Diet and mobility at the end of the Archaic period and the initial stage of the Early Ceramic period in central Chile are the subjects of this paper and are discussed on the basis of the results of stable isotope analysis of 20 individuals sampled from the Andean cordillera, central valley, and coast. The results indicate that the diet of Archaic groups living along the coast did not incorporate marine resources to any significant extent. Individuals sampled from the Early Ceramic period do not reveal consumption of animal protein, which raises the question of alternative sources for the protein necessary for survival. In terms of mobility, the results of the investigation suggest that the cordillera was occupied by people with a high-mobility pattern.

For some time, researchers have held a dichotomous vision of the Archaic and Formative periods throughout the Americas. The interpretation of prehistory in central Chile, in the southern part of the New World, is not unfamiliar with this paradigm. Consequently the Archaic period (11,000–400 BC) has become synonymous with hunters and gatherers with high mobility, whereas the period immediately following, the Early Ceramic period (400 BC–AD 1000), has implied a sedentary community with a horticultural subsistence and producing ceramics—an interpretation that was thought to be valid for the entire region (Falabella and Stehberg 1989).

Recently, this idea has begun to be modified. On one hand, evidence of cultigens such as quinoa (Chenopodium quinoa) is known from sites dated to the end of the Archaic (Planella, Cornejo, and Tagle 2005). On the other hand, there are groups attributed to the Early Ceramic period that neither became sedentary nor adopted horticulture (Cornejo and Sanhueza 2003). In light of new evidence provided by stable isotope analysis, the goal of this paper is to discuss diet and mobility at the end of the Archaic period and the initial stage of the Early Ceramic period.

Background and Problems

A first problem of interest is to explore the dynamics of marine adaptation among Archaic groups. The available data from the few coastal sites investigated, such as Punta Curaumilla and LEP-C, suggest an initial coastal occupation (6850 BC at Punta Curaumilla) by inland groups of hunters and gatherers, which over time would become more habitual, utilizing a broader spectrum of coastal resources (Falabella and Planella 1991; Ramírez et al. 1991).

A second problem of particular relevance to this discussion is the mobility and diet of the Archaic III/IV groups (6000–400 BC). In the case of inland valley sites, Cuchipuy and Tagua Tagua II (at the southern extreme of the study area), the importance of local lacustrine resources, such as frogs, rodents, nutria, birds, fish, and freshwater mollusks associated with Lake Tagua Tagua, is evident, as is the importance of camelids (Durán 1980; Kaltwasser, Medina, and Munizaga 1980). In the northern section of the study area, in the Chacabuco area, Late Archaic sites are small and ephemeral, focusing on the exploitation of lithic quarries for raw material, consistent with a highly mobile settlement system (Hermosilla et al. 2003). Some sites, such as Vegas La Fortuna, have been associated with the occupations of Cuchipuy and Tagua Tagua II on the basis of stemmed and unstemmed lanceolate points (Jackson and Thomas 2000).

In the highlands, the Archaic III/IV occupations of El Manzano 1, La Batea 1, Las Morrenas 1, and Los Queltehues, among others, show evidence of repeated use of the Andes Cordillera between 1,000 and 3,000 m a.s.l., with an emphasis on the consumption of guanaco and a general use of fine-grained raw materials procured from highland sources (Cornejo and Simonetti 1997–1998). Although the precise range of mobility has not been defined for these groups, the possibility of a year-round human occupation of the Cordillera has been established, according to the reported ethnohistoric accounts at the moment of contact, describing the occupation of both sides of the Andes Cordillera by groups of hunters and gatherers (Madrid 1977).

