds with varying fiber quality that existed in prehispanic times (Wheeler, Russel, and Redden 1995), however, makes it difficult to make any statement about the species from which the wool was derived that is anything more than speculative at this point. Regardless, the carbon and nitrogen isotopic data reveal a highland source for elaborate Virú textiles locally woven with woolen yarns, which were no doubt part of garments worn by members of the local elite.

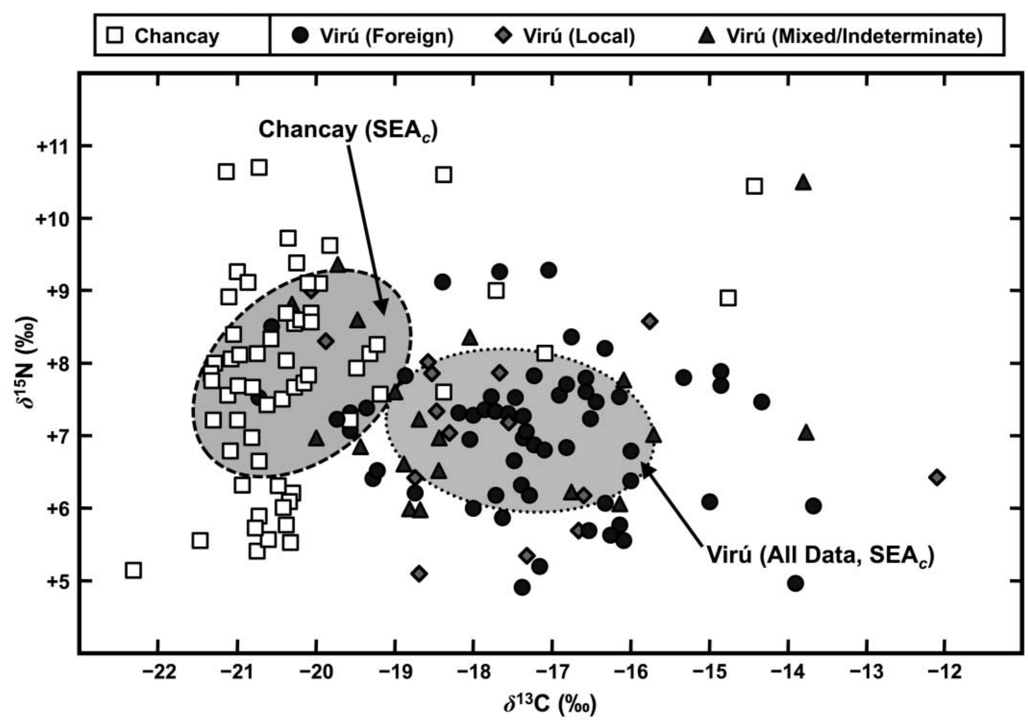

Figure 5. Carbon and nitrogen isotopic compositions for Virú and Chancay textiles, with standard ellipse areas corrected for sample size (SEA$_c$). A color version of this figure is available online.

