SOUTHBOUND

Late Pleistocene Peopling of Latin America

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Late Pleistocene Peopling of Latin America

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Introduction

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INTRO

The Debate at the Beginning of the 21st Century on the Peopling of the Americas

Laura Miotti[1], *Nora Flegenheimer*[2], *Mónica Salemme*[3], *and Ted Goebel*[4]

A meeting on the late-Pleistocene peopling of the Americas held November 2010 at La Plata, Argentina, was the fifth in a series of international symposia on this topic originally organized by Mexican scholars. This book and the bonds established between archaeologists are two main results this event produced. Both of them are crucial to the development of this area of inquiry and in different ways are relevant to filling the gaps in research on the early peopling of South America and the entire continent. Most of the papers in this book focus on southern South America. (At the conference the geographic focus was better balanced, and several papers on topics from Siberia, North America, and even Australia were presented.)

To appreciate the value of these contributions they should be placed in context. From our perspective, the knowledge gathered in the last hundred years about the peopling of the Americas has developed according to the perspectives of central and peripheral cultures (Anglo-Saxon and Latin America). We are convinced that archaeologists are builders of concepts, identities, and cultural images, and that the viewpoint underpinning archaeological research shapes its development. Consequently the cultural heritage of researchers is equally as important as their academic traditions. This book compiles papers from different Latin American archaeologists, anthropologists, and paleoecologists in an attempt to bridge divisions between the academic

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environments of the central countries and those of Latin America. Although current trends in globalization sometimes are perceived as veiled colonialism, the challenge nonetheless is to introduce both basic information and theoretical perspectives into the arena of international discussion, because very often this scientific discourse has been narrowly confined to the country of its inception. In the past archaeological science in Latin America related to the peopling of the New World has been strongly influenced by its colonial past and by the Native and African-American peoples that compose a large part of the population. Archaeologists, including those interested in early peopling, are nowadays becoming increasingly aware of the political implications of their work, and they are becoming committed to freeing their research from the parochial confines of their mother country.

In this book, authors present the highlights of selected reports and discussions from the La Plata meeting (including archaeology, genetics, cranial morphology, paleoenvironments, and history), all bearing on the significance and context of First Americans research in Latin America.

First Americans research has been quickly growing in volume and scope in recent years, with the result that national meetings now routinely include sessions focusing on the dispersal of humans in South America. This situation differs from the archaeology of North America—particularly of the U.S.—where theoretical and methodological advances made possible by support from academia were further assisted by public and government agencies intent on justifying and legitimizing their interests.

First Americans research is important in its wide geographical application and its consequences on an even wider scale. To understand the early peopling of the Western Hemisphere, scholars necessarily must be aware of information produced in numerous countries and published not just in English but also in Spanish, Portuguese, French, and even Russian. This enormous barrier—language—has prevented sharing vitally important data. Many publications circulate only locally, and although new ideas and information generated from the study of early sites is known and readily available within the researcher's mother country, too often the work is unknown elsewhere in the world. South American archaeologists have access to articles published in well-established journals and books from the Northern Hemisphere (which sometimes translate the articles into other languages). North American archaeologists, however, do not have ready access to information and ideas published in Latin America. Even though information is becoming more widely circulated every year, poor communication among different countries remains an obstacle to science and is sorely in need of further improving.

Latin American Archaeological Research Today

To illustrate the growth in information and ideas in First Americans research in Latin America, Figure 1 graphically shows the content of presentations given at the five recent international symposia "Early Man in America" since 2002. Presentations grew in number from 32 in 2002 to 132 in 2010. The number of contributions in archaeology, always the most popular topic, has increased from a low of 11 to a high of 41. Methodological papers increased from 4 to 23, and theoretical papers presenting or reviewing continental-scale or regional-scale models grew from 3 to 18. The last meeting saw remarkable growth in cultural-material studies. Perhaps most important is the tremendous increase in the number of participating countries, thereby enriching and enlarging the theme, spawning diverse ideas, and energizing sparkling discussion among participants.

The past five years particularly have witnessed major changes in archaeological thought

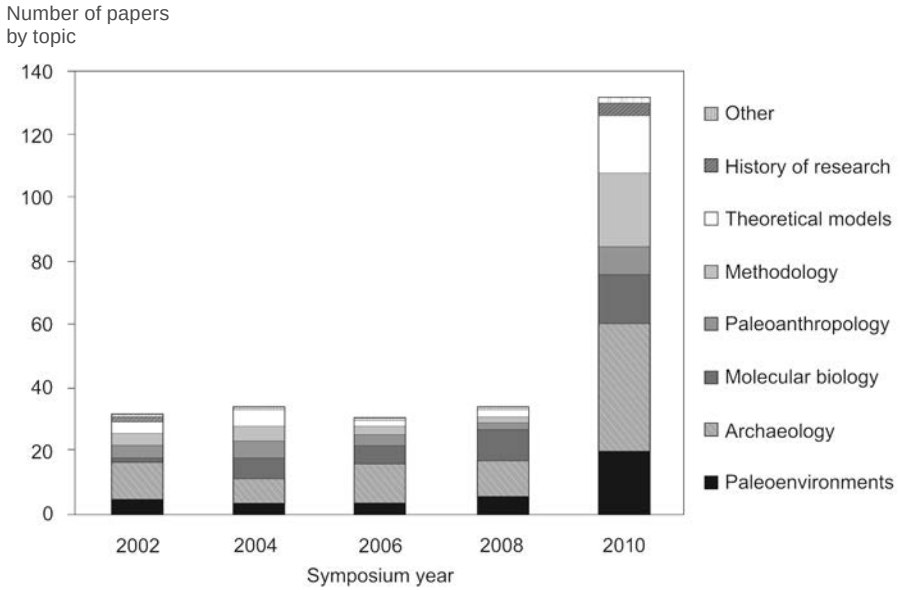

Figure 1. Bar graph showing variety and distribution of research themes presented at the "Early Man in America" symposia during the past decade, 2002–10.

among Latin Americanists. We have seen an increase in research productivity and significant improvement in the quality of scholarship. The far-reaching implications of these improvements are visible in expanded curricula in schools and in an awakening of public interest, which in turn have promoted further growth in archaeological science and related disciplines throughout Latin America. In particular, we have seen encouraging growth in new archaeological, biological, and radiocarbon data, new methods and theories, interdisciplinary research, and the number of research teams composed of members from different countries. We can credit this scientific progress to maturing academies and improved communication among institutions and scientists.

The Future

More than five decades ago, North American archaeologists recognized that the earliest trademark for the First American was the Clovis point (Wormington 1957); today we can confidently assert that the earliest Latin American trademark was significant diversity in material culture and human adaptation. Furthermore, as Bryan previously hypothesized (1973), tropical forests and mountains would not have been barriers for early colonizers. Now and in the future we can effectively address questions about when and how people dispersed across Latin America.

How do we perceive Central America? Perhaps it should be considered as a buffer zone, probably a corridor or land bridge for populations moving between the two continents; thus this area could show major archaeological conformities with one or possibly both hemispheres.

The VI Symposium, Colombia!

We propose that the current interdisciplinary, international effort be continued in the future. We believe it is crucial to construct the optimum framework for cataloguing and dovetailing

reports from various disciplines and for disseminating new knowledge produced in different countries since the last previous event. A quite successful venture in this regard was a thematic session held September 2011 during the UISPP Congress in Brazil. It served as an effective bridge between researchers and institutions of the last "Early Man in America" symposium and the next. We expect that the VI symposium, to be held in Colombia in 2012, will benefit from further development of ways to share new ideas.

We sincerely thank the authors who, by contributing their research findings, have enlarged our knowledge of the First Americans and made this volume possible.

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Part 1
Peopling Models and Bioanthropology

PART 1

PART 1

PART 1

The Impact of Early Man Debates on Argentine Archaeology around 1900

Irina Podgorny[1]

➤**Keywords:** Classification criteria, museum studies, history of archaeology

This paper argues that the coming into being of the supposedly fossil man found in the Tertiary beds of the Pampas created a paradoxical context. Whereas it attracted international interest in Argentine findings, it radically transformed the practice of local archaeology (Podgorny 2005). Historiography had rooted this transformation in Aleš Hrdlička's rejection of the evidence of early man in South America. As this paper proposes, however, Hrdlička's impact on the Argentine practice of archaeology and anthropology was overvalued, creating an argument that veiled the dynamics of the practice of science.

In the late nineteenth century, "prehistoric man" as a scientific object had emerged on the borders of scientific legitimacy. Fake prehistoric objects abounded in Europe and the Americas, where it was difficult to assess the character of those objects arriving from an unknown past. At stake was what, why, and whom to believe. In Argentina—as everywhere—scientific societies appointed commissions to judge and evaluate a rather controversial kind of evidence (Cohen and Hublin 1989; Coye 1997; Podgorny 2000a; van Riper 1993). After the acceptance of fossil man late in the 1850s, prehistory was consolidated in Europe by creating a common sequence of human stages to be applied to the most remote periods of the human past. While some prehistorians proposed that sequences had only a local meaning, others advocated the universal character of the earliest human technological stages. In the U.S., for instance, William Holmes "rejected the effort to establish New World archaeological periods of technology to parallel those of Western Europe" and assumed that "Paleolithic man had never existed in North America" (Hinsley 1981:105). In Argentina, however, naturalists supported local man's great antiquity, partially owing to the presence of two European promoters of the "interna-

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tional movement of prehistory": Giovanni Ramorino and Pellegrino Strobel, Italian professors of natural history in Buenos Aires, who early in the 1870s reported "prehistoric news" to Europe and also encouraged local naturalists to search for prehistoric artifacts. Ramorino was a patron to scholars. One, an Italo-Argentine schoolteacher named Florentino Ameghino (1854?–1911), late in the 1870s reported on the association of fossil mammals with objects of human manufacture (Podgorny 2000a, 2009).

Moreover, since the 1850s French collectors led the trade in fossil mammal bones from the Pampas. For them, "prehistoric man" was another object to be offered to the museums. In a context where the search for "prehistoric objects" was seen as a mere attempt to create a new commodity for the European market of natural history, Ameghino's reports were not fully accepted. Pursuing further legitimacy, in 1878 Ameghino attended the International Exposition in Paris, where he exhibited the evidence of the "Man of the Great Armadillo," sold part of his collections, and became trained in geology and the classification of fossil mammals. In 1880 Ameghino published *La antigüedad del hombre en el Plata*, describing the methods of geological archaeology to be applied in Argentina and Uruguay. Ameghino returned from Paris in 1881, having arranged the local prehistoric tools in a sequence inspired by the model proposed by Gabriel de Mortillet, which patterned the whole Argentine prehistory in parallel with the European sequence (Podgorny 2000b, 2009).

Once in Argentina, Ameghino included in the sequence several deposits from the Plata basin (Ameghino 1885). He was then appointed assistant director to the newly established Museo de La Plata (Podgorny and Lopes 2008), where he shifted his interest to the earliest Patagonian mammals. In 1887 Ameghino broke with Museo de La Plata researchers, starting a war—comparable to the U.S. "bone wars"—in describing the most primitive mammals of Patagonia (Brinkman 2010, Podgorny 2002). As a result, Ameghino published his *Contribución al estudio de los mamíferos fósiles* (1889), which included a rather sophisticated classification of local prehistory that was his last work devoted to the topic. The "fossil mammal rush" of the 1890s gave birth to hundreds of new fossil species, new genera, and also uncountable debates over the age of the Patagonian stratigraphic beds and the origin and distribution of mammals (Podgorny 2005; Simpson 1984).

As for his research, Ameghino returned to the subject of mankind. In 1884 he had sketched a theoretical phylogenetic tree, describing man's hypothetical ancestors and predicting the species to be found in the years to come. As Director of the Museo Nacional de Buenos Aires (1902–11), Ameghino described supposedly human fossil remains from the Pampas. The hypothetical genus of the 1880s then became an actual species; the Old World fossil specimens (Spy, *Pithecantropus erectus*, Heidelberg) became offspring of the Homunculus from Patagonia; and the anthropomorphic apes became bestialized forms of man (Podgorny 2005).

Ameghino's proposals were received as a matter of fact by educators working at the newly established University of La Plata; some Argentine newspapers created a favorable context for accepting the local origin of all humankind. As analyzed elsewhere (Podgorny 1997, 2005), Ameghino's ancestors of man were discussed in several languages and scientific meetings; for several years they attracted worldwide attention. All over the anthropological world, casts of the South American human ancestors circulated in different academic circles to analyze their morphology.

Ameghino's interpretations, however, were far from being generally accepted by scientists either from Argentina or abroad. Aleš Hrdlička's visit to Buenos Aires in 1910 has to be framed in this world of facts and doubts (Podgorny and Politis 2000). Hrdlička's rejection of the evi-

dence could have been conclusive for the North American anthropological field, but it was not definitive for European anthropologists who analyzed the evidence following their own methods and hypothesis (Podgorny 2005). Ameghino replied only to the European responses. His death in 1911 meant that he avoided reading Hrdlička's conclusions published in 1912 in a book that did not circulate among Argentinian scholars. In this sense, the impact of Hrdlička on Argentine anthropology still deserves further study.

Moreover, Ameghino would soon become a national icon. During the Great War, Argentine socialists, some writers, and philosophers began to promote Ameghino as an example of the evolution of Argentine thought. In this context, the debates about the Tertiary man of Buenos Aires, an idea held by his brother Carlos in the 1910s, was interwoven with cultural disputes, confining the issue within national boundaries. These unsolved controversies and the so-called "ameghinismo," i.e., the honors paid to the national savant, shaped the classification of anthropological and archaeological collections of Argentina's museums. Geographical criteria replaced the contested 19th century geochronology and French-shaped sequences in the displays and school books (Podgorny 1999). This drift from chronology to geographical distribution was partially a result of the controversial character of Early Man findings in the Pampas. Ameghino could hardly have imagined that his endeavors to include time in his findings would turn into the rejection of time as the crucial dimension of local archaeology, something that would survive even when the Ameghinian debates were almost forgotten.

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GIS Model of Topographic Accessibility to South America

PART 1

Lucía Magnin[1], *Diego Gobbo*[2], *Juan Carlos Gómez*[3], *and Antonio Ceraso*[4]

➤**Keywords:** South America, topographic accessibility, first Americans

In this paper we analyze the surface of South American territory to create accessibility models (Llobera 2000) related to two different theoretical models of the entrance routes to the South American continent, as described in detail in Miotti and Magnin ("South America 18,000 Years Ago: Topographic Accessibility and Human Spread," this volume). The accessibility models are drawn at a continental scale and seek to incorporate data useful as proxies of the environment at the Last Glacial Maximum (LGM) (ca. 20,000–18,000 RCYBP) (Miotti 2006).

The methodology employed here is oriented toward delimiting natural corridors of low resistance to pedestrian movement for the South American continent using GIS. It differs from the calculation of least-cost paths because it does not show the shortest path to link one origin and one destination point. Instead, the corridor is a surface which, owing to its ease of accessibility, is potentially usable as a pathway (Cerrillo 2008; Llobera 2000, 2006). The objective is to use present topography to model ancient coastlines (Isla and Bujalesky 2008), to take into account the extension of glacial masses (Clapperton 1983; Hollin and Schilling 1981; Rabassa 2008; Stanford et al. 2005) as barriers to passage, and to use topography as a surface to calculate access costs (Llobera 2000).

The specific objective of this work is to generate two predictive maps, one considering rivers as partially permeable barriers, and the second considering rivers and marine coasts as movement stimulators.

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Data and Methods

The general methodology used here is the Optimal Displacement Model delineated by Fábrega (2006). However, we depart from that author´s perspective because in our model the origin points are not archaeological sites, but random points within a grid of polygons that cover the study area.

This analysis does not seek to establish optimal access between sites (for an example of this approach see Anderson and Gillam 2000), but to characterize the terrain according to its natural accessibility irrespective of the point of origin for the movement, thus generating a model for natural mobility. This methodology based on a grid of random points was previously applied at a different scale to another study problem by Cerrillo (2008).

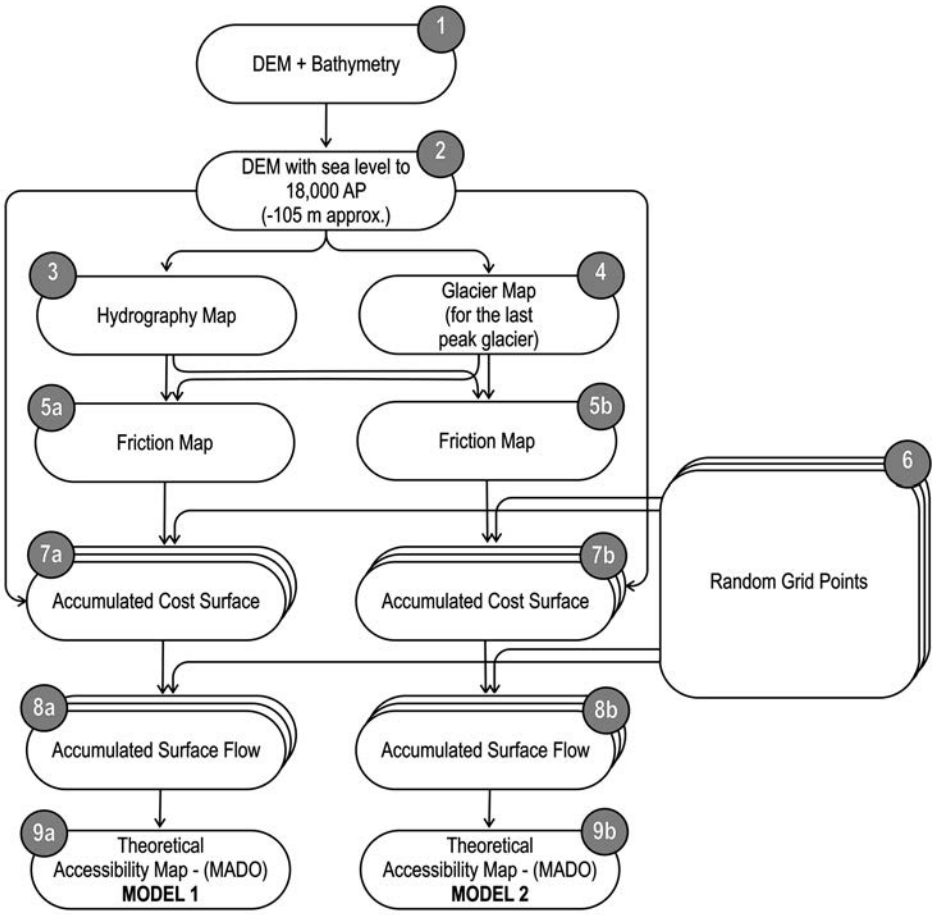

Figure 1. The input data, reprocesses applied, and models obtained in the GIS analysis.

In this contribution we use SIG (ArcMap-9.2 and Grass-6.4) to model the main accessibility characteristics that the South American territory could have presented during the LGM. The

different processes applied can be viewed in the diagram in Figure 1. Owing to the flexibility of GIS (Geographic Information Systems) in managing, testing, and revising models, the data used here can be revised in the future. The analysis followed through nine steps, as described below.

1. As basic data we used a digital elevation model GEBCO_08 Grid. This is a three-dimensional model of ocean bathymetry and emerged topography with a spatial resolution of 30 arc-seconds (each pixel measures 945.44 m on each side). These data and all products were projected to WGS 1984 UTM Zone 20S.

2. These basic data were used to model the extent of land area in the LGM. Sea level was set at 105 m below present level (Isla and Bujalesky 2008). The resulting grid file has 6109 columns and 8993 rows. This modeling procedure is a simple device that models shorelines broadly; however, it is a simplification of a reconstruction process (Waters 1992, Dincauze 2000).