If there is indeed evidence of some exotic highland resources, such as obsidian, at sites along the coast and in the lowland valleys (Cuchipuy, La Fortuna B, Las Cenizas) and evidence of marine mollusks in inland sites (Cuchipuy, Tagua Tagua II), published data fail to explain the contextual importance of these finds or the manner of their procurement (Durán 1980; Gajardo Tobar 1958–1959; Jackson and Thomas 2000; Kaltwasser, Medina, and Munizaga 1980). The subsistence of the hunter-gatherer undoubtedly implies a strategy of high mobility; however, from the available data it remains unclear whether this mobility is broad (at a regional level) or restricted (within a limited area). What is clearly expressed
by the recovered ecofacts is that edible resources from each locality are being utilized. In the context of this discussion, one would expect marine resources to be consumed exclusively on the coast, with no consumption of these products in inland sites, as well as indications of occupation within circumscribed geographical areas.

A third problem to consider is the correlation between the incorporation of domesticates into the diet and the appearance of ceramics. In spite of the early presence of quinoa in sites in the Andes Cordillera, such as Las Morrenas 1, which dates to the Archaic period (Planella, Cornejo, and Tagle 2005), available data suggest a gradual incorporation of cultigens into the diet. This is verified in several contemporaneous sites in which some degree of horticultural activities may or may not be seen (Sanhueza, Vásquez, and Falabella 2003). This is especially apparent at the beginning of the Ceramic period, during the Initial Ceramic-Using Communities (ICC; Comunidades Alfareras Iniciales [CAI]; 300 BC–AD 200), where despite the presence of cultigens such as quinoa (Falabella and Stehberg 1989; Planella et al. 2006; Quiroz and Belmar 2004; Sanhueza and Falabella 1999–2000, 2003) and ceramics, the groups fundamentally maintained a hunting and gathering subsistence.

It is evident that the populations at both the end of the Archaic period and the initial Ceramic period were familiar with quinoa, although there is no way to measure the importance of this cereal in their diets, and it is very possible that its incorporation into the diet became increasingly important as the process of horticulture became more rooted in central Chile. For the purpose of our discussion, it remains to be confirmed whether a change toward sedentism is made in ICC sites, as would be expected from a community whose subsistence is based on horticultural productivity.

Finally, in terms of the Early Ceramic period sites in the Andes Cordillera, there are two problematic topics we must focus on: mobility and the incorporation of cultigens into the diet. It has been proposed that, contemporaneous to the horticultural producers of ceramics along the coast and in the lowland valleys (post AD 200), the highlands would have been occupied by groups of hunters and gatherers who maintained a settlement/subsistence pattern and a lithic technology similar to that of the Archaic period yet with the introduction of ceramic wares into the tool kit and, eventually, cultigens (Cornejo and Sanhueza 2003; Planella, Cornejo, and Tagle 2005).

Taking exception to this, the highland site of Chacayes yields an artifact assemblage that clearly places it within the Early Ceramic period; however, it cannot be attributed to the cordilleran hunters and gatherers nor can it be correlated to any of the cultural expressions defined for the region. Moreover, it suggests important parallels to the cultural manifestations of El Molle Culture further north (Sanhueza 1997; Stehberg 1978) and certain similarities to other southern highland sites south of the Río Cachapoal drainage (Falabella et al., forthcoming). Thus, we would expect differences between the hunter-gatherers from the “Archaic Tradition” and the groups that inhabited the site of Chacayes.

Isotopes, Diet, and Mobility

Enhanced by experimental research, the analysis of stable isotopes has established itself as an effective method to study diverse aspects of diet and human mobility, giving fresh meaning to the truism that we are what we eat. With respect to diet, analyses of isotopes help to distinguish (a) marine diets (which eventually led to littoral adaptations) from the terrestrial diets typical of inland inhabitants and (b) hunting-and-gathering diets from horticultural diets.