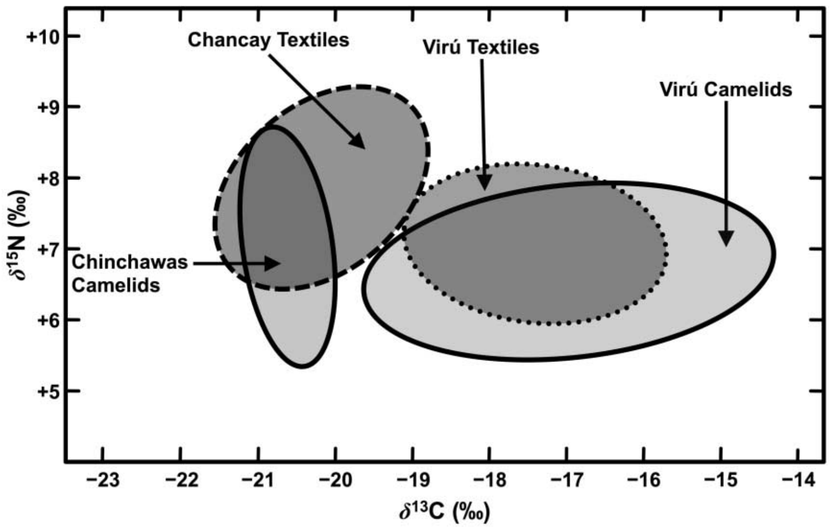

Figure 6. Standard ellipse areas corrected for sample size for Virú and Chancay textiles, with comparative camelid data sets from highland (Chinchawas) and coastal (Virú: Huaca Gallinazo and Huaca Santa Clara) sites (Szpak et al. 2014*b*). The bone collagen $\delta^{13}C$ values have been adjusted by −1.3‰ to account for differences in tissue-diet carbon isotope fractionation between bone collagen and hair keratin (Szpak et al. 2014*b*). A color version of this figure is available online.

Local elites may have specifically sought highland wool because it was nonlocal, rare on the coast, and exotic. Moreover, while it is quite plausible that this fiber was valued for the warmth it provided, the key advantage of wool over cotton is that it can be dyed more easily. Therefore, if the goal (or task) of a weaver were to make a fine fabric in vivid colors to be worn by a member of the local elite, she would certainly choose wool over cotton. The fact that the finest of the Virú fabrics are tapestries made from dyed camelid wool lends support to this notion (Millaire 2009). With regard to the entire corpus of textiles analyzed from EIP contexts in Virú, wool is rare relative to cotton. Of the textiles analyzed to date from Huaca Gallinazo and Huaca Santa Clara, 83% are made exclusively with cotton (Millaire 2009). Since sumptuary or prestige goods are believed to be among the most effective means for materializing ideologies and political power (Goldstein 2000*b*), the crafting of nonlocal wool into finished textiles with local iconography would have been an effective materialization of corporate power (Earle 1997, 2002), symbolizing control over long-distance exchange. The use of imported camelid wool in this context may have served as coded information supporting a narrative of connectedness with or dominion over distant powers or lands (DeMarrais, Castillo, and Earle 1996; Helms 1993), which is often evoked as an important aspect of long-distance exchange for elites in chiefdoms or states in the Andes (see examples in Vaughn 2006). The importation of exogenous raw materials and their transformation following local techniques are also seen in Virú ceramics, where highland kaolin was used to make vessels in local styles (fig. 8*A*). Shimada (1982:169–183) addresses a similar situation during the LIP on the north coast between the Lambayeque (coastal) and Cajamarca (highland) polities. He discusses a symbiotic relationship between the two groups involving the importation to Batán Grande of highland raw materials that were later crafted into local styles, reinforcing the prestige of the coastal religious movement centered there. The choice to utilize imported wool (rather than locally produced wool or cotton) in its production would almost certainly have contributed to the value and power associated with such goods.

The Chancay textiles are characterized by isotopic compositions very similar to those of the Chinchawas camelids, modern highland camelids, and the local Virú textiles, strongly

Table 2. Relative contributions (%) of C_3 and C_4 plants for textile and camelid data sets

Context	*n*	Mean C_4 contribution (95% BCI)	Mean C_3 contribution (95% BCI)
Virú textiles (all)	94	35.0 (32.5–37.5)	65.0 (62.5–67.5)
Virú textiles (local spin)	27	31.2 (27.1–35.3)	68.8 (64.5–72.9)
Virú textiles (foreign spin)	59	50.0 (47.3–52.2)	50.0 (47.8–52.6)
Virú textiles (local weave)	17	29.9 (24.7–35.3)	70.0 (64.5–75.3)
Virú textiles (foreign weave)	61	48.7 (46.3–51.1)	51.3 (48.9–53.7)
Chancay textiles	60	25.1 (22.2–28.0)	74.9 (72.0–77.8)
Virú camelid collagen	99	47.9 (44.2–47.9)	52.1 (48.4–55.8)
Chinchawas camelid collagen	13	21.8 (14.6–29.0)	78.2 (71.0–85.4)
Modern camelids	29	17.5 (12.3–22.4)	82.5 (77.6–87.7)

Note. Contributions were estimated with the Bayesian mixing model SIAR (stable isotope analysis in R; Parnell et al. 2010), as described in CA+ supplement A. BCI = Bayesian credible interval.