3. The hydrographic network was modeled by the module ESRI ArcHydro-1.3 via the command for calculating accumulated flow. The resulting hydrographic network is a raster file composed by continuous-flow accumulation values. The lower values do not represent a significant barrier to the passage, and conversely, higher values constitute a potential barrier to be crossed by purely pedestrian means.

4. The extent of glaciers as barriers was incorporated into the model from the scanning, georeferencing, and orthorectification of maps published in Rabassa (2008:163) and Stanford et al. (2005:338).

5. From the digital elevation model (2), hydrography map (3) and glacier map (4), two friction surfaces were generated. In Figure 1, the friction map "5a" expresses extremely low accessibility values for glaciers (considered barriers to passage); accessibility values for rivers become lower as their cumulative flow values increase from the headwaters to the mouths. The friction map "5b" also considers glaciers as barriers to access, but it assigns high accessibility values to the network of rivers and a coastline of 50 km around the perimeter of the continent, which are considered attractors to movement.

6. A regular grid of polygons of 300 by 300 km was generated to cover the entire study area, and one point was randomly chosen within each polygon (N = 244).

7. Each of these points in turn was set as the origin to generate a cumulative cost surface using the GRASS module "r.walk" (http://grass.fbk.eu/grass70/manuals/html70_user/r.walk.html). This algorithm is superior to others because it includes Naismith rules for calculating cost estimates of specific slope intervals, it makes anisotropic estimates, and it resolves the tendency to generate polygonal artifacts in the resulting surfaces using the "chess knight's move" (Whitley and Burns 2007). In Figure 1, the cumulative cost surface maps resulting from the use of friction map 5a were named "7a," and the maps resulting from the use of friction map 5b were named "7b".

8. Using each accumulated-cost surface map, flow-accumulation surface maps were generated using the GRASS module "r.watershed," setting the remaining points of the grid as the origin, and establishing the destination point by the accumulated-cost surface map used every time. This was achieved using a python script, which automates the process of calcu-

lating the cost maps (r.walk) and flow-accumulation map (r.watershed).

9. The final step is summing the accumulated flow surface maps derived from the friction maps ("5a" and "5b" in Figure 1).

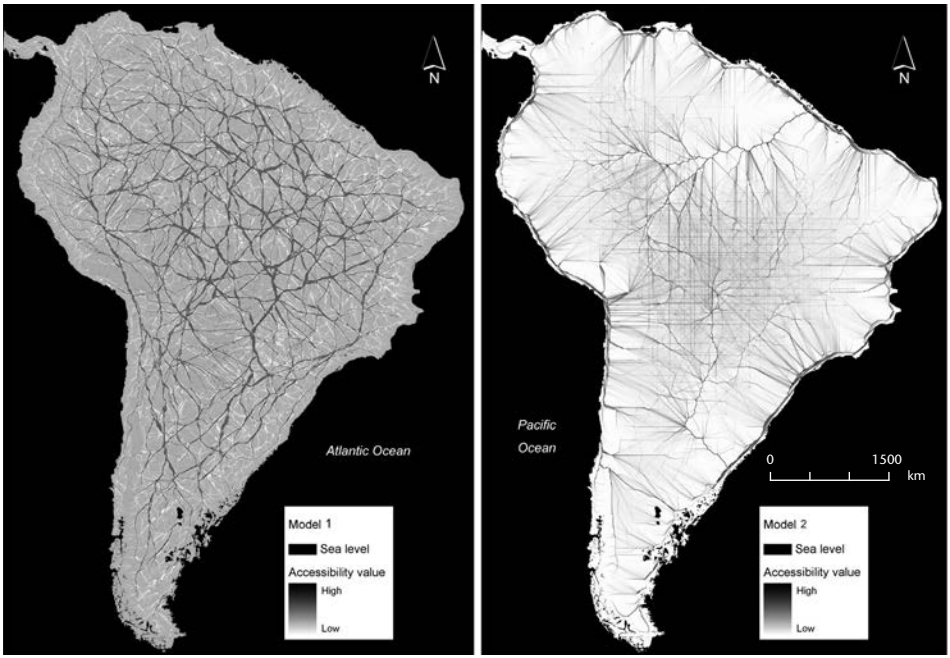

Figure 2. Dual accessibility models produced by the GIS analysis presented in text and Figure 1.

Results and Conclusions

Models of general accessibility of America were generated (Figure 2). These do not assume points of origin or destination for pedestrian population flow into the continent. They are continuous data surfaces with cells containing values that express areas of higher accessibility considering the total origin points analyzed.

This methodology proved to be a useful tool for creating a formal, reproducible description of two theoretical models of population movements of the first Americans, which is explored in more detail in Miotti and Magnin (this volume).

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PART 1

PART 1

South America 18,000 Years Ago: Topographic Accessibility and Human Spread

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➤**Keywords:** Human colonization, digital models, Pleistocene/Holocene, South America

Theorized entrance routes to the South American continent have been debated throughout the twentieth century (i.e., Martin 1973; Sauer 1944), and they are still being discussed and contested. Among the factors analyzed in the diverse theories are demographic considerations, paleoenvironmental conditions, the effect of natural barriers, the availability of resources necessary for survival, and various technologies used by the first colonizers. Most prevailing theories propose that populations either followed a strategy of terrestrial advance or moved along rivers and coastlines.

The models for settlement of early America therefore propose two fundamentally different lifeways for these highly mobile groups, terrestrially adapted (Martin 1973) and water adapted (Bryan 1978; Dixon 2000; Erlandson 2001; Fladmark 1983; Meltzer 1993). In the first case, human movements adhered to a terrestrial-advance strategy; in the second case, population movements followed rivers and coastlines (Miotti 2006).

Methodologically, models predicting possible routes have applied several lines of evidence, such as human craniometrics and genetic analysis (Meltzer 1993; O'Rourke and Raff 2010; Pucciarelli et al. 2006), demographic simulations (Gillam et al. 2007; Steele et al. 1998), and digital modeling of territorial analysis (Anderson and Gillam 2000).

This paper proposes a geographic digital-modeling approach, such as that suggested by Anderson and Gillam (2000). Our main goal is to contrast two digital models of terrain

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accessibility generated for South America presented by Magnin et al. (this volume), against archaeological data for the earliest occupations on the continent. The models contrast the two prevailing ideas concerning human dispersal across the continent (terrestrial vs. littoral and riverside). We assess both models and discuss objections to both.

It is reasonable to assume that during the colonizing process, areas with lower costs of access to humans were settled before areas naturally less accessible (Borrero 1995; Miotti 1998, 2006). Therefore people moving through the landscape would have chosen more-accessible paths, for example, flatlands, coastal plains, and river banks, rather than strenuous routes, such as mountainous terrain. We can also assume that glacial masses were barriers to general movement. After analyzing the data, we will discuss whether one of the models better fits the data, evaluate the predictive potential of both models, and finally assess alternative models for human dispersal across the continent.

Data, Method, and Results

The data include two digital models (Figure 1) and a set of geo-referenced archaeological information. The digital models are raster maps whose individual cells contain accessibility values presented in Magnin et al. (this volume). They were generated based on (1) estimated bathymetry for the span ca. 18,000–9000 RCYBP, (2) inland altitudinal values (masl), and (3) glacial extent (Magnin et al. 2010, this volume). Archaeological data include 30 sites with reliable contexts dated to earlier than 10,500 RCYBP, when glacial withdrawals and re-advances took place (Rabassa 2008) (Figure 1).

The applied methodology assigns an accessibility value from each model to every site, by means of value extraction using Zonal Statistics in GIS Spatial Analyst (http://webhelp.esri.com/arcgis-desktop/9.2.), to obtain a value distribution for each model. The value obtained is not the localized pixel value of the precise location, but a median value calculated for a 10-km buffer surrounding the site. This method determines the accessibility of the territory immediately surrounding each site and avoids possible errors caused by assigning values to a very small area unit. The resultant distribution of values (Figure 2) shows that in model 1 most sites fit in the lowest accessibility-value bin, while in model 2 the highest number of sites fit in the second defined bin.

Discussion

According to the expected pattern (sites should be located in areas with highest accessibility values) the results indicate that the data fit model 2 better than model 1. Since we can assume that most of the coastal evidence from the earliest period is submerged today, inferences about population movements along the coast cannot be verified. The analyzed evidence could be valid, however, for showing that riversides were traveled intensely since the earliest times. These results, however, must be considered a first step in developing and testing models. Although we could detect trends in the data, we could not rule out or confirm any of the theoretical models discussed. Furthermore, the models may not be mutually exclusive (Miotti 2006).

We conclude that a GIS-based dispersal model is a thought-provoking way of analyzing archaeological data relating to early human occupations. It describes complex patterns of mobility as a digital map which can be analyzed to detect spatial trends in archaeological data. Future work and testing could lead to a better fit between the archaeological data and models.

Furthermore, the present study has launched an intense discussion of the South American data. Although definite patterns of site accessibility have emerged and model 2 had a higher

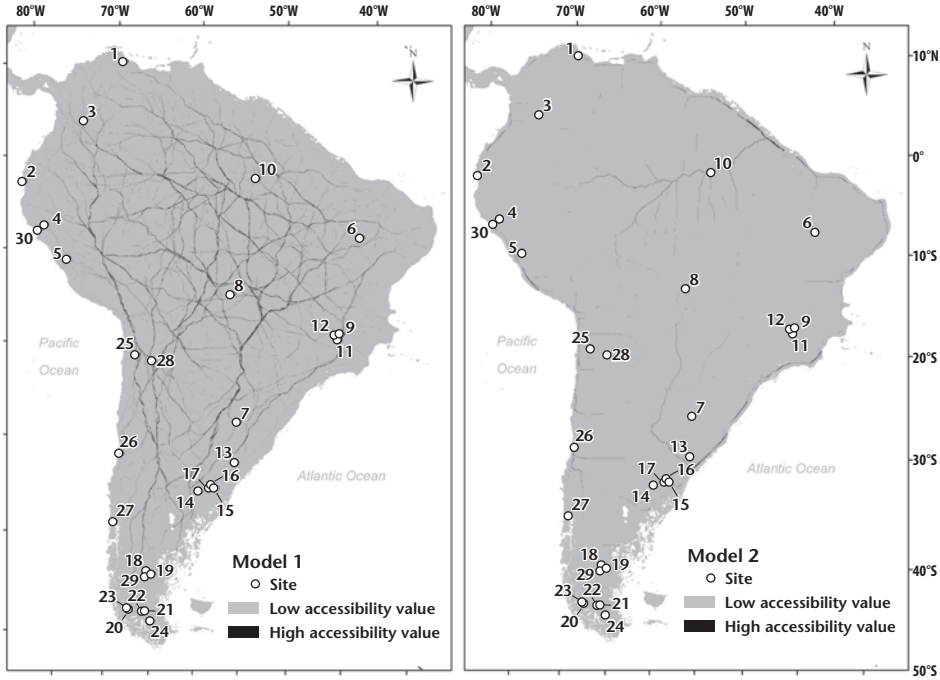

Figure 1. Archaeological sites located on model 1 and model 2 dispersal maps (generated by Magnin et al. (this volume). Accessibility values are symbolized in two classes (low and high) by the method of natural breaks. Sites:

1	Taima-Taima	**11**	Santana do Riacho	**21**	Fell
2	Vegas Temprano	**12**	Lapa Vermelha IV	**22**	Palli Aike
3	El Abra and Tibitó	**13**	Cerro de los Burros	**23**	Cueva Lago Sofia 1
4	Cumbe	**14**	Cerro La China 2	**24**	Tres Arroyos
5	Telarmachay	**15**	Cerro El Sombrero	**25**	San Lorenzo-Tuina
6	Pedra Furada	**16**	Los Pinos	**26**	Tagua-Tagua
7	Touro Passos	**17**	Arroyo Seco 2	**27**	Monte Verde
8	Santa Elina	**18**	Los Toldos	**28**	Hornillos 2
9	Lagoa Santa	**19**	Piedra Museo	**29**	Cerro Tres Tetas
10	Pedra Pintada	**20**	Cueva del Medio	**30**	Paiján

predictive value, it would not be right to assume that the location of early sites can be explained solely in terms of environmental variables (Kohler and Parker 1986). Instead, human choices may have been differently motivated.

Conclusions

In this paper we sought to find patterns of differential mobility and use of specific environments as a way to characterize the strategies employed by dispersing first Americans. The results favored model 2, the model representing water-adaptation strategies, as the model that better fits the analyzed data. The current discussion dealing with theories and methods, however, shows that in light of the great potentiality of the methods and the complexity of the issue, neither the terrestrial nor the water-based model can be rejected at the moment.

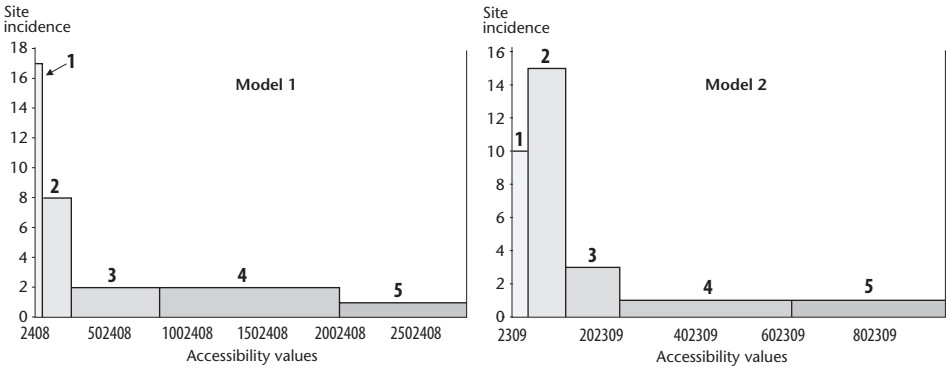

Figure 2. The quantity of sites registered in each of five bins defined by natural breaks in the accessibility values for model 1 and model 2. The following table lists the specific sites contained in each accessibility-value bin (see Figure 1 for site numbers).

Model 1

bin 1: site no. 3, 4, 7–12, 14–16, 19, 22, 24–25, 27–28
bin 2: site no. 1, 5–6, 13, 17, 23, 29–30
bin 3: site no. 2, 26
bin 4: site no. 18, 20
bin 5: site no. 21

Model 2

bin 1: site no. 1, 4, 8, 11, 14–15, 19, 26, 29–30
bin 2: site no. 3, 5, 6–7, 9, 10, 12, 13, 16–18, 22–23, 25, 28
bin 3: site no. 2, 21, 27
bin 4: site no. 24
bin 5: site no. 20

Future studies could incorporate archaeological and environmental data with more accurate dating to analyze which areas were repetitively occupied, to evaluate possible changes adopted through time, and to add more information about how spatial knowledge of territories was built into the long-term process of the peopling of the South American continent.

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PART 1

PART 1

A Review of the Early Peopling and Cultural Diversity of Colombia during the Late Pleistocene

Francisco Javier Aceituno[1]

➤ **Keywords**: Early migrations, cultural diversity, Colombia

The archaeological record of Colombia is a key for understanding the settlement and expansion of the first Americans because of its central geographic position in Neotropical northwest South America. Colombia has several early archaeological sites scattered throughout the northern Andes, with a chronological breadth and diversity so large that archaeologists have failed to establish solid relationships between them. The aim of this paper is to contribute to the discussion of the peopling of northwest South America by reviewing the cultural diversity in late Pleistocene.

In very general terms the Colombian Pleistocene archaeological record is located in the Sabana de Bogotá (Eastern Cordillera), middle Magdalena River basin (Middle Magdalena from now on), central Cordillera, and Popayán Plateau (Figure 1).

On the Sabana de Bogotá, an Andean plateau at 2600 masl, hunter-gatherers showed significant continuity in their culture from the latest Pleistocene until the middle Holocene. In this region we find the earliest ^{14}C date on a Colombian archaeological site at the El Abra site, where 37 chert flakes were associated with a date 12,460 ± 160 RCYBP (GrN-5556). These were found with a Holocene faunal assemblage and a set of stone tools referred to as "Abriense," an edge-trimmed tool tradition (Correal 1986). At the open-air butchering Tibitó site, Abriense stone tools were recovered associated with faunal remains of mastodon (*Haplomastodon* sp. and *Cuvieronius* sp.), American horse (*Equus* sp.), and deer (*Odocoileus virginianus*) dated to 11,740 ± 110 RCYBP (GrN-9375) (Correal 1982). Tequendama, dated stratigraphically between

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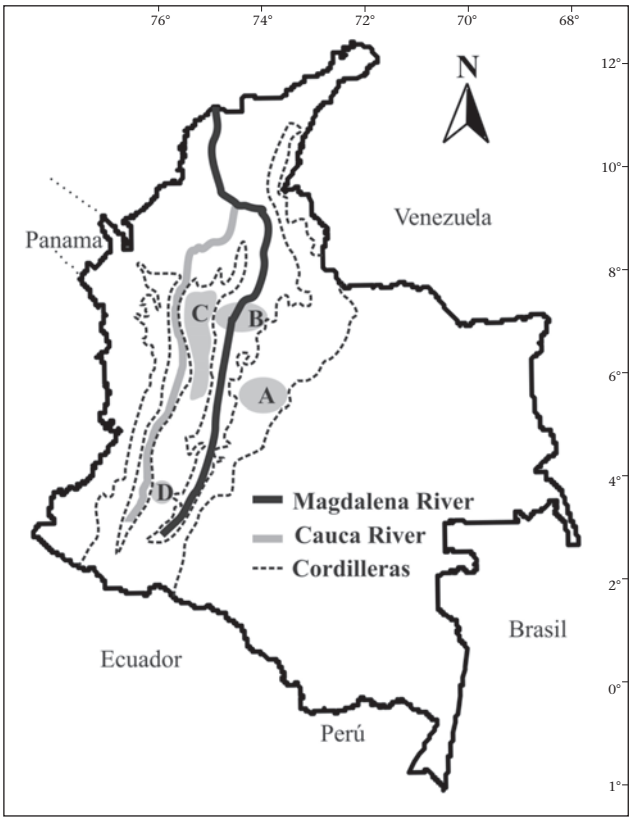

Figure 1. Pleistocene archaeological regions in Colombia: **A,** Sabana de Bogotá; **B,** middle Magdalena River basin; **C,** central Cordillera; **D,** Popayan Plateau.

ca. 12,500 and 10,920 ± 260 RCYBP (GrN-6539), contained faunal remains similar to those found at El Abra but a different kind of technology called "Tequendamiense," distinguished from Abriense by the presence of allochthonous raw materials and scrapers, thinned flakes, and a projectile point (Correal and Van der Hammen 1977:34).

In the lowlands of Middle Magdalena a chert and quartz lithic tradition flourished as early as 10,400 ± 90 RCYBP (B-146798) to the middle Holocene. Its main features were simple flakes, plano-convex scrapers, and triangular Fishtail projectile points with straight, oblique, or rounded wings, and a long thin tail (López 1999). These tools were recovered from stratified sites but were not associated with faunal or botanical remains.

In central Cordillera, 1650–2100 masl, two sites date to the late Pleistocene: El Jazmin, dated 10,120 ± 70 RCYBP (Ua-24497) (Aceituno and Loaiza 2007), and La Morena, dated 10,060 ± 60 RCYBP (B-245566) (Santos 2010). Their lithic technology clearly focused on exploiting plant resources, which makes it significantly different from that of other early cultures in northwest South America. At both sites simple flakes, axes, hoes, hand stones, and milling bases were found.

On the Popayán Plateau in southern Colombia, at about 1600 masl, is the site of San Isidro, dated at 10,050 ± 100 RCYBP (B-65878). Lithic materials consist of thousands of chert artifacts, which include unretouched and retouched flakes, lanceolate bifaces, and hand-stone tools (Gnecco 2003).