The distinction between marine and terrestrial diets can be observed in nitrogen and carbon isotopes, as both are enriched by the consumption of marine resources (Schoeninger, De Niro, and Tauber 1983). Analyzed isotopic data from central Chile (table 1) clearly demonstrate this tendency (Falabella et al. 2007). The dietary pattern of hunters and gatherers should be distinct from that of horticulturalists, first, by a major dependence on wild faunal proteins, which would be observed by enriched δ15N values (see Hedges and Reynard 2007; Koch 2007; see Schwarcz, Dupras, and Fairgrieve 1999 for problems regarding this) and decreased δ13C collagen-apatite spacing (Δδ13CCol-ap; Bocherens 2000; Schwarcz 2000). Second, the distinction between hunters and gatherers and horticulturalists who consume maize can be seen by the marked enrichment of δ15N in the latter. Since the C3 photosynthetic pathway is dominant in the wild vegetation of our Mediterranean-like study area—as is the case with all domesticated plants with the exception of maize (Zea mays), which is C4—this distinction is viable (Falabella, Planella, and Tykot 2008).

In discussing mobility, we will use δ18O isotopic distinctions. Oxygen isotopes provide valuable information because of the topography of our study area. Central Chile has the advantage that in less than 200 km running east and west, groundwater originating from precipitation demonstrates great variation in δ18O, due to the significant increase in altitude and the drop in temperature as we move inland from the coast (fig. 1). A lineal latitudinal transect of 140 m of our study area shows a decrease in the average annual δ18O from precipitation from −3.5‰ at the coastal margin to −17.3‰ at 4,200 m a.s.l. (Moser et al. 1972; fig. 2). The values increase again crossing the cordillera eastward to Argentina, where a mean δ18O value of −5.7‰ has been reported for the city of Mendoza (827 m a.s.l.; Rozanski and Araguás 1995). These data confirm that δ18O is sensitive to changes between coast and inlands and to the differences in altitude, enabling us to distinguish between peoples living in coastal, lowland valley, and highland environments. North-south mobility is also expressed in oxygen isotopes, but the differences are of less magnitude. Climatic variation, a source of change in the isotopic composition, should not affect this research since, with the exception of a single sample from Los Queltehues, the
conditions in temperature and precipitation remained stable throughout the period under investigation (Jenny et al. 2002; Villa-Martínez 2002).

Most of the water necessary for human organism is consumed on a daily basis, such that the bone $\delta^{18}O$ fundamentally reflects the value of the water consumed (Schoeninger, Kohn, and Valley 2000). While the O isotope fractionation is impacted by environmental conditions as well as physiological factors, progress in identifying these fractionations (Levinson, Luz, and Kolodny 1987; Longinelli 1984; Luz, Kolodny, and Horowitz 1984) has enabled the incorporation of the $\delta^{18}O$ of phosphates and carbon structures in provenience studies (Bentley et al. 2007; Budd et al. 2004; Ehleringer et al. 2008; Schwarcz, Gibbs, and Knyf 1991; White et al. 2004, 2008).

Methodology

Analyzed samples consist of both male and female adult femoral cortical bone, with the exception of Chacayes sample 2, which consists of a mandible (table 2). This element was chosen for its density as well as its lesser propensity to diagenetic contamination. The carbon and nitrogen of collagen (organic matrix of bone) and the carbon and oxygen of structural carbonate in apatite (mineral matrix of bone) were analyzed. Both collagen and apatite are constantly replaced throughout the individual’s lifetime in such a way that the bone’s isotopic composition reflects the average diet of the latter years of the individual’s life (Richards and Hedges 1999).

Analytical procedures were performed under the supervision of Dr. Robert H. Tykot, following well-established protocols, in the Laboratory for Archaeological Science at the University of South Florida (Tykot 2004). For extracting collagen, the bone sample was cleaned and soaked in 0.1M NaOH for 24 h to remove humic acids. Repeated removal of mineral bone (apatite) was done with 2% HCl; humic acid contaminants were further removed with 0.1M NaOH for 24 h and the fat content with a defatting solution. Collagen pseudomorphs were analyzed with a CHN (carbon, hydrogen, nitrogen) analyzer as well as a Finnigan MAT mass spectrometer for stable isotopes. The integrity of the sample was assessed visually with the resulting pseudomorphs, checking that the percentage of collagen output was >1% and that the measure of CO$_2$ and N$_2$ produced in the mass spectrometer was adequate.