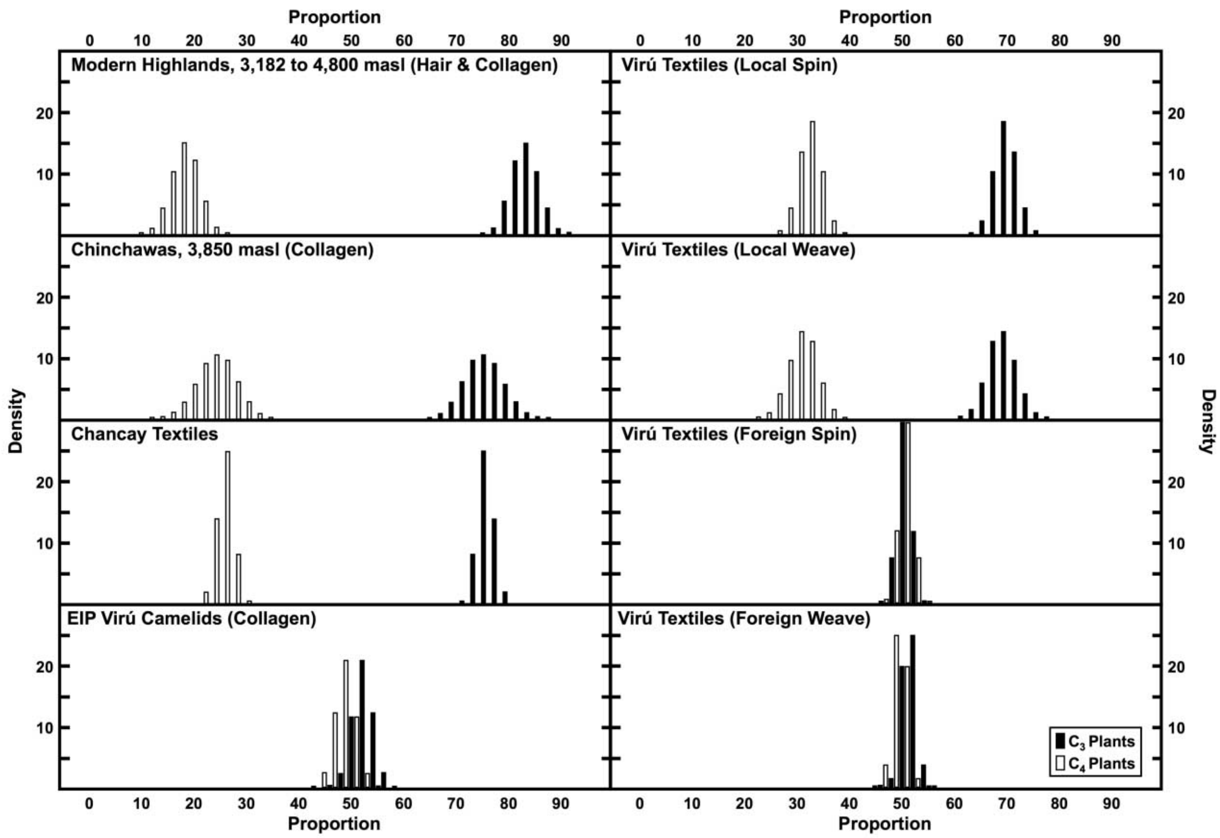

Figure 7. SIAR (stable isotope analysis in R) density histograms showing estimated contributions of C_3 and C_4 plants for Chancay and Virú textiles (divided according to spinning and weaving style), alongside comparative camelid data sets presented in figure 6. A color version of this figure is available online.

suggesting that the camelids that produced their wool were also raised on high-altitude grasslands. The Chancay textile data set consisted entirely of materials spun in a manner consistent with the highlands (2Z/S), and the majority of the wool was dyed. Rowe (1980) hypothesized that camelid wool textiles at the coastal LIP site of Chan Chan in the Moche Valley (north coast of Peru), which were mostly dyed and spun in a characteristically highland style (2Z/S), were produced, spun, and dyed in the highlands before being exported en masse to the coast for local weaving. The isotopic data for the Chancay textiles are entirely consistent with this pattern. While the weaving styles characteristic of the north coast of Peru