Regarding the sites mentioned above, the first major question has to do with the age and origin of the first settlers in Colombia. The record from the earliest occupations at Sabana de Bogotá suggests that these were pre-Clovis forager groups that used a wide range of hunting resources (Correal 1986; Dillehay 2000; Dillehay et al. 1992). Little is known, however, about the origin of these groups. So far, the closest relative geographically is the Caribbean Joboid tradition, possibly dated ca. 15,000–12,800 RCYBP (Bryan 1986); it is not, however, easy to establish an archaeological relationship between these two early northern South American complexes because of chronological, lithic technological and settlement differences. Nevertheless, the coastal setting of early El Jobo sites in northern South America suggests that the Caribbean coast could have been an important migration route into South America. Considering the variety of wild resources that the upland environment offered, one can hypothesize that human groups that eventually settled in the Colombia highlands entered the region via the Caribbean lowlands, followed a north-south direction through the Magdalena River basin, and settled at Sabana de Bogotá during the Guantiva interstadial ca. 15,000–11,000 RCYBP (Correal and Van der Hammen 1977), .

Seen as a group, the other early cultures are characterized by younger ^{14}C dates and diverse technologies and adaptive strategies. The relationship among these cultures, as well as with Sabana de Bogotá, remains an unsolved question because of the scarcity of data linking them in time and space. Starting from Middle Magdalena, some authors have tried to relate them with the Clovis culture (López 1999; Ranere and López 2007); however, no large animals (or Pleistocene fauna) have been found in association with artifacts, and the projectile points found lack flutes, a distinguishing feature of the Clovis tradition. A relationship can be inferred between the Middle Magdalena and Sabana de Bogotá occupations, based on the use of Middle Magdalena chert in the manufacture of Tequendamiense tools and on the technological similarities between the two regions (Correal and Van der Hammen 1977).

The sites of central Cordillera and Popayan Plateau contribute novel data about the diversity of adaptive strategies in the late Pleistocene; little that can be said, however, about their relationship with Middle Magdalena sites, beyond noting that there may have been contact between the regions, as suggested by the presence of Magdalena projectile points at various places in central Cordillera (López 1999). Less clear still is the relationship, if any, of these sites with Sabana de Bogotá.

In summary, the relationship between early settlement and cultural diversification in Colombia is far from being established, since many questions remain unanswered. For instance, how many migration events are implied by the cultural diversity documented in the archaeological record of the late Pleistocene and early Holocene? With the data available today, we can only suggest several working hypotheses to be tested with future information. One hypothesis is that pre-Clovis people who came to Colombia about 12,000 RCYBP are responsible for the expansion and cultural diversity of the late Pleistocene archaeological record. An alternative hypothesis assumes two or more human populations arriving at different times with different adaptive strategies. The latter hypothesis leaves open the possibility for the arrival of pre-Clovis and Clovis, as well as post-Clovis populations.

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Native Male Founder Lineages of South America

PART 1

Virginia Ramallo[1], *Marina Muzzio*[2], *María R. Santos*[2], *Josefina M. B. Motti*[2], *Laura S. Jurado Medina*[1], *Claudio M. Bravi*[2], *and Graciela Bailliet*[1]

➤**Keywords:** Y-chromosome lineages, South America, regional differentiation

Advances in knowledge of the human genome have enlarged our understanding of the male-specific, Y-Chromosome region. During recent years almost 600 biallelic polymorphisms have been described for it, and we now benefit from a standard nomenclature system and solid phylogeny (Karafet et al. 2008; YCC 2002). It is now apparent that the distribution of major clades from the phylogeny is consistent with the continental distribution of lineages.

Most South American Native males carry a Y-chromosome lineage characterized by a single base-pair polymorphism (M3). All populations from Alaska to the Strait of Magellan share this lineage, in average frequencies of around 60% or higher (Bianchi et al. 1998; Bortolini et al. 2003). This lineage was initially considered to be the "founder" (Underhill et al. 1996), and further information showed that M3 occurred either in America or in Siberia shortly before migrating (Lell et al. 2002); thus it has been considered autochthonous. M3 belongs to the Q haplogroup, bears the derivate state for the M242, M346, and M3 polymorphisms, and was named Q1a3a sub-haplogroup (Karafet et al. 2008). Another lineage, the Q1a3* para-haplogroup, entered America revealing a derivate state for M242 and M346, and the ancestral state for M3. Because it is present in Eurasia, it has been considered a "founder lineage" for America, being more frequent in North than South America (Bortolini et al. 2003; Bolnick et al. 2006, Bailliet et al. 2009).

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The aim of this paper is to analyze the Q1a3a and Q1a3* haplotypes to identify the relatedness of American populations and their regional and chronological differentiation.

Materials and Methods

We analyzed 137 individual samples corresponding to the Q1a3a sub-haplogroup, and 13 individuals belonging to the Q1a3* sub-haplogroup, selected from 759 samples of voluntary male donors from 16 populations in Argentina: Susques (18), Rinconada (4), Cochinoca (4), Humahuaca (10), San Salvador de Jujuy (6), Salta (14), Catamarca (6), Tucumán (1), Córdoba (1), Wichis from Salta (15), Wichis from Formosa (26), Toba (4), Chorote (5), Mocovi (3), Mapuche (8), Tehuelche (9); and Paraguay: Lengua (12), Ayoreo (7). All Q1a3a and Q1a3* samples were analyzed for seven Y-chromosome short tandem repeat (Y-STR) polymorphic loci (DYS389I/II, DYS390, DYS19, DYS393, DYS391, DYS392) and four biallelic markers (SNPs). The SNPs analyzed by PCR-RFLP were M3 (Bianchi et al. 1998), M242 (Seielstad et al. 2003), M346 (Sengupta et al. 2006), and P27 (Karafet et al. 1999).

For each dataset we calculated the diversity parameters, an AMOVA (Excoffier et al. 1992) based on the sum of square differences (Rst), by Arlequin 3.1 (Excoffier et. al. 2005). We constructed maps from the genetic distance matrix (Nei 1972) using multiple dimensional scaling (MDS) (Kruskal 1964) by NTSYSpc 2.11 (Applied Biostatistics 2000–2003), and built a Median Joining Network of Q1a3* haplotypes (after MP procedure) employing Network (v 4.2.1.0, www.fluxusengineering.com) (Bandelt et al. 1999).

Results and Discussion

A total of 97 haplotypes were found in 137 Q1a3a individuals. Fixation Index (Fst) for these lineages was 0.112, and the mean gene diversity was 0.501. We observed great allele-frequency differentiation of Q1a3a haplotypes. In the MDS plot (Figure 1), the first axis separates populations by their geographic position: The northwestern Andean populations as Rinconada, Cochinoca and Humahuaca lie on the upper left side; and the northeastern Gran Chaco

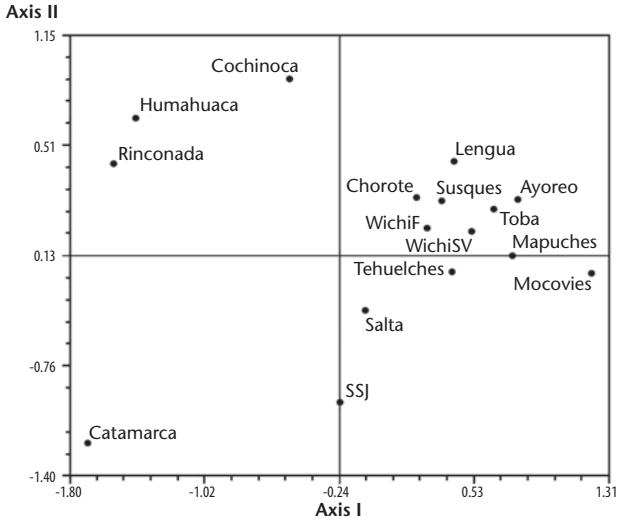

Figure 1. Two-dimensional scaling of genetic distances (Nei 1972) based on seven Y-chromosome STR haplotypes belonging to Q1a3a haplogroup from 17 populations from Argentina and Paraguay (SSJ, San Salvador de Jujuy) (STRESS1 = 0.11876).

populations, including Wichi, Toba, Chorote, Ayoreo and Lengua, lie on the upper right side. Finding Susques in this position is probably due to shared haplotypes with the Wichi and suggests some recent interpopulational contact.

Fourteen individuals belonged to the Q1a3* para-haplogroup. This clade was only present in one Mapuche, two Mocoví, one Wichi, one Salta, one Córdoba, seven Lengua, and two Ayoreo. Frequencies were below 6% except for the Lengua (29%) and Ayoreo (22%), although there was a considerably high allele-frequency differentiation (mean gene diversity = 0.478). Genetic drift was probably the phenomenon that caused their numerical restriction.

Network analysis of Q1a3* haplotypes showed three Lengua at the central position; the only haplotypes that differed in one or two allelic changes from these were from Lengua or Ayoreo populations. The other haplotypes diverged in more allele changes, while three median vectors (indicating absent haplotypes in the sample) were interposed between the central and derived haplotypes. This is concordant with the hypothesis of severe drift acting over these less-frequent haplotypes. Lengua 2 and Lengua 3 each carried two identical haplotypes (Figure 2).

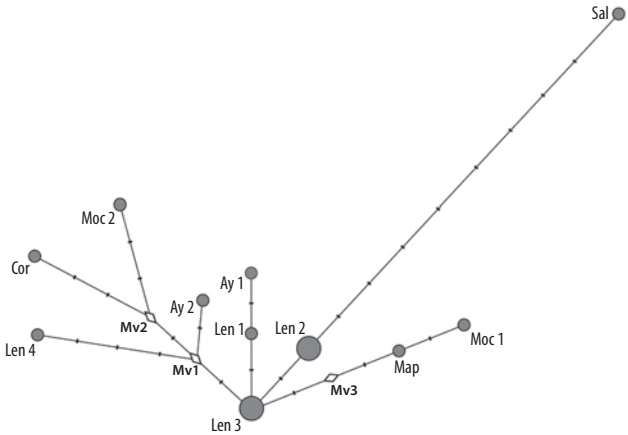

Figure 2. Microsatellite network for South American Q1a3* haplotypes. Circle size is proportional to frequency (**L,** Lengua; **A,** Ayoreo; **Mo,** Mocoví; **Ma,** Mapuche; **Cor,** Córdoba). (Mv 1, 2 and 3 are median vectors not found in the sample.)

The sample analyzed is large and includes self-acknowledged Native American communities. Those Native groups left out are very difficult to contact. It is unlikely that increasing the sample size of the general population would give a significantly higher diversity than the one described, since admixed populations have very low frequencies of male native lineages. We expect that increasing the amount of microsatellites would improve the resolution of the lineages described and thus achieve a more defined regional differentiation.

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PART 1

Dental and Craniofacial Diversity in the Northern Andes, and the Early Peopling of South America

Miguel E. Delgado-Burbano[1]

➤**Keywords:** New World colonization, Pleistocene/Holocene boundary, northern Andes

The North Andean region is a key area for studying the initial peopling of South America, given that the most likely routes of colonization go through its territory. Despite this fact, few attempts have been made to analyze large skeletal samples from Colombia (Neves and Pucciarelli 1991; Neves et al. 2007; Pucciarelli et al. 2010; Rodríguez 2007). Two models for early settlement of the study area have been advanced on the basis of the analysis of patterns of cranial-morphological diversity. The first one states that the present and past Colombian Amerinds are biologically homogeneous and that the existing diversity is a product of one migratory wave and in situ microevolution (Rodríguez 2007). The second one, in agreement with the most frequent version of the dual-origin model (Neves and Pucciarelli 1991), proposes that South American Amerinds, including Colombians, must be viewed as a highly variable set of populations with at least two well-differentiated craniofacial patterns, the morphologically specialized Amerindian and the morphologically more generalized Paleoamerican. In fact, Neves et al. (2007) suggested that Paleoamericans survived in the Sabana de Bogotá region until the late Holocene, when they were replaced by Amerindian populations. The aim of this study is exploratory, to assess the degree to which dental and craniofacial diversity found in prehispanic samples from northwestern South America (Colombia) fits into one of the aforementioned models.

Nearly 600 adult individuals of both sexes from several archaeological sites (ca. 10,100–400 RCYBP) were analyzed. A total of 32 craniofacial measurements on non-deformed skulls were

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recorded following the criteria set by Howells (1973). A multiple imputation program (NORM 2.03) was employed to estimate missing values. The measurements were converted into Mosimann shape variables (Darroch and Mosimann 1985) and subsequently transformed to z-scores to minimize sex-related size differences. The morphological affinities between samples were evaluated by means of Mahalanobis D^2 generalized distance ($p < 0.001$), represented in a neighbor-joining tree. The comparative sample included early-Holocene samples from North America (Kennewick, Brown's Valley, Pelican Rapids, Wizards Beach, Buhl [Owsley and Jantz 1999; Green et al. 1998]); Central America (Tlapacoya, Cueva del Tecolote, Chinalhuaca, Metro Banderas, Peñon III) (González-José et al. 2005); South America (Lagoa Santa, Baño Nuevo-1, Pali Aike) (Neves and Hube 2005; Mena et al. 2003); and recent samples from Central and South America (southern North America, Mexico, Peru, Argentina, Chile [Howells 1989; González-José 2003]). In 23 samples, 51 dental non-metric traits following the individual count method were recorded using the ASUDAS system (Turner et al. 1991). Intertrait correlations and sexual dimorphism were evaluated through chi-square and tetrachoric correlation tests. The biodistances were analyzed using the mean measure of divergence statistic (MMD; $p < 0.025$) and displayed in a neighbor-joining tree. The compared samples were prehispanic and recent Amerinds from North America (Turner 1985), Central America (LeBlanc et al., 2007) and south central Andes (Sutter 2005).

Figure 1 shows the morphological affinities based on craniofacial variation. The most conspicuous finding is the scattered distribution of the samples without a clear geographic or temporal trend. From an intra-region perspective the high craniofacial diversity likely suggests multiple founder populations and spatial distinctiveness. The dissimilarities between Paleoamericans and Amerinds are not so evident, and the remarkable among-sample differentiation (multiple branches), including the early-Holocene groups, indicates much more diversity than expected (Delgado-Burbano 2012). Figure 2 shows that the Native American dental diversity is geographically structured. The neighbor-joining tree indicates that the early- and middle-Holocene samples share dental similarities with the late-Holocene samples. The continental differentiation also denotes high diversity (i.e., distinct patterns of variation) (Delgado-Burbano et al. 2010). Regionally, the patterns of dental diversity show, notwithstanding the geographical structuring, intraregional dissimilarity. It is not surprising that the craniofacial and dental non-metric diversity reflects relatively dissimilar biological and spatial relationships because they are constrained by selective pressures of distinct nature and vary in different ways. The evolutionary relationships and detection of several patterns of morphological variation inferred from both kinds of phenotypic evidence, however, consistently disagree with the two referenced models. First, the recent Colombian Amerinds and their ancestors seem to have high biological diversity resulting not only from in situ microevolution (*cf.* Rodríguez 2007); and second, the fact that the Amerindians share close affinities with alleged Paleoamericans probably suggests an ancestral-descendant relationship. This last observation also implies the entry into the region of more than one (biologically diverse) founder population phylogenetically and geographically related to the Central and North American and northeast Asian regions (*cf.* Neves et al. 2007).

The morphological evidence presented here suggests that South American peopling was a complex process occurring during the Pleistocene/Holocene boundary, probably the result of multiple discrete expansions of highly variable founder populations. The diversity is likely a product of migratory events, microevolutionary processes, and environmental-spatial constraints. Finally, given that the patterns of craniofacial and dental variation found

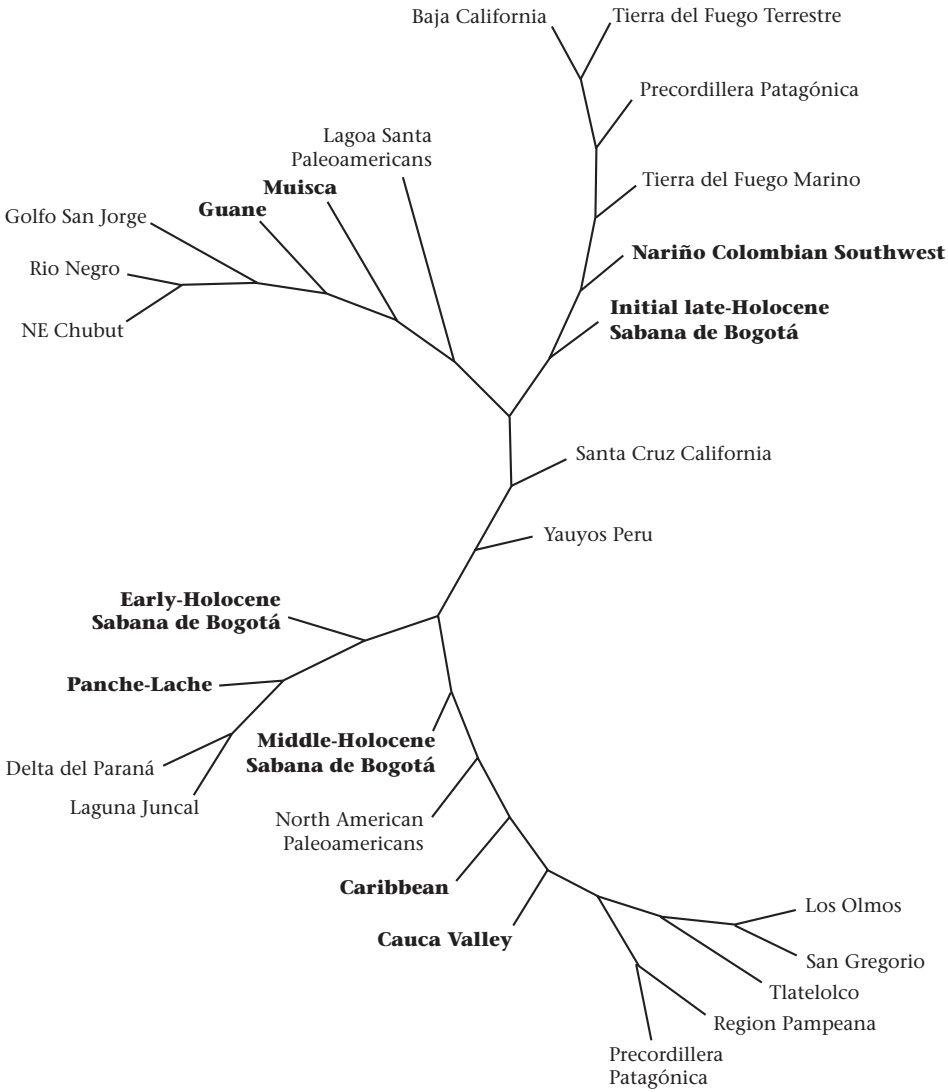

Figure 1. Neighbor-joining tree based on D^2 distance matrix representing morphological affinities among 27 American samples. Colombian samples appear in bold.

in the northern Andes are relatively difficult to explain under the assumptions of the most common models applied to the early settlement of the Americas, it becomes clear that further investigation is required.