For the extraction of carbonate from apatite, the sample was cleaned ultrasonically and crushed, sifted, and sorted centrifugally. The collagen was removed, repeatedly soaking the bacterial and humic proteins with 2% bleach solution. Bone was treated with 1 mL of 1M acetic acid sodium acetate solution for 24 h to remove nonbiogenic carbonates. Experimentation has demonstrated that this will remove the contaminant without any significant alteration of the carbonate structure. The samples were analyzed using a Finnigan MAT mass spectrometer coupled with a Kiel III device. The analytical mass spectrometry precision is ±0.1‰ for carbon and ±0.2‰ for nitrogen. The $\delta^{13}C$ and $\delta^{15}N$ results were reported in relation to the Pee Dee belemnite standard, and $\delta^{18}O$ is reported in relation to the international AIR standard.

The reconstruction of subsistence and mobility depends on

### Table 1. Average values and standard deviation of different resource categories analyzed in central Chile

<table>
<thead>
<tr>
<th>Resource</th>
<th>$n$ (sample)</th>
<th>$n$ (species)</th>
<th>$\delta^{13}C$</th>
<th>$\delta^{15}N$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coastal lacustrine fauna</td>
<td>2</td>
<td>2</td>
<td>$-22.9 \pm .8$</td>
<td>7.1</td>
</tr>
<tr>
<td>Inland lacustrine fauna</td>
<td>1</td>
<td>1</td>
<td>$-16.0$</td>
<td>2.1</td>
</tr>
<tr>
<td>Marine mammal</td>
<td>1</td>
<td>1</td>
<td>$-11.7$</td>
<td>20.2</td>
</tr>
<tr>
<td>Marine fish</td>
<td>5</td>
<td>5</td>
<td>$-13.7 \pm 1.7$</td>
<td>16.7 $\pm$ 2.6</td>
</tr>
<tr>
<td>Marine mollusks</td>
<td>4</td>
<td>4</td>
<td>$-15.3 \pm 1.6$</td>
<td>15.9 $\pm$ 1.5</td>
</tr>
<tr>
<td>Marine algae</td>
<td>2</td>
<td>2</td>
<td>$-15.7 \pm 2.3$</td>
<td></td>
</tr>
<tr>
<td>Terrestrial fauna (guanaco)</td>
<td>6</td>
<td>1</td>
<td>$-19.5 \pm .6$</td>
<td>5.0 $\pm$ .9</td>
</tr>
<tr>
<td>C3 wild vegetation</td>
<td>14</td>
<td>11</td>
<td>$-26.6 \pm 2.9$</td>
<td></td>
</tr>
<tr>
<td>C3 cultigens</td>
<td>6</td>
<td>6</td>
<td>$-26.6 \pm 1.6$</td>
<td></td>
</tr>
<tr>
<td>C4 cultigens (maize)</td>
<td>1</td>
<td>1</td>
<td>$-11.2$</td>
<td></td>
</tr>
</tbody>
</table>

the retention of the original biogenic indicators in bone. In the case of apatite, the comparison between teeth (which are less exposed to diagenesis) and bones from the same individuals shows a correspondence between them and leads us to believe that the processing procedures were adequate and that the structural indicators of carbonate yield reliable results (Falabella et al. 2007). While we cannot completely rule out diagenetic contaminations in the case of $^{18}O$, we believe that if these were to exist, they would not obscure the differences between individuals who drank water with markedly different isotopic values.