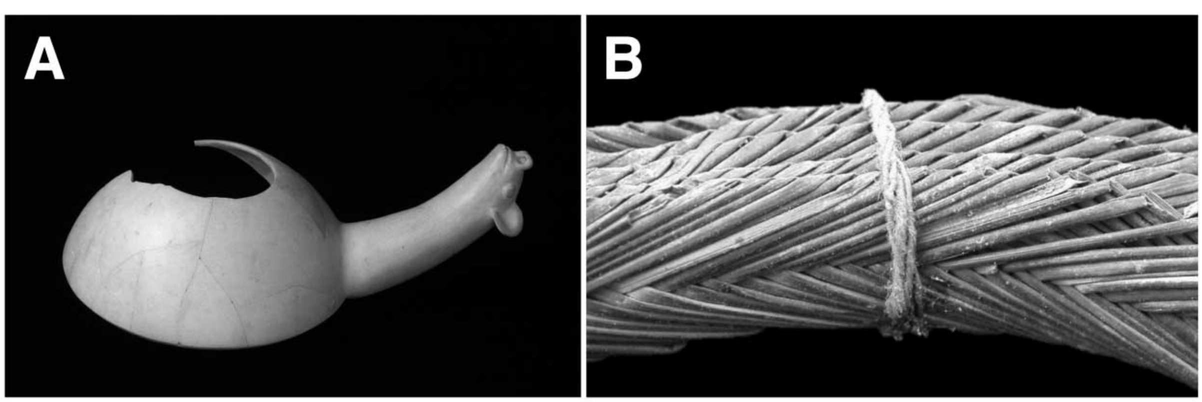

Figure 8. Exotic objects recovered from Huaca Santa Clara. *A*, Kaolin clay *canchero* of Virú style. *B*, Braided grass belt of foreign (possibly Amazonian) origin. A color version of this figure is available online.

are relatively well understood (Boytner 1998*a*; Millaire 2009; Rowe 1980), the lack of relevant studies on the central coast make it difficult to assess whether these materials were in fact woven on the coast. Certain technical (e.g., open mesh, elaborate gauzes, supplemental weft, dolls) and stylistic (e.g., interlocking avian and fish figures) elements are considered characteristic of the Chancay style and indicate the presence of specialized, local weavers affiliated with this group. It is therefore likely that these textiles were fashioned on the coast, but additional studies of Chancay and central coast textile traditions are necessary to contextualize regional styles for comparative purposes. Although knowledge of Chancay political organization is extremely limited, the isotopic data from these textiles provide clear evidence of the systematic importation of camelid wool from high-altitude regions.

The Virú textiles that were spun and woven in nonlocal styles have carbon isotopic compositions inconsistent with high-altitude camelid wool (fig. 7). Rather, their carbon isotopic compositions are very similar to that of contemporaneous camelids (from Huaca Gallinazo and Huaca Santa Clara) that were most likely raised outside the highlands at low-altitude or coastal sites (Szpak et al. 2014*a*). In other words, the isotopic data for Virú textiles that are technologically foreign to the north coast are wholly inconsistent with wool of highland origin. Although it is possible that highland weavers relocated to coastal Virú settlements, where they made their own traditional textiles from locally produced wool (as Goldstein [2000*a*] posits for Tiwanaku diaspora communities), there is no archaeological evidence in Virú to support this assertion. Alternatively, the wool used to craft these textiles may have originated in the *yungas* (~1,000–2,300 m asl) or low sierra (~2,300–3,500 m asl) zones between the coast and highlands, an intermediate area thought to have been important in coast-highland exchange networks (Topic and Topic 1983). Variable carbon isotopic compositions indicative of comparable dietary contributions of C_4 plants have been recorded for camelids in these zones, both at Conchopata (~2,700 m asl) in the Ayacucho Valley (Finucane, Agurto, and Isbell 2006) and at Cerro Baul (~2,500 m asl) in the Moquegua Valley (Thornton et al. 2011).