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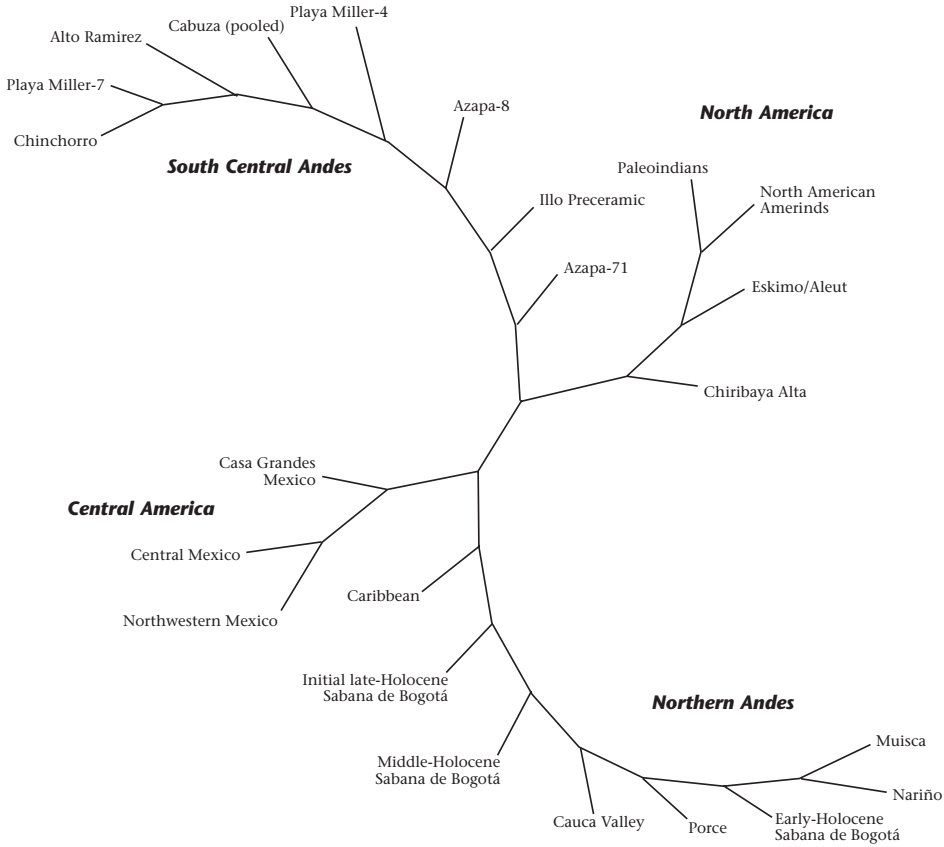

Figure 2. Neighbor-joining tree based on MMD distance matrix representing morphological affinities among 23 American samples.

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PART 1

PART 1

The Bioanthropological Evidence of a ca. 10,000 CALYBP Ten-Individual Group in Central Patagonia

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➤**Keywords:** Human remains, early Holocene, central Patagonia

Despite the general consensus for a human arrival in South America prior to 13,000 CALYBP (Goebel et al. 2008), bone remains of these groups are particularly absent from the archaeological record (Dillehay 2009). This is especially the case for Patagonia, where the burial pattern supposedly associated with the earliest settlers was dated to no earlier than ca. 4400 CALYBP in Cerro Sota and Lago Sofia 1 (Borrero 2008). Most sites in Patagonia yielding human remains do not predate the middle Holocene, and those older either lack direct radiocarbon ages on human bones, as in the case of Epuyán Grande cave (Crivelli et al. 1996), or have questionable dates, as in Pali Aike (Neves et al. 1999). At the Baño Nuevo 1 site (Figure 1), a cave located in the westernmost steppes of central Patagonia (45° 16′ S, Aisén, Chile), excavations recovered several funerary features in a high-resolution dated stratigraphic context (Mena and Reyes 2001; Mena and Stafford 2006; Mena et al. 2003). Baño Nuevo 1 is characterized by low humidity and stable temperature, favorable conditions for preserving a wide variety of material and organic remains, including the bones of 10 individuals dated at 10,200–9700 CALYBP.

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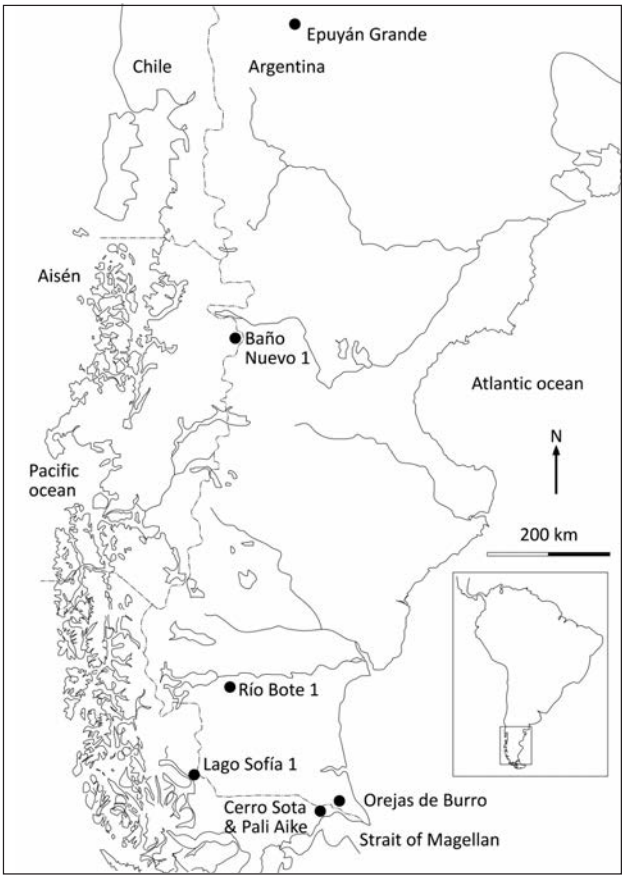

Figure 1. The sites in Patagonia mentioned in the text.

This paper addresses three major issues: Are the remains of these individuals contemporary? What was their diet? What are the genetic relations of this group? We sum up previous data and present new evidence of ^{14}C AMS dates on bone samples, δ^{13}C and δ^{15}N isotope data, and mtDNA analyses (Table 1).

Results

Radiocarbon dates were calibrated to a 2σ range with OxCal 4.1 program, using the ShCal 04 curve (Bronk Ramsey 2009). All direct dates on bones overlap within the range of 10,200–9700 CALYBP. This situation presents two alternative interpretations: Either the remains represent a synchronous multi-individual death event; or inhumations were deposited by a single group within a limited time frame, which makes them chronologically indistinguishable using current dating methods.

Results of the isotopic analyses of seven of the ten skeletal remains show a δ^{13}C range of between -18.5‰ and -24.5‰, with a mean value of -20.37‰ (sd = 2.097), and a δ^{15}N range between 7.3‰ and 16.5‰ , with a mean value of 11.48‰ (sd = 2.7883). Individual 7 yielded significantly different values in both cases, which we attribute to probable contamination. If

Table 1. Results of ^{14}C AMS, $\delta^{13}C$ ‰, $\delta^{15}N$‰, and mtDNA analyses of human remains from Baño Nuevo 1. All individuals were recovered in layer 3. Calibrated dates are presented with a 2σ range.

Indiv.	Age (yrs)	Sex	Lab	RCYBP**	CALYBP	$\delta^{13}C$ ‰	$\delta^{15}N$‰	mtDNA Haplogroup
1	6 ± 3 mo	Ind.	CAMS 79933	8950 ± 50	10,195–9777	-19.01	10.33	C
2	20–25	M	CAMS 36633	8850 ± 50	10,151–9603			B (?)
			CAMS 36634	8880 ± 50	10,159–9685			
			UGAMS 5924*			-21	11.5	
3	40–45	F	CAMS 101893	8950 ± 60	10,200–9744			B
			UGAMS 5925*			-18.5	10.4	
4	6 ± 3 mo	Ind.	CAMS 101894	8945 ± 40	10,189–9785	-19.36	11.71	B
5	6 ± 3 mo	Ind.	UCIAMS 10098	8990 ± 30	10,199–9914			NS
6	15 ± 9 mo	M (?)	UGAMS 5926*			-21.2	7.3	B
7	20–22	M	UGAMS 5927*	9020 ± 30	10,228–9922	-24.5	16.5	NA
8	6 ± 3 mo	Ind.	No collagen					B
9	6 ± 3 mo	Ind.	Incomplete					NS
10	15 ± 9 mo	M (?)	UGAMS 5002*£	8960 ± 40	10198–9796	-19	12.6	NA

* New data provided in this paper.
** All dates are on bone collagen except £ on tooth collagen.

yrs years **Ind** indeterminable
mo months **NS** not sufficient sample
M male **NA** not amplified
F female

we exclude these results, mean values are more coherent: -19.68 (sd = 1.14) for $\delta^{13}C$ and 10.64 (sd = 1.85) for $\delta^{15}N$. Results, when compared with the isotopic ecology of selected resources and with values for other archaeological samples, suggest a terrestrial-hunting continental diet associated with prey feeding on C3 photosynthetic-pathway plants (Barberena 2002; Tessone et al. 2009). The early-Holocene archaeofaunal record at the site, dominated by *Lama guanicoe* (Velásquez and Mena 2006), and observations on oral pathologies (mainly on individuals 2 and 7) showing abrasion, wearing, and chipping of dental enamel, corroborate this interpretation.

Previous PCR-RFLP analyses on individuals 1 through 4, new samples obtained for individuals 2, 7, and 10, and reruns on individuals 1, 2, 4, 6, 7, and 8 show a dominant presence of mtDNA haplogroup B (five individuals) and a single occurrence of haplogroup C. Sequencing the hypervariable regions 1 and 2 confirms these results. Thus data obtained at Baño Nuevo 1 suggest an early-Holocene presence of haplogroup B at 45° S near the Andes. Its high representation suggests this haplogroup should be considered among the earliest peopling groups in Patagonia. Haplogroup B has been confirmed for other late-Holocene samples obtained south of 50° S, including Río Bote 1 (ca. 4000 CALYBP) (Franco et al. 2010) and Orejas de Burro 1 (3700 CALYBP) (L'Heureux and Barberena 2008), with the Magellan Strait being its southernmost limit (Moraga et al. 2009). Studies on the last surviving peoples in Patagonia, however, show an almost complete absence of haplogroups A and B at this latitude. The southern limit of haplogroup B is 42° S along the Pacific (García et al. 2006) and 45° S along the Atlantic (Bravi, pers. comm. 2010). Nineteenth-century samples from the southernmost channels alternatively only show the presence of haplogroups C and D (García-Bour et al. 2004).

Conclusions

Baño Nuevo 1 has yielded a 10,200–9700 CALYBP ten-individual burial context, either synchronous or deposited during an indistinguishable radiocarbon time span. Although the funerary function of the site is highly noticeable, it is framed by a series of other campsite occupations

which continued until 2890 CALYBP (Mena et al. 2000). Following the expectations raised by archaeofaunal analyses, isotopic nitrogen and carbon data suggest the individuals had diets relying strongly on large ungulates such as *Lama guanicoe*. MtDNA results are consistent with a dominance of haplogroup B ca. 10,000 CALYBP, which can be further argued as the period of one of the earliest peopling events of Patagonia. The significance of Baño Nuevo 1 is that it preserved an extremely rare sample of a discrete human group. The number of individuals at Baño Nuevo 1 substantially increases the magnitude of known early-Holocene populations, especially when compared with periods immediately before and after.

Reassessing Pali Aike, Cerro Sota, and other early sites yielding human remains has changed our ideas about the first people in Patagonia. Dating the osteological remains of the first settlers remains a challenge, however, because the direct-dated individuals in Baño Nuevo 1 are ca. 3000 calendar years younger than the earliest reliable and demographically viable human presence in Patagonia dated around 13,000 CALYBP (Steele and Politis 2009).

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PART 1

PART 1

An Appraisal of Human Remains from Pali Aike Cave (Magallanes, Chile): Inferences about Demography and Mortuary Practices during the Early Holocene

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➤**Keywords:** Human burial, early-Holocene Chilean southern Patagonia

Pali Aike cave is on the extinct volcanic crater of the Pali Aike lava field (52° 05′ S; 69° 44′ W), about 27.5 km from the Strait of Magellan, Magallanes province, Chilean Patagonia (Figure 1). This cave was excavated by American archaeologist Junius Bird during two field seasons (1936 and 1937), during which he recovered human-bone remains and a number of other archaeological and paleontological materials. These are currently housed at the Anthropology Division, American Museum of Natural History, New York. The original description of the finds by Bird presents evidence of three highly disturbed and cremated burials (C. Lester and I. Tattersall in Bird 1983; Bird 1988). Here we review the Pali Aike human remains and present results of a new analysis of them.

Spatial Distribution and Chronology of the Burials

The Pali Aike human remains were recovered from three excavation units (F, C and D; see Figure 30 in Bird 1988:78). The skeletons were incomplete, disarticulated, fragmented, and scattered around the cave at different depths (Table 1). Bird (1983, 1988) considered that

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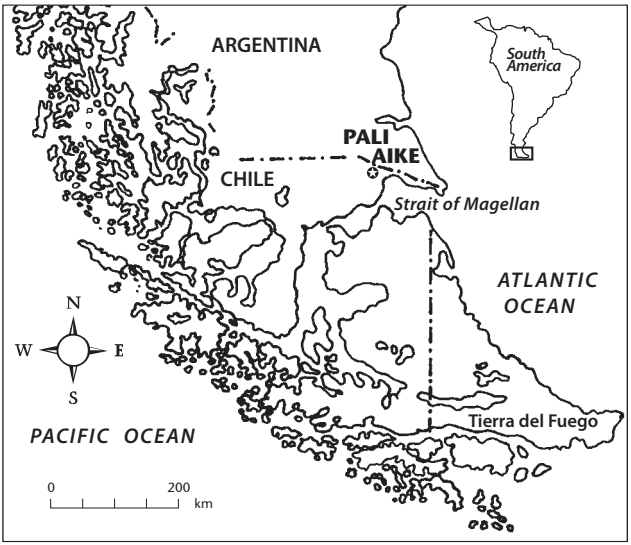

Figure 1. Location of Pali Aike cave.

the activities of burrowing animals may have contributed to the spatial and stratigraphic dispersion of the skeletons.

The human bones were physically associated with remains of sloth (*Mylodon* sp.) and extinct horse (*Hippidion saldiasi*) found in the cave (Bird 1983, 1988). Therefore, Bird thought that human occupation in Pali Aike cave took place during the end of the Pleistocene.

Table 1. Age and sex structure of human individuals identified in Pali Aike cave.

Individual	Sex	Age (years)	Location*
AMNH 99.1/772—PA.4	Indet.	Subadult: 3 ± 1	F (45.72 cm)
AMNH 99.1/773—PA.1	Male	Old adult: 45+	C (152.40 cm)
AMNH 99.1/773—PA.3	Male	Adult: 21+	C (152.40 cm)
AMNH 99.1/774—PA.5	Indet.	Subadult: 5–6	D (76.2–91 cm)
AMNH 99.1/775—PA.2	Male	Middle adult: 35–39	D (106–121 cm)
AMNH 99.1/775—PA.6	Indet.	Subadult: 10 ± 2	D (106–121 cm)

*For locations see plan view of the excavation presented in Bird (1988:78, Figure 30).

The problem is that physical association of Pleistocene fauna and human remains were never established from a taphonomic perspective to support the human and megamammal interaction (Borrero 2005). The presence of some sloth skeletons beneath an ash layer is evidence that this taxon was using the cave before the arrival of humans. When humans dug to bury their dead, this possibly produced a vertical migration of faunal and other archaeological materials (Borrero 2005). So, a number of lines of evidence suggest the humans and extinct fauna were not contemporaries.

This interpretation is consistent with a radiocarbon date on one of the human individuals (99.1/773, or PA.1) (Figure 2A) that yielded a minimum age of 7830 ± 60 RCYBP (Beta-099066) (Neves et al. 1999:261), thus placing the burials in the early Holocene.

Figure 2. Human remains from Pali Aike cave, preserved in collections at the American Museum of Natural History, New York. **A,** carbonized calvaria of individual 99.1/773 [PA1], reconstructed using plastic sticks and non-soluble glue; **B**, left femur without thermal alteration of individual 99.1/773 [PA1]; **C,** right radius and ulna without thermal alteration of individual 99.1/775 [PA2].

Appraisal of Human Remains

Upon completing an evaluation of the human remains, we observed that the bone accumulations originally described as three individual burials (identified in the laboratory with the catalog numbers 99.1/772, 99.1/773, and 99.1/774-775) actually contained the incomplete remains of more than one individual each. Due to the absence of taphonomic information regarding the stratigraphic and spatial relationship of the bones found in the F, C and D units, as well as our recognition of there being more than three individuals represented in the cataloged skeletal series, we decided to re-quantify the minimum number of individuals (MNI) ignoring the artificial units conceived by Bird during the excavation. This avoids overestimating the total number of individuals and the aggregate problems that characterize the quantification of MNI. According to our MNI recount, at least six incomplete individuals (three subadults and three adults) are preserved in this collection (Table 1).

In addition, not all individuals showed signs of charring or calcinations. For example, the 99.1/773 (PA1) individual has a carbonized skull (Figure 2A), but its other axial and appendicular bones are not burned (Figure 2B), and many of the bones of the 99.1/775 (PA2) individual were not cremated (Figure 2C). In turn, no evidence of structures to burn the bodies was found in the cave, nor were there traces of combustible material or calcined bones in the assemblage. Therefore there is no evidence of the reduction of the bodies or other treatments related to cremation preserved in the curated collection (see discussion in Buikstra and Swelge 1989; Davies and Mates 2005; Reverte 1984–85; Schmidt and Symes 2008).

Conclusions

We consider these new data as relevant to discussions of the mortuary practices and demography of the early-Holocene hunter-gatherer populations of southern continental Patagonia. The originally identified MNI in the Pali Aike cave has been increased significantly from three to six individuals. These data become very important for archaeologically assessing the early demography of the area. In addition, we consider that the definition of the Pali Aike cave as a cremation site, which has been accepted for decades (Bird 1983, 1988), may not be completely accurate. The presence of some carbonized human bones is not enough evidence to support the conclusion that the individuals recovered at Pali Aike cave (with partial and heterogeneous anthropic combustion) are the result of cremation events. Cremation is much more than the burning of bodies; therefore finding partially carbonized skeletal remains (not calcined) should not be considered an unequivocal sign of inhumation through cremation.

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PART 1

Part 2
Archaeology of Early South Americans

PART
2

PART
2

The Itaparica Technocomplex: The First Conspicuous Settlement of Central and Northeastern Brazil from a Technological Perspective

PART 2

Antoine Lourdeau[1]

➤**Keywords:** Lithic technology, Pleistocene-Holocene transition, Brazil

In Brazil, several archaeological excavations have yielded information suggesting human occupation from the late Pleistocene. The most interesting sites from this point of view are Toca do Boqueirão da Pedra Furada (Parenti 2001) and Santa Elina rockshelter (Vilhena Vialou 2005). Such evidence of ancient occupation, however, remains at present relatively isolated in Brazil, where sites are disconnected from one another. It is only during the Pleistocene-Holocene transition and the early Holocene that signs of the first dense occupation of the region appear, with an increase in the number of known archaeological sites. In central and northeastern Brazil, this archaeological episode is generally associated with the Itaparica tradition.

A Controversial Techno-cultural Complex

Defined in the 1970s, the Itaparica tradition has been considered a supposedly uniform cultural complex, typical of central and northeastern Brazil during the Pleistocene-Holocene transition and early Holocene between 12,000 and 7000 RCYBP (Schmitz 1987, 2002). It was identified, using typological criteria, by the presence of unifacially shaped artifacts, generally called "*limaces,*" "plano-convex tools," or "unifaces" (Figure 1), and the near-absence of bifacial projectile points. Such a definition, based on a single type of tool and lacking detailed

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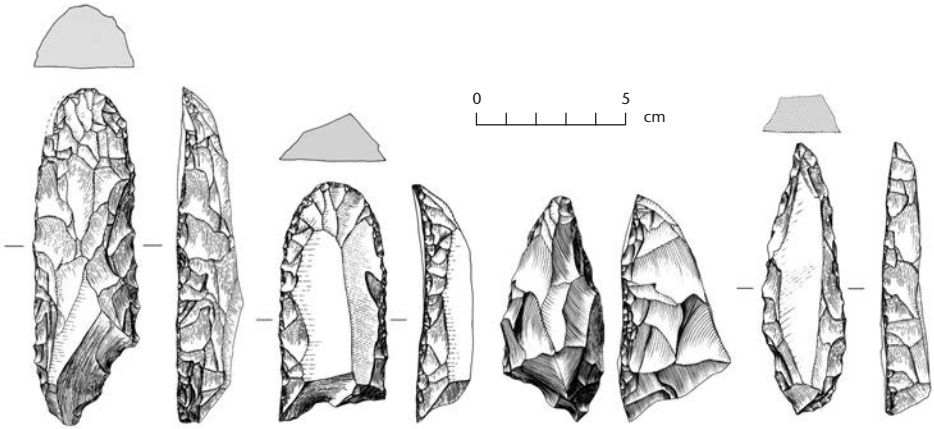

Figure 1. Unifacially shaped artifacts from the GO-JA-01 rockshelter.

descriptions, led to a divergence in points of view and criticism regarding the homogeneity of the complex to the point that its very existence has been questioned. If we examine the available published literature, however, it is clear that in this region a remarkable concentration of sites dating between 12,000 and 7000 RCYBP with such unifacial artifacts exists.