Results and Discussion

With the exception of two cases in which reliable collagen was not obtained, the 20 individuals sampled from nine archaeological sites (table 2) provided material without evidence of diagenetic changes. These samples are not considered to represent whole populations but only individuals. While the number of samples available for analysis is small, the results allow us to discuss the hypotheses that have thus far attempted to explain the subsistence and mobility of these groups and to review, from a new perspective, the data that were used to formulate them.

Our first result is the apparent nonexistence of a marine-based diet during the Archaic period. Archaic peoples from the coast have $\delta^{13}C$ and $\delta^{15}N$ values, which indicate that marine resources were not a regular part of their diet (table 2). Marine fauna, including those from lower trophic levels, have much higher $\delta^{13}C$ and $\delta^{15}N$ average values than the four sampled individuals (table 1). People who consume these types of resources have both enriched C and N due to the baseline values of marine fauna and the N isotope fractionation that occurs with each trophic level (+3‰), even though these resources do not constitute 100% of the diet. Archaic period Chinchorro populations of the northern coast of Chile give clear examples of this ($\delta^{15}N$, 23.0‰; $\delta^{13}C$ collagen (Ccol),
Figure 2. Variation in $\delta^{18}O_{\text{SMOW}}$ of the average annual groundwater from precipitation from the coast to the cordillera, relative to the increase of altitude above sea level (adapted from Moser et al. 1972). SMOW = standard mean ocean water.

$-11.9\%o$), as well as people along the Patagonian coast line ($\delta^{15}N, 20.0\%o; \delta^{13}C_{\text{coll}}, -12.1\%o$), yielding isotopic values that leave no doubt that marine resources were consumed (Tieszen, Iversen, and Matzner 1992; Borrero and Barberena 2006). On the other hand, results from analyzed individuals from central Chile ($\delta^{15}N$ ranging from $7.0\%o$ to $13.1\%o$; $\delta^{13}C_{\text{coll}}$ ranging from $-17.6\%o$ to $-19.8\%o$) suggest that consumption of marine resources was at best occasional or circumstantial and cannot in any way be considered to reflect a “marine adaptation.”

These results are consistent with the expectations for the earliest coastal occupations, which had been interpreted as representing initial contact by inland hunters and gatherers, as is the case for individuals of the earliest phase of site LEP-C (samples 1 and 18; Ramírez et al. 1991; Falabella and Planella 1991). This is not expected for individuals of later time periods (represented by samples 3 and 7), for which we had expected strong indicators of a marine diet. Our results show values of a predominantly terrestrial diet for individuals 1 and 3. The other two samples (7 and 18) show a slight increase in both the $C_{\text{coll}}$ and $N$ as well as less collagen-apatite spacing, reflecting a minor contribution of marine protein to the diet as well as individual variability.

The proposal of a marine-based diet was based on both the existence of sites on the coast and the presence of mollusk shells—which increased in size after the initial phase—as well as on fish and marine mammals in site refuse. Our sample includes only four individuals, and our results suggest that this evidence is not sufficient to infer a “marine adaptation.” The abundant presence of mollusks in sites evidently indicates that they were consumed at some time, but their great “visibility” in the archaeological record has led to an exaggerated emphasis of their importance in the diet. Along these lines, from the isotopic values obtained for the Archaic period, it is more reasonable to propose a very occasional utilization of marine resources, more in keeping with the idea of circumstantial procurement based on availability (e.g., oyster [Argopecten purpuratus] embankment) rather than a well-developed procurement strategy. In fact, there is no record of a specialized technology for the exploitation of marine resources for the coastal sites of central Chile, such as is observed at Norte Chico or on the southern coast (Llagostera 1989; Quiroz and Sánchez 2004); the only examples of fish hooks and net sinkers are found for later time periods. Of course, we cannot generalize that this situation applies to other coastal settlements on the basis of four individuals from a single site, but we would like to emphasize that this isotopic analysis is consistent with the data from Archaic artifact assemblages in central Chile.