The majority of the foreign textiles from Virú were bags that we suspect were used to transport trade or tribute goods (CA+ supplement B). On the basis of their isotopic compositions, these bags may have been made and used by the inhabitants of the intermediate zone between the coast and the highlands. These people could have served as buffers or intermediaries between coastal and highland groups in a complex trade network, bringing products originating there (e.g., coca, mineral ores, medicinal plants) or in the highlands (e.g., alpaca wool, kaolin clay) to Virú settlements in the middle and lower valley. Huaca Santa Clara, the site from which most of these foreign bags were sampled, contains a number of agricultural storage facilities associated with corporate architecture, which suggests that the site had an administrative function in which local elites controlled agricultural production and redistribution (Millaire 2010*a*). It is therefore possible that these bags were used to transport goods from the sierra or *yungas* zones to Huaca Santa Clara for redistribution, where they were either discarded or reused until they were too worn. The orientation of six hilltop citadels (including Huaca Santa Clara) at the neck of the Virú Valley suggests that these sites may have served as checkpoints for people passing between the highlands and coast. Elsewhere on the north coast of Peru, archaeological work in the Chicama (Attarian 2003), Moche (Billman 1996), Chao (Kent et al. 2009), Santa (Wilson 1988), and Nepeña (Proulx 1982) Valleys has revealed the presence of forts, fortifications, defensive walls, parapets, and lookouts strategically positioned at the valley neck, a pattern suggesting that control of coast-highland movements was a key preoccupation for local authorities during the EIP.

Summary and Conclusions

Isotopic data for textiles and other animal products have considerable potential for enabling a better understanding of patterns of production and trade in prehistoric political economies. Two patterns of isotopic data are present for the textiles analyzed in this study. The first, which includes the Chinchawas camelids, the Chancay textiles, and the elaborate locally spun and woven Virú textiles, is characterized by low carbon isotopic variability and low dietary contributions of C_4 plants. These data are consistent with camelids raised in high-altitude pastures and the importation of wool to the coast for textile production. The second pattern, which includes the nonlocal (based on spinning and weaving) textiles from the lower Virú Valley, is characterized by wool derived from camelids with higher dietary contributions of C_4 plants (~50% on average) and more variable carbon isotopic compositions. These data are wholly inconsistent with wool originating in the highlands and may indicate the use of wool originating in the *yungas* or the low sierra. The isotopic data for the second group clearly demonstrate that wool derived from camelids raised outside of the highlands was used to manufacture textiles, and they suggest a set of production and exchange networks for camelid products in Peru that is far more complex than previously believed. A simple model in which camelid wool is strictly a highland product that moves to the coast is untenable. Additional studies of this nature will be useful in documenting the extent to which camelid wool originating outside of the highlands may have figured in coastal textile production and whether such patterns were driven by larger geopolitical forces. For instance, was there a differential reliance on local versus foreign wool during periods when insularity was relatively great (e.g., middle EIP) or reduced (e.g., late EIP and Middle Horizon)?

For a dominant group to effectively materialize ideology as a source of power, it must be possible for this group to control the production, distribution, and consumption of a particular material, which is considerably easier for rare, foreign materials than for abundant, local materials (DeMarrais, Castillo, and Earle 1996). Both the Virú and the Chancay appear to have exercised these forms of control by using imported camelid wool crafted in local styles and brightly dyed, which also served as a highly visual and very effective vehicle for demonstrating political power and reinforcing ideologies (political, religious, or both) on a daily basis. While the camelid wool itself may not have served to differentiate those who wore these fabrics (it is unclear to what extent imported camelid wool could be visually differentiated from local cotton), the vivid and striking colors that were possible with this medium would have clearly communicated the wearers' connection to and control over exotic raw materials. In Virú, the undyed and technologically nonlocal bags point to a distinct set of relations, this time with communities, individuals, and animals from the *yungas* or the low-sierra region, as well as the exogenous materials they once carried down the valley.

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