In this context, we have attempted to construct a detailed technological description of these lithic industries to obtain an overall definition of each assemblage and thus to verify the technological uniformity of lithic production in this region during this period. A techno-functional approach was applied, since it is particularly suitable for revealing the intentions and underlying concepts of lithic reduction. This type of analysis enables an overall study of knapped tools by integrating blank-production schemas, intended volumetric structures, tool production schemas, and their functional potential (Boëda 1997, 2001; Soriano 2000).

Lithic assemblages were selected for the study from the GO-JA-01 rockshelter, Toca do Boqueirão da Pedra Furada, and Toca do Pica-Pau. These archaeological assemblages are dated between ca. 10,500 and 7500 RCYBP (Figure 2).

The Unifacially Shaped Artifact: A New Blank Form

This study has demonstrated that unifacially shaped artifacts that typify the lithic industries in central and northeastern Brazil during the Pleistocene-Holocene transition and the early Holocene constitute a new blank form within the history of techniques. All the artifacts analyzed reflect a single concept based on four principles:

1. **Volumetric** These pieces have a fairly thick elongated shape symmetrical along the longitudinal axis, and one of the faces is flat.

2. **Production** The blank form is obtained from a large flake whose dorsal face was subsequently shaped; shaping removals may be invasive; they are centripetally flaked from the edge of the blank and may extend around the entire periphery; the ventral face of the flake blank forms the flat face of the volumetric structure.

3. **Functional** This volume supports at least one tool whose transformative part lies at the

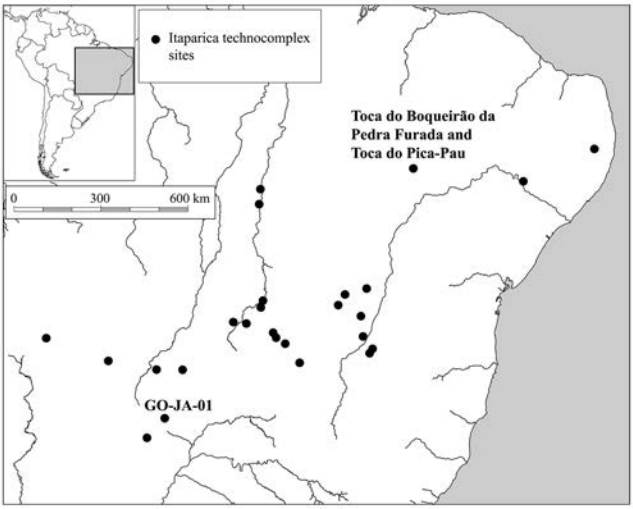

Figure 2. The location of Itaparica technocomplex sites.

apical extremity and is symmetrical along the longitudinal axis; these tools were grasped at the half opposite the transformative part; many of these artifacts were likely hafted.

4. **Long use life** The form serves as a stock of raw material, and its plano-convex structure supports repeated rejuvenation and reshaping phases before becoming exhausted.

Apart from these common traits, variability can be observed in these artifacts. Two volumetric classes are clearly distinguished, including (1) a group of thick pieces with asymmetric profile, in which the minimal thickness is located at the same end as the transformed part; and (2) a group of thin pieces with symmetrical profile, in which the thickness is constant along the length of the tool. Added to this volumetric variability is techno-functional variability. The transformed ends have relatively varied traits of delineation, angle, and surface, which implies an obvious variety of potential functions of these tools. Different functional structures also exist. Some of the artifacts were made to support only a single tool whose transformed part is always at the end of the piece ("tool objects"). Others, in contrast, were produced to constitute matrices from which several tools could be made and used contemporaneously or in sequence ("tool-blank objects"). In addition to the transformed part of these tools that is systematically placed at one end, other transformed parts are located on the sides or the opposite end.

Artifacts without evidence of resharpening and artifacts at the end of their use life exhibit the same overall volumetric, technological and functional variability. Because this variability is independent of the amount of reworking done on the tool, it does not depend on the stage of reuse of the artifact.

The Technological System of Industries with Unifacially Shaped Artifacts

The unifacial artifacts described above are not the only objectives of production. They are systematically accompanied by tools made on unshaped flakes. The blank is made without first preparing a core by simple reduction, repeated short unidirectional removals. The tool is then modified by retouch to make the edge or the grasping part functional, but without altering the original shape of the flake. Although the techno-functional properties of flake tools vary, there

is a consistent pattern to their volumetric structure: Modules are rectangular and more or less elongated, with the transformed part on one of the long edges. The opposite long edge is either backed or has an oblique scar. These tools are thus usually grasped laterally. This differs clearly from unifacially shaped artifacts, which seem usually to be gripped at one end rather than at the side. Thus the function of flake tools complements that of unifacially shaped artifacts.

The Itaparica Technocomplex and Its Implications

Comparing the industries at the three sites studied and sites listed in the bibliography (Bueno 2005; Fogaça 2001; Rodet 2006) verifies that the conception of unifacially shaped artifacts is consistent throughout all the collections and that unifacially shaped artifacts always have a complementary relationship with flake tools. This commonality confirms that an Itaparica technocomplex definitely existed in central and northeastern Brazil during the Pleistocene-Holocene transition and early Holocene (Figure 2). The fact that the ascendancy of this technocomplex coincides with the first phase of dense occupation in the region verifies that it was a unified settlement episode.

The existence of such a techno-cultural complex in Brazil, conceptually so different from the North American Clovis culture and yet contemporaneous with it, throws into question the basic premises underlying American prehistory. It contradicts the Clovis-first model without needing to dispute the dating of the earliest archaeological sites in the Americas. It underscores the importance of rethinking the peopling of the Americas by recognizing the importance of models based on South American archaeological data.

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Exploring Morphometric Variations in Fishtail Projectile Points from Uruguay, Pampa, and Patagonia

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➤**Keywords:** Fishtail projectile points, geometric morphometrics, South America

PART 2

Fishtail or Fell I type (FTPP) projectile points are usually associated with the early hunter-gatherer populations who inhabited South America in the late Pleistocene and early Holocene. These artifacts are defined by a convex blade, rounded shoulders, slightly concave stem sides, concave base, and sometimes fluting on one or both faces (Bird 1969). The largest number of these points has been collected from Uruguay, the Pampas (Argentina), and Patagonia (Argentina and Chile).

In this study, we evaluate FTPP variations at a supra-regional scale by means of geometric morphometric techniques. For this purpose we use published images of projectile points from the Argentinean Pampas (n = 7) (Bayón and Flegenheimer 2003; Flegenheimer 2009; Flegenheimer et al. 2010; Nami 2007), southern Patagonia (n = 16) (Amorosi et al. 2007; Bahamondes and Jackson 2006; Bird 1969, 1988; Nami 1985/86, 1987, 2003), and Uruguay (n = 25) (Baeza and Femenías 2005; Castiñeira et al. 2011).

Methodology

To capture the shape of the Fishtail points and standardize the size, we used digital images of entire specimens that had a graphic scale or metric reference. A total of 34 reference points were placed on each image, including 7 landmarks on the extremes of curvature and 27

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semi-landmarks to describe shape in intermediate spaces. Geometric morphometric analysis followed the procedures established by Bookstein (1996/97), Klinderberg (2008), Goodall (1991), and Rohlf (2004).

Results

Principal Component analysis based on shape variables produced a first component (PC1) summarizing 54% of the morphological variation. It describes the general shape of the FTPP, indicating changes in its elongation and compression. The most contracted shapes, located on the negative extremes of PC1, present a greater convexity in the blades, which are proportionally shorter and expanded (Figure 1). Most elongated morphologies, with proportionally longer blades, are located in the positive values of the same axis. The second component (PC2, 15%) shows local deformation, mainly in the shoulder angle. This axis shows a progressive increase of this angle from negative to positive scores, with the most obtuse angles being registered by extreme positive PC2 scores (Figure 1).

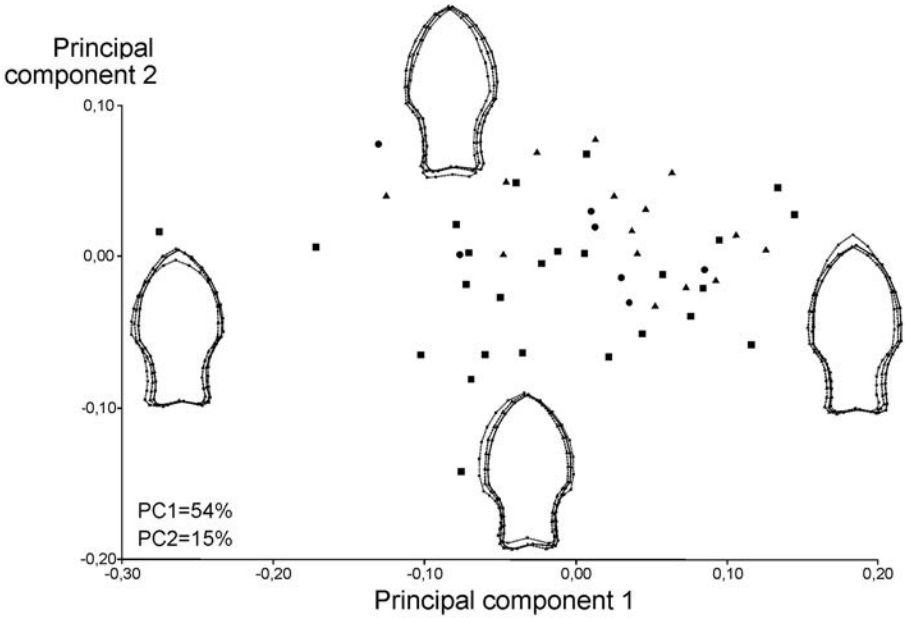

Figure 1. Principal components analysis of shape variables (● FTPP from Pampas region, Argentina; ▲ FTPP from Patagonia region; ■ FTPP from Uruguay).

Assessing covariance between different modules of the projectile points through Partial Least Squares (Rohlf and Corti 2000), considering the blade and the stem as independent modules (Figure 2), shows significant results (p [10.000 perm.] = 0.02).

A Regression analysis of Procrustes coordinates (i.e., shape) against centroid size (size) was performed to explore the relationship between shape and size. The significant results (p [10.000 perm] = 0.02) indicate that both variables are related, although the percentage of morphological variance explained by size changes is small (6.2%).

Canonical Variates analysis indicates the existence of significative variations in the average

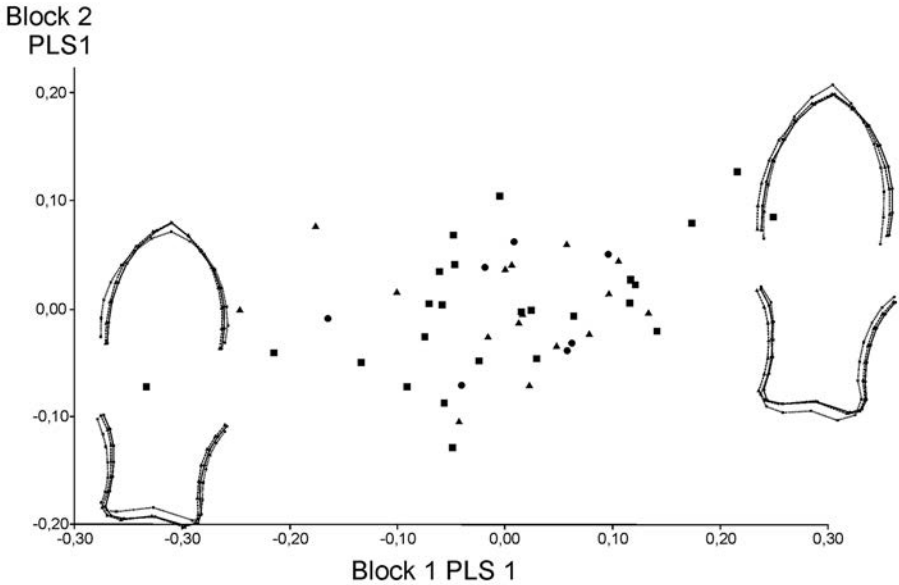

Figure 2. Blade-stem covariance analysis (Partial Least Squares) (● FTPP from Pampas region, Argentina; ▲ FTPP from Patagonia region; ■ FTPP from Uruguay).

shape between Uruguay and Patagonia samples (Procrustes distance = 0.063, p = 0.03) (Figure 3), while spatially closer sets do not show morphological differences (Procrustes distance Uruguay/Pampa = 0.046, p = 0.49; Pampa/Patagonia = 0.044, p = 0.42). This same analysis indicates that these differences are independent of the lithic raw materials exploited in each area (all pairwise comparisons show a p-value > 0.05). Also, the comparison of the average size of projectile points does not show significant differences among areas (Welch t test F = 2.68 p = 0.1).

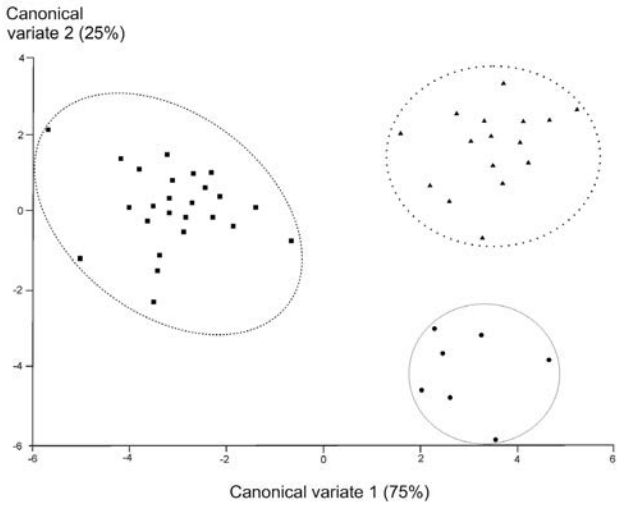

Figure 3. Analysis of canonical variates by area (● FTPP from Pampas region, Argentina; ▲ FTPP from Patagonia region; ■ FTPP from Uruguay).

General Trends

The geometric morphometrics analysis presented above has detected significant patterns in Fishtail point morphometrics. Three general trends can be inferred from the results of the analysis:

1) Morphological variations observed in the Principal Components analysis suggest that shape compression and elongation behave as a continuous variation that can be interpreted as the result of the life trajectory of these artifacts

2) Although the major shape variability was observed in the blades of the points, changes in the stem accompany this variation, an aspect that suggests that the reactivation of these pieces was made outside the haft.

3) The lack of any significant difference in projectile point size either by area or by lithic raw material would strengthen the standardization of the design on a broad scale. However, our analysis has registered a strong relationship between morphological variation and distance among the geographical areas. This suggests some regional variation in Fishtail point shape.

Our thanks to César Mendez for his kind contribution of some projectile point images, to Rolando González José for always answering our doubts in the use of statistical programs, and finally to Gustavo Franco Castiñeira for helping us with the translation.

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PART 2

PART 2

Variability of Triangular Non-Stemmed Projectile Points of Early Hunter-Gatherers of the Argentinian Puna

Salomón Hocsman[1], *Jorge G. Martínez*[1], *Carlos A. Aschero*[1], *and Alfredo D. Calisaya*[2]

PART 2

➤**Keywords:** Triangular non-stemmed projectile points, late Pleistocene/early Holocene, Argentinian Puna

In this paper we report an analysis of morphological variability in triangular non-stemmed projectile points, typical of archaeological contexts of the late Pleistocene/early Holocene of the Puna of northwest Argentina. The sites under consideration are Inca Cueva 4 (ICc4) and Alero Caído 2 (AC2) in the northern Puna and Quebrada Seca 3 (QS3) in the southern Puna.

ICc4 is a cave 17.60 m wide by 6.50 m long, with an initial occupation marked by a dwelling structure dug into sterile sand with an access step, inner and outer deposit holes, and an outer dumping ground. The room floor was partially covered by grass (Aschero 1984). Available dates for the ICc4 occupations are 9230 ± 70 (CSIC-498), 9900 ± 200 (AC-564), 9650 ± 110 (LP-102), and 10,620 ± 140 RCYBP (LP-137) (Aschero 2010). AC2 is a recently discovered rockshelter 6 m wide by 4 m long. Although there are no absolute dates available for this site, a series of diagnostic artifacts of a possible early occupation (before 9000 RCYBP?) were recovered from its basal layers (Aschero 2010). Finally, QS3 is a rockshelter with a sheltered area of 9 m by 5 m. The occupations associated with triangular points are dwelling contexts with scarce artifacts, ecofacts, and structures. These occupations have been dated to 9790 ± 50

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(UGA-9257), 9410 ± 120 (LP-881), 9250 ± 100 (LP-895), 9050 ± 90 (Beta-59930), 8660 ± 80 (BETA-77747), and 8640 ± 80 RCYBP (BETA-59929) (Martínez 2003).

The objective of analyzing the variation in the morphologies of projectile points—their tips, blade edges, bases, and contact joints between blades and bases—using macroscopic description (Aschero 1975, 1983) is to identify the original design and to measure modification due to maintenance or reworking (Hocsman 2009). These methods of extending use-life are identified by analyzing the variation in shape geometry, blade-edge asymmetry, edge outline, bevel symmetry, tip-, blade-, and base-edge angle, as well as retouch morphology, which denotes maintenance (e.g., irregular scaly or stepped scaly patterns).

Figures 1 and 2 show the analyzed assemblages of triangular points from ICc4-AC2 and QS3. Certain elements are different in the two samples. The raw material is different: A greater variety of rock types is available in the northern Puna, whereas obsidian is available in the southern Puna. Although flakes and bifaces were used in both sites to manufacture points, nonetheless there are significant differences in the blank selection and work investment during manufacture. The projectile points vary dimensionally, and they tend to be smaller in the northern Puna (mean length 26.30 ± 4.48 mm; mean width 20.02 ± 2.58 mm; mean thickness 5.10 ± 1.38 mm) and larger in the southern Puna (mean length 33.85 mm ± 10.11; mean width 22.90 ± 3.29 mm; mean thickness 5.79 ± 0.77 mm). Furthermore, morphological attributes suggest that point-maintenance/reworking processes were much more severe in the northern Puna; we suggest that the length differences are really a product of more pronounced extension

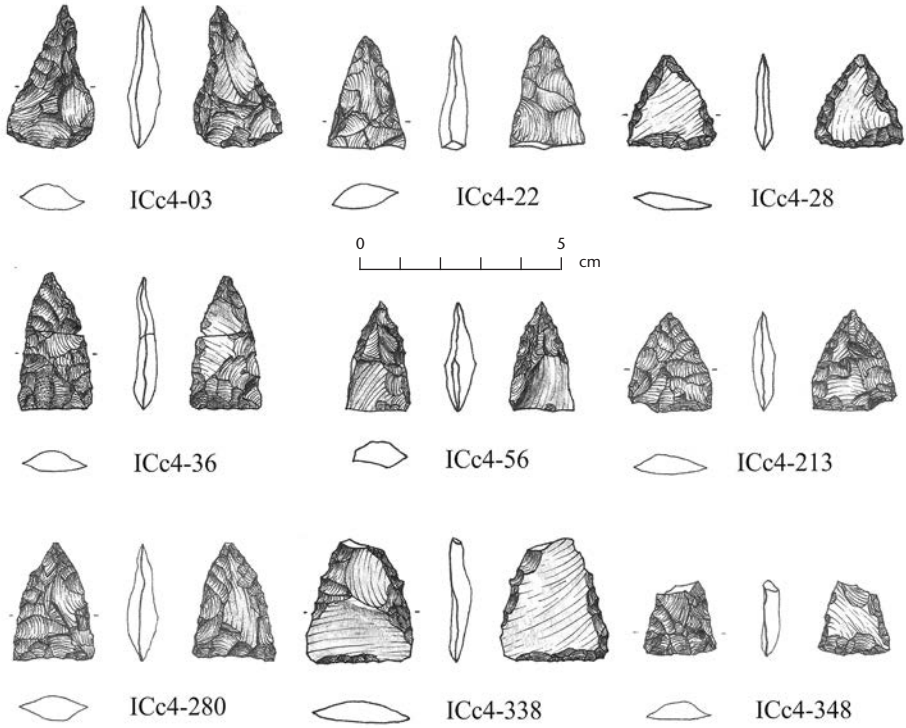

Figure 1. Non-stemmed triangular projectile points from Inca Cueva 4 site, Argentinian Puna.