Reviewing the results of $\delta^{18}O$ values (table 2; figs. 1–3) is even more surprising. These are entirely consistent with the expectations for peoples who regularly ingest local waters from the coast ($\delta^{18}O_{\text{SMOW}}, -3.5\%o$ [SMOW = standard mean ocean water]) and very different from the expectations for peoples who move between coast and inland, where the values for water are substantially lower (Moser et al. 1972). The data suggest that these four individuals who, contrary to what had been assumed, did not in fact come from the central inland area but rather spent at least the latter years of their lives living on the coast. The consistency of the value of the $\delta^{18}O$ of bone samples with that of local waters, however, opens up
the possibility of diagenetic contamination, which should be further examined in the future.

For the moment, these data present a scenario that is particular to central Chile, where there would have been populations occupying the coast without developing a marine adaptation per se and with mobility that would not have included inland forays. In this manner, one might posit a north-south movement along the coast; however, comparisons of the technological differences between assemblages from central Chilean contexts to those from coastal sites farther north and farther south, do not support this idea. Thus, it is likely that coastal hunters and gatherers of this period had developed a subsistence pattern with movement confined to areas directly adjacent to the coastline, using a broad range of available terrestrial resources in that area.

The relatively restricted east-west movement suggested by the results of the coastal δ18O samples is conducive to a discussion of a second problem relevant to this paper: the settlement pattern of hunters and gatherers during the Archaic period in general.

Contrary to the coastal pattern, the values of δ13C for bones analyzed for three individuals from sites in the Andes Cordillera are very disparate, with a range between −4.8‰ and −7.2‰ (table 2; fig. 3). These values have far greater positive values than those of the lowland samples, and they are considerably distant from the values of the highland waters (δ18OSMOW between −9.8‰ at 1,300 m a.s.l. and −17.3‰ at 4,200 m a.s.l.; fig. 2; Moser et al. 1972). Unlike the coastal data, these results cannot be attributed to sample contamination; all indicators point to the fact that the bones do not correspond to local waters. This suggests that these three highland individuals were only occasional inhabitants of the Cordillera and that the water they customarily drank had different characteristics. That is to say, they must have either traveled through different regions or inhabited different places during variable time periods. The range of travel could have been either eastward or westward, since both directions feature considerable distance from the values of the highland waters.

The values of δ15N also are disparate (table 2). Nitrogen is highly sensitive to climatic change, as well as to such variables as altitude and latitude. A very low value, such as that recorded for the Queltehues sample (δ15N, 3.9‰), together with a high Δδ18OCap (8.5), at first glance indicates a low consumption of meat. On the other hand, the enrichment of C is in both the collagen and the apatite, which would indicate a more enriched diet than the one we have attributed to the wild resources of central Chile during this time period. These values, thus, can be associated to a different climate, such as the