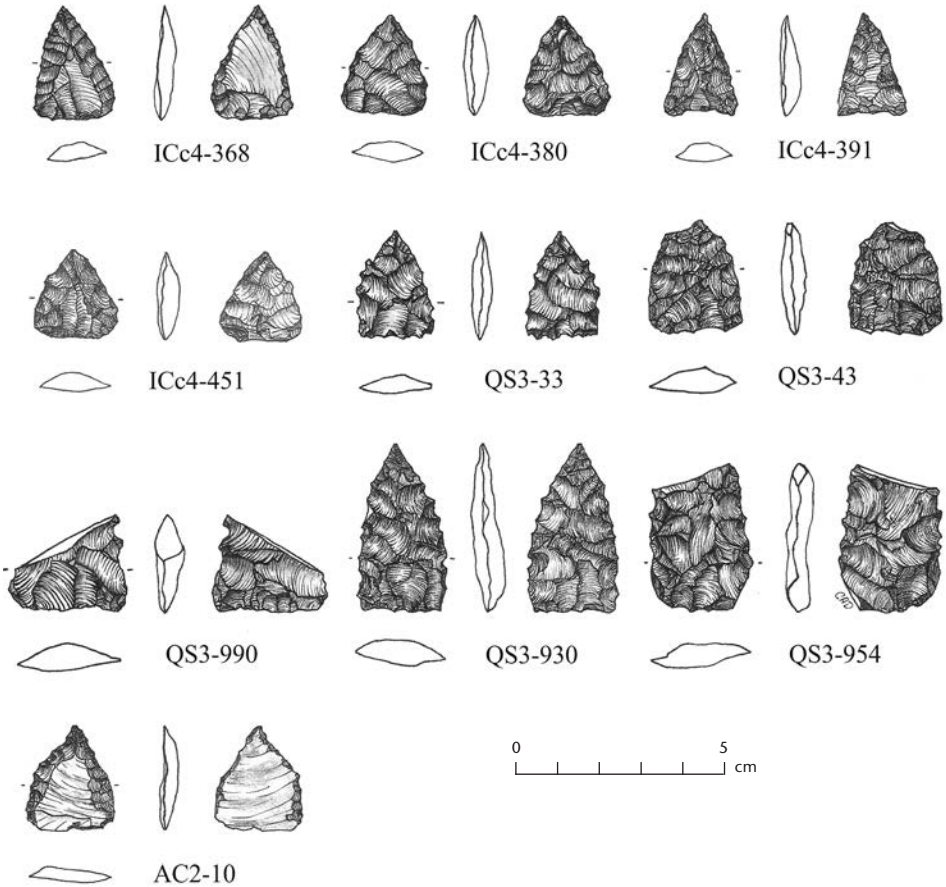

Figure 2. Non-stemmed triangular projectile points from Inca Cueva 4, Quebrada Seca 3 and Alero Caído 2, Argentinian Puna.

of use-life in the north. This interpretation is supported by other characteristics of ICc4 and QS3. Although they are both residential bases, there is a large difference in intra-site space at ICc4. Longer artifact life histories are thus expected in this last site.

The analyzed assemblages exhibit significant morphological variability. Nevertheless we are able to identify certain general trends in variation as a function of life history. First, there is a progression in size from long forms to short and medium ones. Second, although these pieces are characterized as triangular, they are actually subtriangular, with convex bases and edges that become straight by maintenance or reworking. It is this reworking that generates the triangular and pelecyform morphology (Brezillon 1983). Otherwise they involve substantial modification as a transformed cordiform as in Tuina 1 (northern Chile) from ca. 10,800 to 9100 RCYBP (Núñez et al. 2002), Third, the point tips vary from sharpened to non-sharpened. Fourth, the convexity of the blade edges diminishes, from attenuated convex linearity to very attenuated convex linearity or straight, and combinations of these. Fifth, denticulation is pres-

ent at the beginning of life history and tends to disappear through use and resharpening. Sixth, the rectilinear or very attenuated convex-linear bases are diversified in rectilinear, attenuated and very attenuated convex-linear and attenuated and very attenuated concave-linear shapes. Seventh, sharply defined basal corners (i.e., blade-base contacts) become rounded through reworking.

Thus, through transformed design analysis we have been able to reconstruct the basic design (Aschero 1988) of early-period projectile points. These are non-stemmed sub-triangular projectile points, with long forms, sharpened tips, attenuated convex-linear blade edges, denticulated edges, attenuated convex-linear or rectilinear bases, and angled blade-base contacts.

The morphological variation of the blade-base contact area observed in the ICc4 and QS3 points may be related to two hafting modes. Whereas in some cases the contact between the blade and base is a sharp point, in other cases this contact is rounded. Other combinations are also observed. On the one hand, the binding that secured the projectile point to the foreshaft/mainshaft would have surpassed the basal area in the case of angled contacts (which prevailed in long and medium pieces); thus, it held the proximal portion of the blade. We emphasize that resharpening of basal sectors was observed in these pieces in the area close to the base. On the other hand, when the tie only held the foreshaft/mainshaft, as in the case of rounded ends, the basal edge was exposed. There is no evidence in these pieces of differentiated basal areas.

Finally, the widespread early macroregional dispersion of this particular design of projectile point is notable in early archaeological contexts in the Argentinian and Chilean Puna. Understanding morphological variability as a result of extending use life helps reveal the original design of the projectile points, a principal purpose for disseminating technical information in the Puna context, and also helps us understand the substantial modifications made to subtriangular non-stemmed projectile points throughout their use lives.

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PART 2

Patterns of Cultural Transmission in the Manufacture of Projectile Points: Implications for the Early Settlement of the Argentine Puna

PART 2

Rodolphe Hoguin[1] *and Federico Restifo*[2]

➤**Keywords:** Cultural transmission, early Holocene, Puna

Within the Andean region, the Puna is an elevated desert that rises beyond 3,000 masl. Human settlement of this sector apparently began ca. 11,000 RCYBP during the Pleistocene-Holocene transition, the result of human dispersion from other biomes because of demographic pressures (Muscio 1999). The clearest archaeological records date to the early Holocene (ca. 10,000–8000 RCYBP). Early populations likely were of low demographic density and high residential mobility, given to moving great distances (Aschero 1994). These characteristics likely influenced cultural dynamics (Richerson et al. 2009).

Their lithic technology may have suffered from a loss of knowledge due to discontinuities in cultural transmission as a consequence of high mobility (Henrich 2004). Technological complexity develops as skills and know-how accumulate through time; interrupting transmission hinders the growth of complexity (Henrich 2004). Within the context of early settlement under highly unpredictable circumstances, the mechanisms of guided variation (individual learning by trial and error) would have a significant effect on human adaptation. Nonetheless biased transmission (social learning by imitation) would continue (Boyd and

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Richerson 1985). With these two forces operating simultaneously, we would expect toolmaking to exhibit variability and technical simplicity, at least during certain stages. To evaluate this expectation, this paper studies patterns of cultural transmission associated with lithic technology. We chose as our subject a sample of projectile points because this class of artifacts requires considerable investment to acquire the skills and know-how for their manufacture, making it all the more sensitive to mechanisms of cultural transmission.

The sample is from three archaeological sites within two areas of research: Alero Cuevas, in the Pastos Grandes area; and Hornillos 2 rockshelter and talus 9 of Lapao Grande ravine, in the Susques area (Figure 1). We analyzed stratified projectile-point assemblages from Alero Cuevas (n = 11) and Hornillos 2 rockshelter (n = 8) as well as three surface specimens from Lapao 9. These date to 9600–8200 RCYBP, based on four radiocarbon dates from Hornillos 2 rockshelter (Yacobaccio et al. 2008) and three from Alero Cuevas (López 2008).

To investigate aspects that affect cultural transmission of information for making early-Holocene triangular projectile points, we performed two discriminant analyses based on distances (CAP program, see Anderson and Robinson 2003; Anderson and Willis 2003), taking into account nine qualitative technological variables by means of Jaccard distances and Euclidian distances of three continuous metric variables (Figure 2).

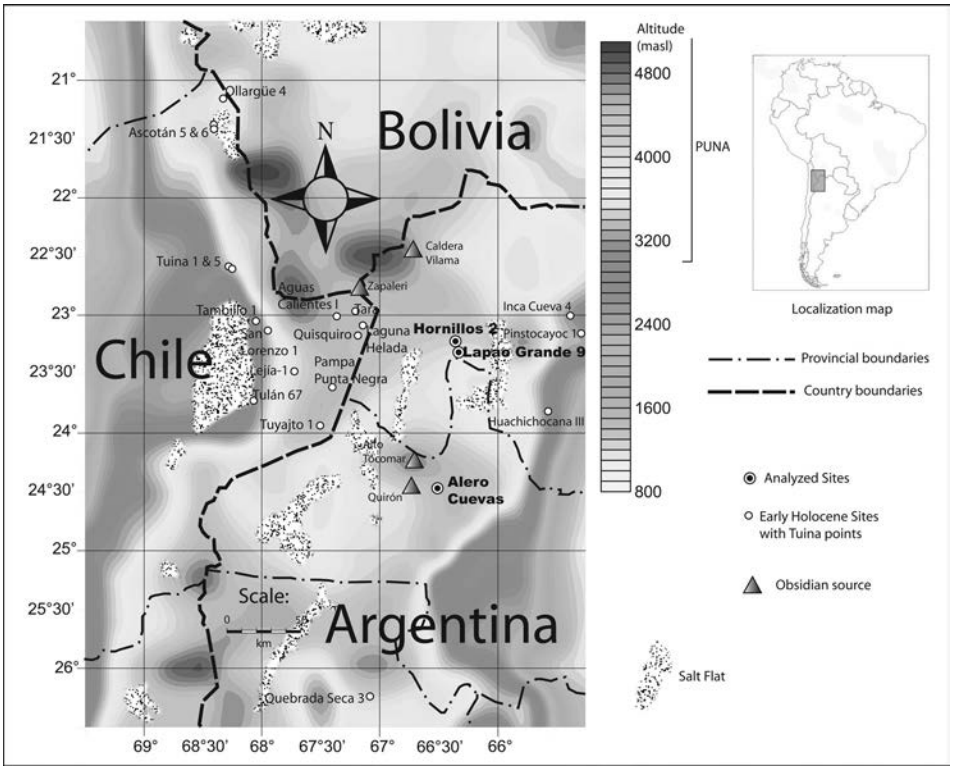

Figure 1. Early-Holocene sites with Tuina (unstemmed triangular) points. (Locations of sites after Núñez et al. 2005.)

PART 2

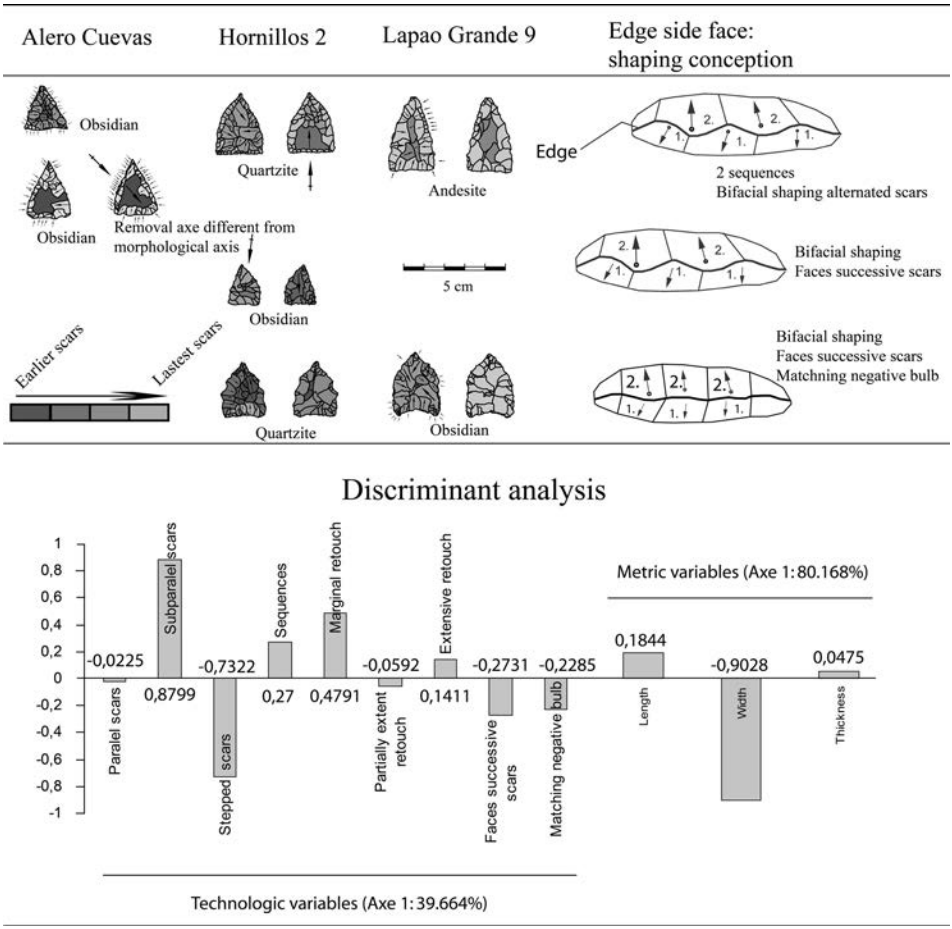

Figure 2. Manufacturing schemes and results of discriminant analysis.

Cross-validation yielded 100% correct classification for the Pastos Grandes sample, and 72.72% for the Susques sample. These results suggest greater heterogeneity in the latter sample. The variables that carry the most weight in discriminant classification among groups are stepped scars (occurring in greater frequency in the Pastos Grandes sample) and subparallel scars (more frequent in the Susques sample), and to a lesser extent, marginal scars (occurring in higher frequency in the Susques sample) (Figure 2). These specific tendencies reveal bias on the part of the toolmaker when making certain technical choices in each area. This analysis also makes apparent the low weight of variables related to greater skill and ability to predetermine tool shape, as demonstrated by the shaping of faces in successive order and the coincidence of bulb scars (Figure 2). Furthermore, high variation detected in the orientation of the axis of extracted blanks in both areas (Figure 2) suggests that blank shape was not predetermined but was instead an opportunistic choice.

Analysis of quantitative variables shows only 45.45% exactitude in each area. In this case

the discriminating variable is width (Figure 2), albeit not a robust one owing to the low degree of exactitude. Inexactitude prevents our detecting significant differences in metric variation.

Considering these results, it appears that the guided-variation mechanism played an important part in projectile-point manufacturing by the human groups that occupied the Puna during the early Holocene. This is a normal consequence of low demographic density and high residential mobility, since these factors impede the learning of skills and the transmitting of knowledge (Heinrich 2004). On the other hand, however, guided variation yields advantages in finding solutions in an unpredictable unknown environment, specifically the circumstances of an initial population, thus promoting innovations in point morphology (Fitzhugh 2001) and production. Nearly as important as guided variation, biased transmission also would have been valuable in the early Holocene (López 2008), particularly in fostering efficient innovations, for example, in the technique of retouching specific to each area. The information transmitted may have circulated regionally along with goods such as obsidian, especially those from Quirón and Zapaleri (Figure 1) recorded in both areas (Mercuri and Restifo 2010; Yacobaccio et al. 2008).

Unstemmed triangular points are common in the diverse early archaeological contexts of the central southern Andes (Núñez et al. 2005) (Figure 1), although distinct differences exist peculiar to each area. A similar study in the eastern and western regions of Jujuy has identified differences in the ranges of supply of lithic resources that nonetheless did not impede the flow of information between the regions (Yacobaccio et al. 2008). Likewise, the two areas studied here, despite their peculiarities, apparently enjoyed a firmer connection with each other than with the eastern region. Future studies will benefit from expanding the samples of artifacts, thus enlarging the database by integrating information from additional sites to test the hypotheses presented here.

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PART 2

Evidence of Early Human Burials in the Southern Argentinian Puna

Jorge G. Martínez[1]

➤**Keywords:** Human burials, early Holocene, southern Argentinian Puna

PART 2

Funeral behaviors of early hunter-gatherers in South America have been scarcely discussed owing to a lack of archaeological evidence. This paper presents the findings and implications of early evidence for human burials found in the southern Argentinian Puna during the period ca. 8400–8000 RCYBP.

The research area is Antofagasta de la Sierra, north of Catamarca province in northwest Argentina. Currently this region is an extreme desert at 3400 masl, within the Salt Puna or Puna of Atacama. The evidence considered comes from Peñas de las Trampas 1.1 (PT1.1), a large rockshelter located at 3582 masl.

PT1.1 rockshelter has a long occupational history; the earliest layer detected includes dung and bones of extinct Pleistocene megafauna dated to ca. 19,600–12,500 RCYBP without any cultural association (Martínez et al. 2004, 2007, 2010). Two recent radiocarbon dates reveal initial human occupation of this site between 10,190 ± 190 RCYBP (UGA-01975) and 10,030 ± 100 RCYBP (LP-1788). These dates, which constitute the earliest human occupations yet detected in the southern Argentinian Puna, extend the existing chronological depth for the area to the end of the Pleistocene period. Both dates were obtained on charcoal samples from the cores of combustion features associated with few lithic artifacts and skeletal remains of burnt modern fauna (unit 3E). The time difference of ca. 2300 years between these layers suggests, for now, that there was no coexistence between humans and extinct megafauna.

The second cultural component in PT1.1 yields information regarding the earliest mortuary practices in this area. Two funerary structures—labeled FS1 and FS2—were detected

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(Figure 1). They are very similar, and each consists of a sub-oval pit; the bases and edges of these features were carefully covered with bundles of grass. They were dug to the top of the upper layer of Pleistocene megafauna dung already mentioned (ca. 12,500 RCYBP). FS1 was 95 x 65 x 46 cm (length x width x depth); subsequently discovered FS2 was 115 x 80 x 42 cm. Radiocarbon dating the grass for each feature determines that FS1 was constructed 8440 ± 40 (UGA-9073) and FS2, 8210 ± 25 RCYBP (UGAMS-9097). Inside both structures were found human bones forming multiple secondary burials; analysis yielded a minimum number of three individuals for each structure (i.e., six in total) (M. G. Colaneri, pers. comm. 2010). The bone assemblages recovered are in an excellent state of preservation,

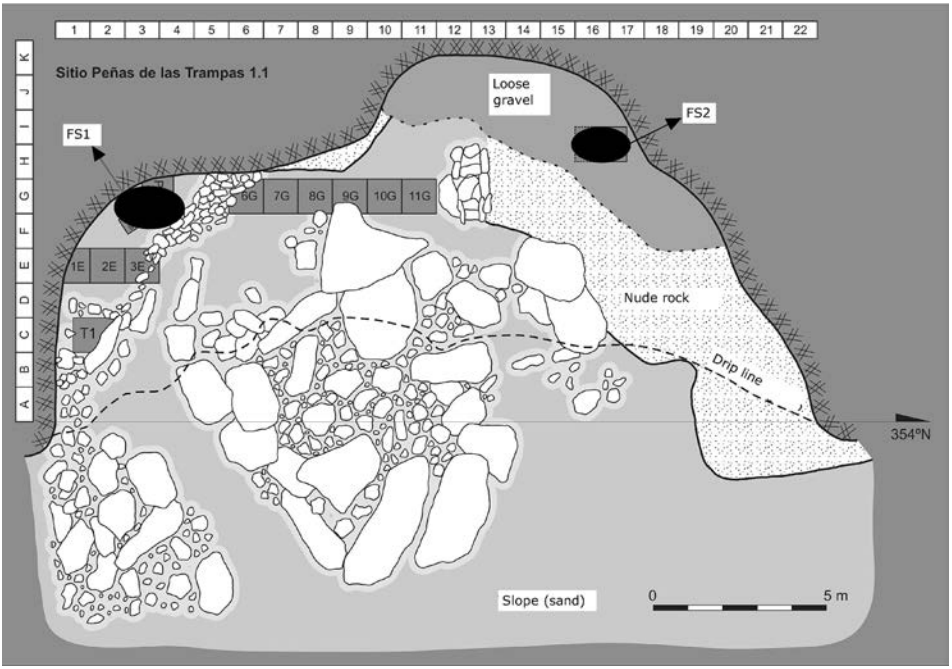

Figure 1. Map of interior space of Peñas de las Trampas 1.1, showing the location of excavation units, walls of rockshelter, and funerary structures 1 and 2.

but the majority of the skeletal parts are absent as a result of cultural practices, given that some bones had postmortem anthropic marks and almost no signs of carnivore traces (M. Mondini, pers. comm. 2010). Regarding the age of individuals, three sub-adults were present in FS1 (all under 10 years); one adult (ca. 20 years) and two sub-adults (under 2 years) were present in FS2. Sex determination was impossible due to the young age of most of the individuals and the absence of diagnostic skeletal parts in the case of the adult of FS2 (A. Calisaya, pers. comm. 2010). The content and general characteristics of both structures are very similar. These human remains are associated with highly complex handicrafts, such as leather pieces (sewn, dyed, and painted), numerous necklace beads made from non-local seeds or fruits (undetermined species); strings and fragments of red dyed mesh or net made from non-local plant fiber identified as *Acrocomia Chunta* (Rodríguez and

Aschero 2005) and a probable headband made with intertwined bird feathers *(Rhea pennata)*.

AMS dating (on collagen) of all individuals of both structures was conducted to assess the likely synchronicity of time of death. The dates, shown in Table 1, reveal a grouping of dates for individuals of both structures within the short span of ca. 8230–8140 RCYBP. Statistically all are synchronous, with the exception of individual 3 of FS2 (ca. 8000 RCYBP) (C. Greco, pers. comm. 2010).

Table 1. Radiocarbon dates of all individuals from funerary structures 1 and 2, Peñas de las Trampas 1.1.

Sample ID	Date (RCYBP)	Lab no.	Sample ID	Date (RCYBP)	Lab no.
PT1.1 FS1. Ind.1	8230 ± 30	UGAMS 4994	PT1.1 FS2. Ind.1	8170 ± 30	UGAMS 4997
PT1.1 FS1. Ind.2	8140 ± 30	UGAMS 4995	PT1.1 FS2. Ind.2	8210 ± 30	UGAMS 4998
PT1.1 FS1. Ind.3	8150 ± 30	UGAMS 4996	PT1.1 FS2. Ind.3	8000 ± 30	UGAMS 4999

The sequence of construction and subsequent use is completely coherent for both features; in the case of FS1, however, an interesting gap of ca. 200 years is observed between its construction and the deposition of the individuals (or part thereof). This means that although the death of almost all individuals occurred in a relatively synchronous way, the deposition of human remains in FS1 was deferred at least 200 years. This is consistent with certain customs (local tradition?) regarding the use of the same site and the same type of funerary practice for about 400 years.

Based on the foregoing, we can define the following sequence of mortuary events:

1) FS1 is built (i.e., excavated and conditioned with bundles of grass) ca. 8440 RCYBP;
2) in FS1 three individuals are deposited (deferred) between ca. 8230 and 8140 RCYBP;
3) FS2 is built ca. 8210 RCYBP;
4) in FS2 individuals 1 and 2 are immediately deposited between ca. 8210 and 8170 RCYBP;
5) in FS2 individual 3 is deposited (deferred) ca. 8000 RCYBP.

The evidence suggests that the presence and absence of skeletal parts of individuals is associated with symbolic or cultural aspects of ancient burial practices, where transport of certain anatomical parts of the deceased was common (human remains intentional removed and deposited in specific places, and skeletal parts eventually removed and redeposited). This type of funerary practice, likely related to ancestor worship associated with an early sense of social circumscription or territoriality (Aschero 2007), was recorded frequently in later times in the Puna area. If these assumptions are valid, it is likely that during the hiatus of ca. 200 years recorded in FS1, several events of deposition, removal, and transport of individuals or parts of individuals may have occurred. The same could be true for the second hiatus observed in FS2 before the deposition of individual 3 at ca. 8000 RCYBP.

Similar findings within this early chronological range for the northern Puna of Argentina include Cueva Huachichocana III, ca. 10,200–8600 RCYBP (layer E3), with burial of isolated skeletal parts (Fernández Distel 1986); Cueva Yavi, ca. 8400 RCYBP (layers E–F), a multiple secondary burial in a structure conditioned with grass (Kulemeyer et al. 1999); Pintoscayoc 1, ca. 8000 RCYBP (Layer 5), a burial of isolated skeletal parts without structure (Hernández Llosas 2000). This information, however, has not yet been properly integrated into a common

complex at the macro-regional scale, so the findings from PT1.1 are the first such evidence found in the southern Puna of Argentina. In this particular case the causes of death have yet to be determined, particularly for the infants, yet their death is likely a direct or indirect result of increasing aridity in this area since ca. 8200 RCYBP (Tchilinguirian 2009).

The findings at PT1.1 enlarge our knowledge of the social and symbolic dimensions of this type of mortuary practice. Although at present there are neither similar nor synchronous findings in the southern Argentinian Puna, we would expect to find these features replicated in other sites in the area. This would further illuminate early mortuary behavior and the related complex social mechanisms that promoted the circulation of allochthonous items by these early hunter-gatherers.

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Procuring Quartz Crystal in Latest-Pleistocene/Early-Holocene Sites in Northern Semiarid and Mediterranean-Central Chile

PART 2

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➤**Keywords:** Quartz crystal, Pleistocene/Holocene transition, northern semiarid Chile

Quartz crystal is one the most frequently encountered lithic raw materials recorded at latest-Pleistocene through early-Holocene sites between 31° S and 34° S in Chile (Figure 1). This abundance has also been noted at other early sites in South America, especially with regards to Fishtail projectile-point (FPP) production at localities such as Quebrada Santa María and Quebrada Batán in northern Perú (Briceño 1999; Maggard 2010) and the Negro River basin in Uruguay, among other locations along the Atlantic rim (Nami 2009). The high quality of some crystalline varieties and its beautiful translucence and shininess likely account for its selection as a toolstone (Nami 2009). Currently, however, there are no regional-based models backed by radiocarbon dates for describing quartz procurement during the period in question.

At 31° 50′ S–32° S, the coastal area around Los Vilos locality (northern semiarid region), quartz is an extra-local raw material found at many sites dating to 12,000–8500 CALYBP. These sites, which were oriented toward a littoral subsistence, are known as the Huentelauquén cultural complex (HCC) (Jackson and Méndez 2005). A total of seven coastal sites besides one inland site yielding quartz can be assigned to HCC either typologically or by their radiocarbon dates. Both translucent and non-translucent quartz varieties are commonly found in small quantities on the surface and in stratigraphic contexts, mainly as debitage and occasionally as

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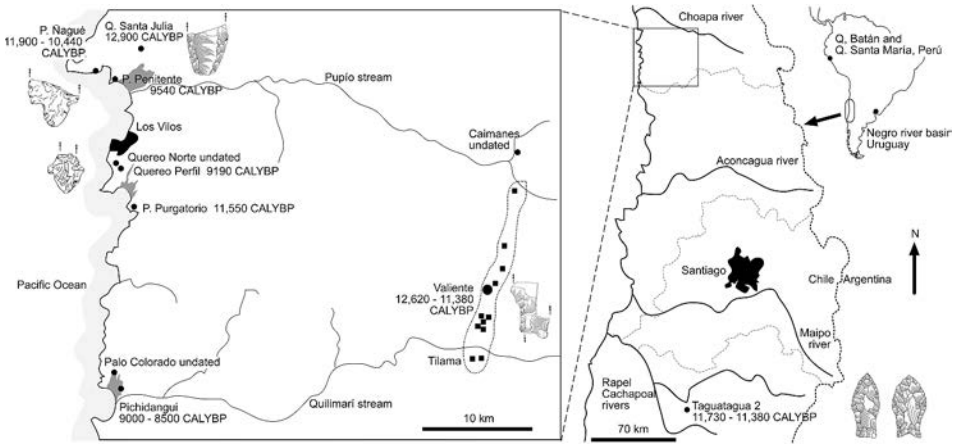

Figure 1. Map of South America, central Chile, and the study area showing sites mentioned in the text. Squares represent locations sampled for assessing raw material; gray areas, dune fields; dotted line, area with quartz occurrence. Bifacial artifacts are not drawn to scale; arrows show fractures.

large lanceolate stemmed projectile points (Ballester et al. 2011; Jackson et al. 1997–98, 1999, 2009; Méndez 2002) (Table 1). The only widely accepted earlier site in the area, Quebrada Santa Julia (QSJ) (Jackson et al. 2007), yielded a variety of fine quartz crystal in about 35% of its debitage assemblage, and as the toolstone for two butchering tools and two bifacial blanks in an occupational floor dating to 12,900 CALYBP (Méndez 2010).

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To evaluate regional availability of lithic resources, Méndez et al. (2010) carried out systematic surface surveys along the area between 31° 56′ S and 32° 05′ S, where a high concentration of quartz was found 35 km from the coast. At the Valiente site (CT14), the research team found bifacial artifacts and debitage in an exposed profile. Excavations at the

Table 1. Quartz occurrence at sites in the study area and distance to the Caimanes-Tilama source (midpoint: Valiente site); values consider only debitage from excavated samples.

		Stratigraphy (%)		
Site	Surface	Quartz	Other rocks	Distance to source (km)
QSJ		35.2	64.8	37.45
Ñagué	Debitage	12.99	87.1	40.15
Penitente	Projectile point	0	100	38.14
Quereo Norte	Projectile point	3.88	96.27	34.97
Quereo Perfil		ND	ND	34.65
Purgatorio	Debitage	ND	ND	32.17
Palo Colorado	Projectile point	ND	ND	34.35
Pichidangui	Debitage	0.19	98.1	34.17
Caimanes	Debitage	58	42	11.29
Valiente*		99.45	0.55	0

*Preliminary data.

site, which cover an area of 9 m^2 and are currently not completed, revealed a low-energy clayey sandy alluvial deposit. A 70-cm-thick section yielded quartz debitage and bifacial fragments, small burnt bone fragments, and isolated charcoal particles. Two dates frame this stratigraphic section—at the top, 9970 ± 30 RCYBP (UGAMS-7820, $\delta^{13}C$ = -20.5, charcoal), and at the base, 10,700 ± 30 RCYBP (UGAMS-5887, $\delta^{13}C$ = -23.8, charcoal). This buried context spans the period 12,620–11,380 CALYBP. Two FPP stems and one mid-section were found at the basal level. Since roughly 10 cm of deposits are yet to be excavated, we believe there is a chance of finding slightly older deposits, probably even contemporary with those at QSJ.

The depositional context at Valiente suggests repeated chipping and discarding events, which we preliminarily interpret as evidence of recurring and discontinuous occupations engaged in early stages of quartz crystal bifacial production motivated by the concentration of this high-quality toolstone. This site is significant because it provides evidence linking the interior with the coast in a radiocarbon-dated time frame. During the latest Pleistocene in the area, quartz was used to make both bifacial and unifacial artifacts, as suggested by evidence gathered at QSJ. Quartz constituted a significant proportion of lithic raw materials at this site, and only quartz of the highest quality was selected. During the early Holocene at Los Vilos, quartz was one of the many toolstones used to produce large bifacial lanceolate stemmed projectile points. This quartz exhibits a wider variability, including non-translucent varieties, and generally appears in fewer quantities. This is probably related to late-stage biface transport and incomplete local reduction sequences.

On a wider regional scale, including Mediterranean-central Chile, it is significant that radiocarbon ages obtained at the Valiente site coincide with those from Taguatagua 2 (Núñez et al. 1994). FPPs at both sites share the same morphotypological attributes and toolstone, high-quality translucent quartz crystal. The sites differ significantly, however, in function. At Taguatagua 2 the context is a series of mastodon butchering events, where orderly disposed carcasses are associated with very few highly curated lithic tools and almost no lithic debitage (Méndez 2010). This activity differs from that described above at the Valiente site, which suggests that the two settlements served complementary functions. Though currently there is no way of knowing if quartz crystal at Taguatagua came from the Caimanes-Tilama source (270 km distant), it is important to note that the preferred use of a rare toolstone may be the basis for suspecting a link between widely separated contemporary sites.

Quartz crystal was valuable, both as an object of beauty and as a toolstone, in the area of Mediterranean-central Chile and particularly at Los Vilos. A significant lithic raw material from the latest Pleistocene through the early Holocene, it was utilized during the first exploration of the region and subsequently ever since. Its technological use evolved as settlement patterns and economic strategies changed. At the Los Vilos locality and its environs, latest-Pleistocene groups became familiar with the quartz source and utilized quartz as a toolstone opportunistically as suggested by the diverse evidence at QSJ. During the early Holocene, HCC groups exploited this source on a larger scale, as suggested by coastal evidence of late stages in projectile points and small amounts of debitage at several locations. Continued research at these sites will refine the model of early procurement of critical lithic resources in the northern semiarid and Mediterranean regions of Chile.

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Human Occupation in the Northern Argentine–Chilean Central Andes during the Early Holocene

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➤**Keywords:** Human occupation, early Holocene, Argentine-Chilean Central Andes

PART 2

The study area, located in northwestern San Juan Province, Argentina, extends from the western slopes of the Andes (4500 masl) to valleys immediately to the east (3700 masl). Farther east, in neighboring Argentina, another mountain range rises with higher elevations than that on the international border; in fact, the western slope of the Andes has very accessible routes from the valleys that reach the coast (Figure 1).

The site Arq. 18 (3761 masl) is a cave/rockshelter located in a small glacial valley with a meadow and stream that drains into the Las Taguas River. Besides enjoying an environment rich in biotic and abiotic resources, the site is located along a natural access route to the Andean divide. The deposit that formed the cave and rockshelter, used as a natural refuge throughout the Holocene, is a conglomerate that likely was eroded in a glaciofluvial environment. Our 2-m^2 excavation was on the slope below the eave of the cave and reached almost 50 levels deep, each level 5 cm thick. The chronological sequence was obtained from 18 conventional and AMS radiocarbon dates that fall between 9000 and 1500 RCYBP, comprising five components of occupation, which are defined by very clear stratigraphic features and dates from the top and bottom of each component.

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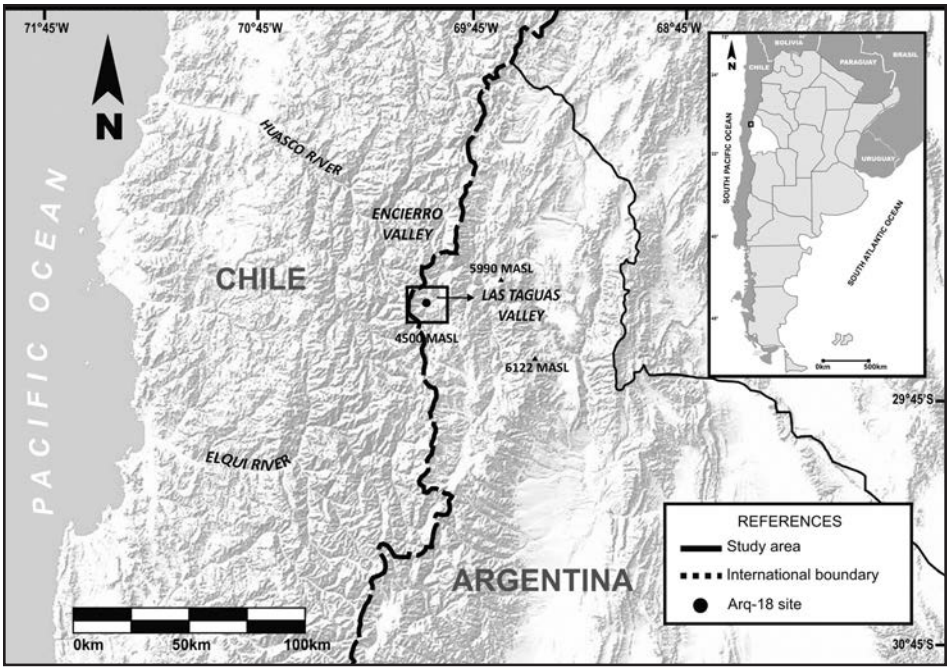

Figure 1. Location of the study area, Las Taguas valley, and the Arq. 18 site.

PART 2

Geomorphology, Paleoenvironments, and Human Occupation of the Area

The Arq. 18 site is located at the eastern end of a small glacial valley, from which glacier melt flows into the Las Taguas River valley. In the valley there is evidence of lateral and basal moraines and one poorly preserved frontal moraine. While these have no absolute dates, Encierro valley 25 km to the north has cosmogenic dates from lateral and frontal moraines that suggest the melting of glaciers in this area and the stabilization of landform surfaces dates between 10,400 ± 1000 and 9300 ± 900 cosmogenic ^{10}Be years B.P. (Zech et al. 2006). These cosmogenic dates indicate that by 9300 RCYBP Encierro valley should have been free of ice. Comparing these data with radiocarbon dates from Arq. 18, one can infer with some degree of certainty that this small glacial valley was ice free, at least at its mouth where the site is located, starting about 10,400 RCYBP. Moreover, the eave of Arq. 18 is composed of debris flow deposited in a proglacial position, consistent with the retreat of the glacier tongue to its headwaters. These results, consistent with those obtained from the site, suggest the temporal limit of possible human exploration in the area. The occupation by groups of hunter-gatherers that seasonally exploited this environment could have started in the early Holocene and continued until the early middle Holocene, about 7000 RCYBP. The site geochronology shows an occupation hiatus of 1600 years.

From 7300 to 5100 RCYBP, there seems to have been a decrease in snow precipitation in the Andes, as reported for the Norte Chico region of northern Chile (Veit 1996). The driest period of the Holocene seems to have been centered at 7500–6000 RCYBP, when the estimated temperature increased by about 3°C (Maldonado and Rozas 2008). Studies in the Negro Francisco lagoon suggest arid conditions from 6000 to 3800 RCYBP (Grosjean et al. 1997).

Veit (1996) has established three periods with more moisture in the mountains and extreme aridity in the lower areas for the Norte Chico region of northern Chile: the first until 7300 RCYBP, the second at 5000–3700 RCYBP, and the third at 3000–1800 RCYBP.