Table 2. Isotopic indices for analyzed individuals

<table>
<thead>
<tr>
<th>Context, site, individual no.</th>
<th>Date (of individual and site)</th>
<th>δ13Ccap</th>
<th>δ18O</th>
<th>δ13Ccollap</th>
<th>δ15N</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Archaic, coast:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LEP-C-1</td>
<td>pre-2000 BC</td>
<td>−19.4</td>
<td>9.0</td>
<td>−11.5</td>
<td>7.9</td>
</tr>
<tr>
<td>LEP-C-3</td>
<td>2000–300 BC</td>
<td>−19.8</td>
<td>7.0</td>
<td>−11.2</td>
<td>8.6</td>
</tr>
<tr>
<td>LEP-C-7</td>
<td>2000–300 BC</td>
<td>−17.9</td>
<td>11.7</td>
<td>−11.8</td>
<td>6.1</td>
</tr>
<tr>
<td>LEP-C-18</td>
<td>pre-2000 BC</td>
<td>−17.6</td>
<td>13.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Archaic, lowland valleys:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cuchipuy-2</td>
<td>5000–2500 BC</td>
<td>−18.5</td>
<td>12.8</td>
<td>−11.0</td>
<td>7.5</td>
</tr>
<tr>
<td>Cuchipuy-3</td>
<td>5000–2500 BC</td>
<td>−19.1</td>
<td>11.0</td>
<td>−11.3</td>
<td>7.8</td>
</tr>
<tr>
<td><strong>Archaic, highlands:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Los Hornos</td>
<td>2620–2460 cal. BC</td>
<td>−17.7</td>
<td>n/d</td>
<td>−11.4</td>
<td>6.3</td>
</tr>
<tr>
<td>Queltehues</td>
<td>n/d</td>
<td>−17.9</td>
<td>3.9</td>
<td>−9.4</td>
<td>8.5</td>
</tr>
<tr>
<td>La Paloma</td>
<td>1425–1190 BC</td>
<td>−19.2</td>
<td>7.6</td>
<td>−12.5</td>
<td>6.7</td>
</tr>
<tr>
<td><strong>ECP lowland valleys:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lenka Franulic-1</td>
<td>170 BC–130 cal. AD</td>
<td>−20.9</td>
<td>n/d</td>
<td>−11.9</td>
<td>9.0</td>
</tr>
<tr>
<td>Valle Verde-2</td>
<td>400 BC–AD 200</td>
<td>−20.1</td>
<td>5.5</td>
<td>−10.0</td>
<td>10.1</td>
</tr>
<tr>
<td>Valle Verde-5</td>
<td>400 BC–AD 200</td>
<td>−19.8</td>
<td>4.3</td>
<td>−12.8</td>
<td>7.0</td>
</tr>
<tr>
<td>Valle Verde-6</td>
<td>370–110 cal. BC</td>
<td>−20.3</td>
<td>3.8</td>
<td>−13.5</td>
<td>6.8</td>
</tr>
<tr>
<td>Valle Verde-7</td>
<td>n/d</td>
<td>−20.3</td>
<td>4.1</td>
<td>n/d</td>
<td>n/d</td>
</tr>
<tr>
<td>Valle Verde-9</td>
<td>390–180 cal. BC</td>
<td>−20.2</td>
<td>4.1</td>
<td>−12.3</td>
<td>7.9</td>
</tr>
<tr>
<td>Valle Verde-12</td>
<td>400 BC–AD 200</td>
<td>−19.6</td>
<td>5.2</td>
<td>−12.7</td>
<td>6.9</td>
</tr>
<tr>
<td>Cuchipuy-1</td>
<td>ca. AD 600</td>
<td>−15.2</td>
<td>7.2</td>
<td>−9.8</td>
<td>5.4</td>
</tr>
<tr>
<td><strong>ECP highlands:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>La Batea</td>
<td>60 BC–AD 1035</td>
<td>−19.7</td>
<td>3.8</td>
<td>−13.5</td>
<td>6.2</td>
</tr>
<tr>
<td>Chacayes-1</td>
<td>680–900 cal. AD</td>
<td>−18.6</td>
<td>7.6</td>
<td>−10.3</td>
<td>8.3</td>
</tr>
<tr>
<td><strong>LICP highlands:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chacayes-2</td>
<td>1310–1460 cal. AD</td>
<td>−11.3</td>
<td>5.6</td>
<td>−6.7</td>
<td>4.6</td>
</tr>
</tbody>
</table>

Note. δ13Ccoll is the collagen value, δ13Cap is the bone apatite value, Ccol-ap = Ccol-apatite, n/d indicates that no data is available; and italicized date indicates individual’s accelerator mass spectrometry (AMS) date. ECP = Early Ceramic period, and LICP = Late Intermediate Ceramic period. ‘d’ value obtained from the AMS dating lab.
The low values of $\delta^{13}C$ indicate that there was no consumption of C4 plant species. Unfortunately, we have no data for N, which would determine whether this reflects sedentarism itself or a restricted mobility within a limited geographical area from which these isotopic values of water would be derived. However, the practice of horticulture is consistent with reduced mobility involving either of these possibilities. The cultivation of quinoa does not impose the same restrictions as growing other crops (e.g., corn) that require continuous care, but one needs to find and prepare an adequate place for its cultivation and return cyclically to harvest it at certain times of the year (Falabella, Planella, and Tykot 2008); this would anchor a population to certain parts of the landscape.

The change in diet observed toward the end of the first millennium BC may have had its origin in various environmental and social situations. Paleoenvironmental data for the region do not indicate any changes that might have impacted the availability of resources during this time period (Jenny et al. 2002) nor, at least in the highlands, is there any evidence of a decrease in fauna, such as guanaco, (L. Cornejo, personal communication). What does remain clear, however, is that the appearance of pottery—represented in the ICC populations—is not associated with a widespread horticultural process in central Chile and that horticulture at this particular time seems to have been restricted to quinoa.

Despite being based on a sample of only two individuals...
(La Batea and Chacayes), the last point we would like to emphasize is that maize was not consumed regularly by all peoples in the Andes Cordillera during the Early Ceramic period after AD 200, despite the proximity of maize-eating and non-maize-eating populations. This suggests that some groups continued the traditional hunting and gathering subsistence during later times. The La Batea sample shows a hunter-gatherer isotopic profile with a C3 diet ($\delta^{13}C_{\text{coll}} - 19.7\%$ and $\delta^{15}N_{\text{cap}} - 13.5\%$). On the other hand, the $\delta^{15}N (3.8\%)$ and $\delta^{18}O (-5.1\%)$ suggest mobility and only occasional highland occupation. The sample from Chacayes shows slightly more enriched values ($\delta^{13}C_{\text{coll}} - 18.6\%$ and $\delta^{15}N_{\text{cap}} - 10.3\%$), especially in apatite, that denote occasional supplements of C4 plants and a $\delta^{15}N$ value (7.6%) that is consistent with consumption of animal protein. This fact changes within this same highland area, at least for some individuals in the Late Intermediate period (AD 1000–1450) as observed in the results for the sample from the latest period at Chacayes, which show abundant consumption of C4 plants similar to contemporaneous populations in the lowlands (Falabella et al. 2007). While N decreases, the small collagen-apatite spacing suggests that animal protein persists in being a substantial dietary component. The values of $\delta^{18}O$ for the two Chacayes individuals are different from each other and show disparity between other cordilleran samples and are lower than would be expected for people who permanently live in the highlands.

Conclusions

It has become evident that the analysis of stable isotopes has the potential to address issues much broader than diet and the introduction of maize. The interpretations presented here have initiated a discussion on a range of topics relevant to understanding the sociocultural dynamics of groups that occupied central Chile during the Archaic period and the beginning of the Early Ceramic period. Topics such as marine adaptation, the beginnings of food production, and the contemporaneous practice of two different subsistence strategies during the Early Ceramic period have been reexamined and reconsidered, notwithstanding our analysis being based on a very small sample. Isotopic results have shown that Archaic populations from the coast, while living near the sea, did not develop a marine subsistence altogether, but incorporation of marine resources into the diet was occasional and variable.

We have provided evidence of restricted mobility within certain environments for populations living on the coast and lacustrine areas of the lowlands. On the other hand, we have identified a greater mobility for hunter and gatherers inhabiting the highlands only seasonally. Our results have supported the onset of sedentarism in the lowlands for the early horticultural populations and have provided data on their probable dietary sources. And finally, we have demonstrated the coexistence of hunters and gatherers with horticultural groups.

In so doing, we have outlined a direction for future research that should involve analysis of a larger sample of individuals from the Archaic period and the initial stages of the Early Ceramic period, as well as of populations that inhabited the highlands. This will provide us with a more solid basis to evaluate these results, determining whether they characterize the time period or merely represent anomalies.

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