These recurring climatic episodes during the Holocene suggest that summer occupation of the western slope of high Andean environments would have escaped a dry season. There is, in fact, a strong correlation between these wet cycles and the chronology of human occupation recorded at site Arq. 18.

Archaeological Record and Components

Cultural material from the earliest occupation of Arq. 18 is scant and, moreover, appears in varying quantities throughout levels. This phenomenon is interesting, considering that the dating of lower layers demonstrates that the site may have been used over a considerable period of time, although perhaps with varying frequency and density of occupation.

Component V, the earliest, dating to 8900–8000 RCYBP, shows a very low quantity and discontinuous accumulation of lithic materials, and almost no bones. Bones steadily decrease in frequency in deeper levels until they nearly disappear in the lowest level. Ph tests (n = 34) indicate sediment more alkaline near the surface and increasingly acidic and humid in deeper levels. The lower levels can be characterized as corrosive sediment, capable of gradually degrading or completely destroying bones (Nielsen-Marsh et al. 2007). It has five absolute dates: 8070 ± 140 (LP-1977), 8252 ± 51 (AA-81732), 8440 ± 100 (LP-1860), 8400 ± 90 (LP-1859), and 8950 ± 100 (LP-1815) RCYBP. They include 16 levels totaling 80 cm thick, which have yielded 22% of the 16,364 lithic elements recovered from the site. Noteworthy is the presence of local raw materials and typical small products on non-local rocks. Because there is an excellent range of lithic resources in the area, this composition could reflect an exploratory stage of occupation (sensu Franco 2004). Among the few artifacts, there are two small triangular projectile points, like those that have been recorded in other early occupations on both slopes of the Andes (Martínez 2007; Núñez et al. 2002) (Figure 2).

Component IV (7300–6600 RCYBP) has the highest density of artifacts in the entire sequence, 45.92% of the lithic elements recovered from the site in eight levels, and continuity in the type

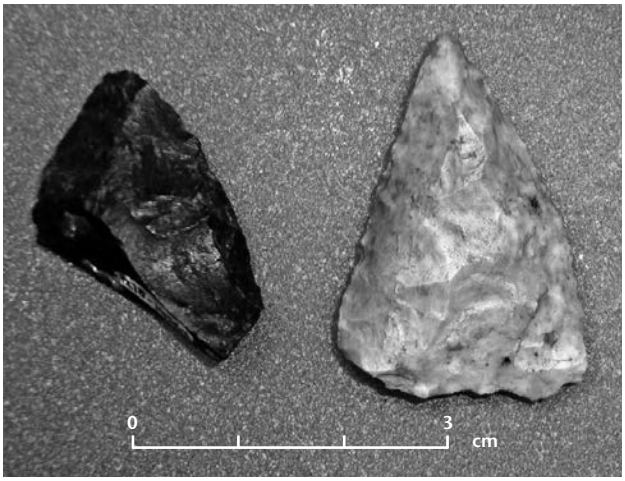

Figure 2. Triangular projectile points from component V, the basal component of the Arq. 18 site.

of triangular projectile points. The record may represent a stage of colonization of the area. The site shows a hiatus of nearly 1600 years after this occupation, comparable with similar situations recorded along the Andes and also coincident with a period of aridity (Zárate et al. 2005). The area was subsequently recolonized by groups with different subsistence strategies. Later occupations in the middle and late Holocene show increasing use of the site by pastoralists.

Conclusions

Las Taguas valley appears to have been first explored (sensu Borrero 1994) about 9000 RCYBP, after the last retreat of glacial ice at 9300 CALYBP in nearby El Encierro valley (Zech et al. 2006). The earliest occupation of the site, as early as 8900 RCYBP, shows some temporal discontinuities and a relatively limited material record. This characterized the first human occupation of the area during the early Holocene. Successive human occupations appear to coincide with periods of abundant water in the mountains and aridity at lower altitudes of the western slopes of the Andes (Veit 1996). Given the topography of the area on both sides of the Andean divide, the characteristics of the archaeological record, and paleoenvironmental data, we suggest that this mountain region was exploited throughout the Holocene from the western slope (Chile).

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Human Occupation of the Central Mountains of Argentina during the Pleistocene-Holocene Transition (11,000–9000 RCYBP)

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PART 2

➤**Keywords:** Argentine Central Mountains, radiocarbon dates, human occupation

Plotting the distribution of radiocarbon-dated sites is a reliable method for assessing the intensity of human occupation, landscape use, and demography in a region (e.g., Barberena 2008; Barrientos and Pérez 2002; Neme and Gil 2009; Rick 1987). To assess the intensity of human occupation in the Central Mountains of Argentina, the database of all available radiocarbon dates (N = 60) was used in this paper. These dates were obtained by several researchers using different criteria. Thus cautionary procedures recommended by Barberena (2008) were observed to minimize the possibility of mistakes.

Two-sigma calibrated radiocarbon ages were processed with the OxCal3 program (Bronk Ramsey 2007). Non-statistically discriminant dates from the same site were combined with OxCal3 (R-Combine function) to avoid over-representing the sequence of segments with multiple dates. Finally, dates expressed in CALYBP were plotted using the CalPal 2007 program (Weninger et al. 2007) to reveal variations in the intensity of the archaeological signal over time (Figure 1).

Results

Results show a discontinuous and low-intensity occupation prior to 9000 CALYBP. The archaeological signal increases and becomes more constant over time after 9000 CALYBP, showing

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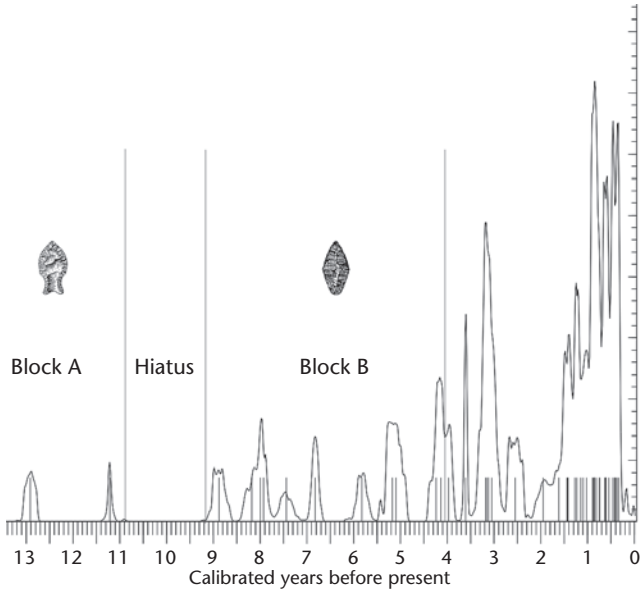

Figure 1. The intensity of the archaeological signal in the Central Mountains of Argentina, based on radiocarbon-dated occupations (in calendar years).

several peaks of intensity and following a trend of gradual increase of the archaeological signal.

The scarce evidence between 13,000 and 9000 CALYBP could be the result of sampling bias, low visibility of archaeological remains in early contexts, or their destruction by taphonomic processes (e.g., Surovell and Brantingham 2007; Surovell et al. 2009). These processes could have generated a false image of the intensity of human presence during this period and should be taken into account. It is possible, however, that the extensive hiatuses accurately identify periods of very low demography with an ephemeral regional occupation.

Although regional surveys have been carried out over the last decades, only one stratified context dating to the Pleistocene-Holocene transition has been detected, . This is component 1A at the El Alto 3 site. This component was dated at 11,010 ± 80 (LP-1506) and 9790 ± 80 RCYBP (LP-1420), that is, between 13,000 and 11,000 CALYBP (Rivero 2009; Figure 2).

Other early dates for the region were clustered between 8200 and 6500 CALYBP. They were obtained from El Alto 3, Arroyo Gaucho 1 (Rivero 2009), Quebrada del Real 1 (Rivero et al. 2009), and Ongamira (González and Lagiglia 1973). The date for Intihuasi Cave in Sierra de San Luis ca. 8900 CALYBP (González 1960) was also added to the analysis.

In Figure 1, the period prior to 4000 CALYBP was arbitrarily divided into blocks A and B, separated by a hiatus of 1500 calendar years. This division was intended to emphasize early evidence and intensity of human occupation during the Pleistocene-Holocene transition in the region. Stratified evidence for block A comes from El Alto 3 (Rivero 2009), and surficial finds of Fishtail points (n = 3) from the mountains of Córdoba and San Luis provinces were also considered (Laguens et al. 2007; Politis 1991; Schobinger 1988). The beginning of block B in Figure 1 marks a notable increase in the archaeological signal intensity, which could be explained by a more stable human presence in the region. Block B is characterized by lanceolate projectile points known as Ayampitin points (González 1960). These points, which have been dated to between 10,250 and 4400 CALYBP, verify human presence in the macro-region

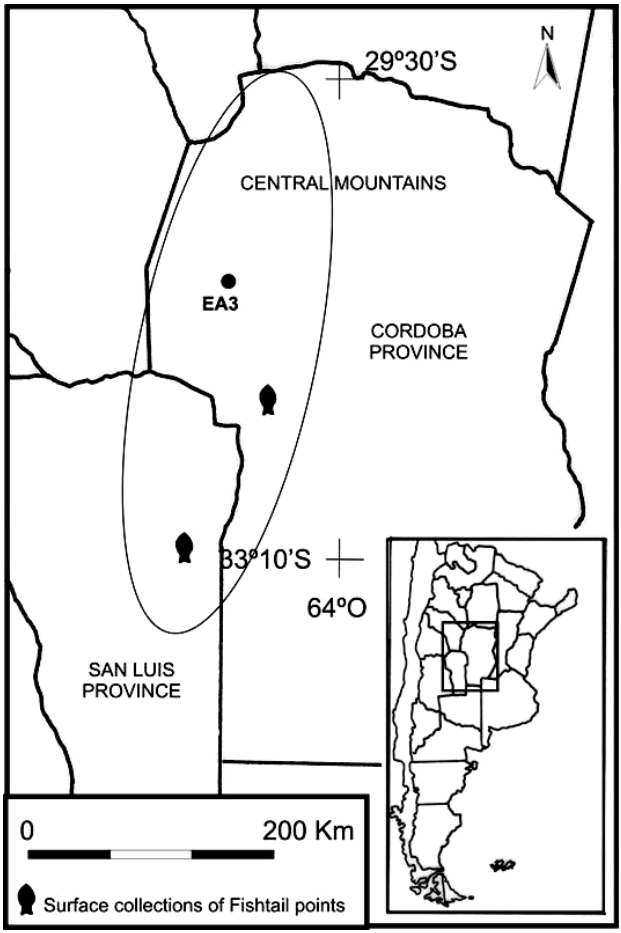

Figure 2. The location of the El Alto 3 archaeological site (EA3) and surface collections of Fishtail points in the Central Mountains of Argentina.

that includes the Central Mountains and the area north of Mendoza and San Juan (Berberián and Calandra 1984; Gambier 1974; García 2003; González 1960; Rivero 2009).

Conclusions

The temporal distribution of radiocarbon dates in the region reveals a temporary hiatus without absolute dates in the interval 10,800–9300 CALYBP. This gap of 1500 calendar years divides two distinct periods of occupation. Block A is characterized by a very weak signal of human presence during the Pleistocene-Holocene transition. Conversely, block B demonstrates that human presence so increased that it can be interpreted as a period of effective colonization of the Central Mountains.

The temporal hiatus could reflect a regional discontinuity in human peopling of the Central Mountains of Cordoba, the result of a local retreat or extinction of populations. This process does not necessarily imply the total disappearance of humans in the area. Rather, it is probably a sparse and scattered signal of reduced archaeological visibility. The evidence thus suggests

that population discontinuity could have occurred if the local population had a low density and had been isolated from major population centers, making long-term biological reproduction and population growth difficult (Anderson and Gillam 2001; Moore 2001; Moore and Moseley 2001).

The increase in human-occupation intensity from the mid-early Holocene (block B) could reflect a period when the Central Mountains were recolonized. The new colonists could have been people from the central Andean region of Argentina, as suggested by stylistic similarities in lanceolate projectile point technology (Rivero and Berberián 2006, 2008).

In conclusion, a retreat or local extinction of the population that occupied the Central Mountains (i.e., a failed colonization) during the Pleistocene-Holocene transition should be considered a possible cause of the population hiatus between 10,800 and 9300 CALYBP. Later, a new colonization could have occurred at 9300 CALYBP. Furthermore, these results caution against using regional peopling models that assume biological and cultural continuity throughout the Holocene.

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PART 2

Lithic Technology at Campo Laborde, an Early-Holocene Megamammal Hunting Site in the Pampean Region (Argentina)

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➤**Keywords:** Lithic technology, megamammal hunting, Pampean region

PART 2

Kill/scavenge sites of megamammals in different parts of the world have provided extensive information on subsistence strategies, hunting techniques, and technologies used. These kinds of sites often contain the remains of one or a few animals associated with a small number of artifacts (e.g., Surovell and Waguespack 2008). In the Pampean region, information about lithic technologies associated with killing and butchering megamammals during the late Pleistocene and early Holocene has been gathered at only two archaeological sites, La Moderna and Paso Otero 5 (Armentano et al. 2007; Martínez 2001; Palanca et al. 1973; Politis and Gutiérrez 1998).

Recent investigations carried out at Campo Laborde (Figure 1), an archaeological site related to the hunting and primary processing of a giant ground sloth (*Megatherium americanum*), provide new evidence to understand the lithic technology linked to these specific activities. This paper presents the results of the techno-morphological analysis of the lithic assemblage from Campo Laborde. The main objectives of this research are to identify the manufacturing stages for each of the lithic raw materials and to infer the technological organization employed by hunter-gatherers who butchered this megamammal species.

The Campo Laborde Site

Campo Laborde is located along a tributary stream in the upper basin of Tapalqué Creek (Buenos Aires Province, Argentina). This single-component site is related to hunting and butchering a giant ground sloth along the edge of a paleoswamp (Politis and Messineo 2008).

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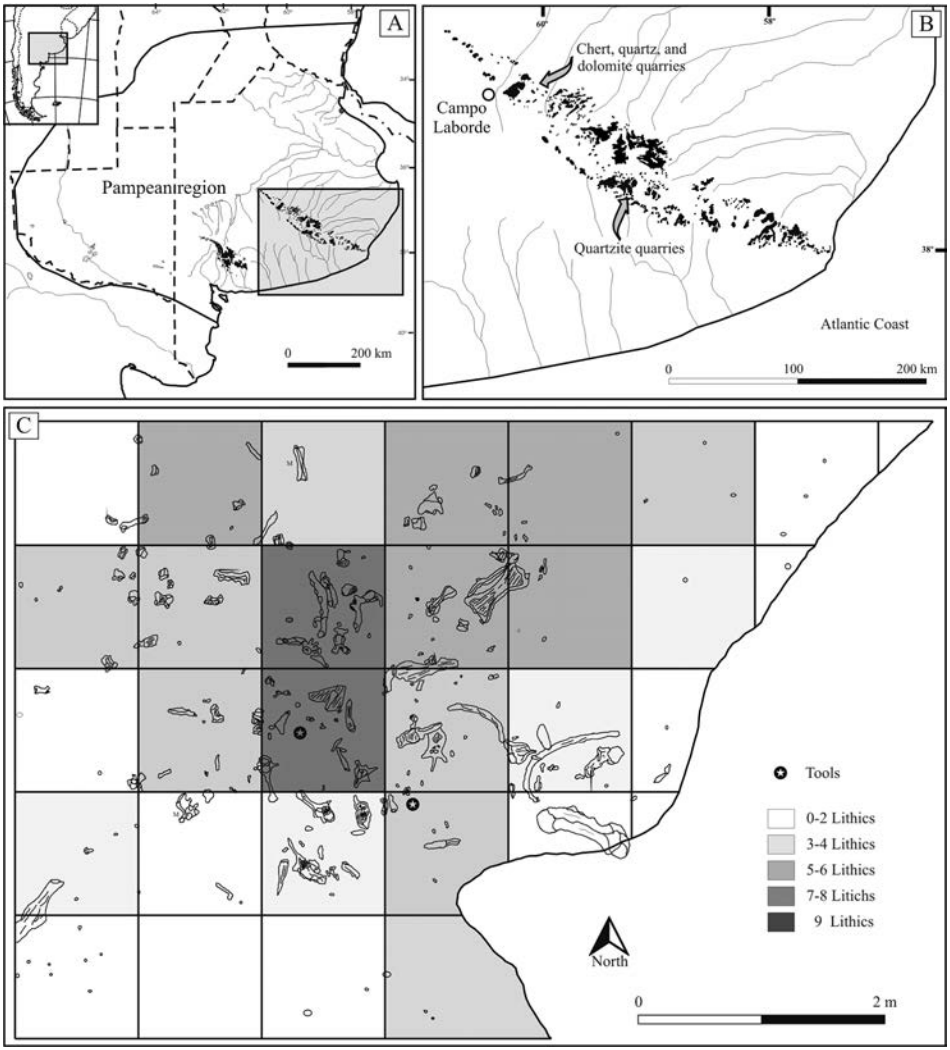

Figure 1. The Campo Laborde site. **A–B,** the location of Campo Laborde and quarries in the Pampean region; **C,** excavation map for Campo Laborde, showing the distribution of megamammal bones and lithic materials.

Both axial and appendicular elements from this species are present (e.g., ribs, vertebrae, tibiae, metapodials, carpals, tarsals, and phalanges), and two ribs were used as tools. The two rib-bone tools each exhibit a rounded and polished fracture edge; they likely were used as expedient tools in butchering tasks (Messineo and Pal 2011). Additional faunal remains at the site include a humerus and femur from two extinct glyptodonts (*Neosclerocalyptus* sp. and *Doedicurus* sp.), and bones from other extant species (*e.g.*, *Dolichotis patagonum*, *Lagostomus maximus*, *Tayassu* sp., *Chaetophractus villosus*, *Zaedius pichiy*, among others) were also identified.

Geologic studies carried out at Campo Laborde show that the archaeological component was recovered from a paleoswamp and a paleosol (4Ab) located in the lower section of the Rio Salado Member, a fluvial deposit representing an aggrading floodplain. Six bone samples were processed and yielded ages between 9730 ± 290 and 6740 ± 480 RCYBP. Moreover, two samples of soil organic matter obtained from paleosol 4Ab and the paleoswamp yielded dates of 7960 ± 100 and 8090 ± 190 RCYBP, respectively (Messineo and Politis 2009: Figure 1).

Lithic Analysis

The lithic assemblage from Campo Laborde includes 105 flakes, 24 angular debris fragments, and 2 tools. The main lithic raw material is fine-grained orthoquartzite of the Sierras Bayas Group (49.62%), followed by chert (25.95%), silicified dolomite (17.56%), and other lithic raw materials in lower percentages (Table 1). A cursory examination of the horizontal spatial distribution of archaeological materials shows a non-homogeneous assemblage. Most lithic artifacts were recovered within the concentration of giant ground-sloth bones, which suggests that hunters knapped directly around the carcass (Figure 1C).

Table 1. The debitage assemblage from Campo Laborde, by lithic raw material.

	Flakes		Angular debris		Tools		Total	
Lithic raw material	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Orthoquartzite	49	75.39	14	21.54	2	3.08	65	49.62
Chert	30	88.24	4	11.76	–	–	34	25.95
Silicified dolomite	21	91.30	2	8.7	–	–	23	17.56
Quartz	2	40	3	60	–	–	5	3.82
Undetermined	3	75	1	25	–	–	4	3.05
Total	**104**	**80.15**	**24**	**18.32**	**2**	**1.53**	**131**	**100**

The assemblage has an intermediate percentage of complete flakes (37.14%), with relatively more flake fragments including proximal (40.95%) and distal (21.91%) sections. With the exception of an orthoquartzite flake larger than 20 mm, the rest of the debitage is small (< 10 mm). Flakes of chert range between 1.6 and 6.6 mm, silicified dolomite between 1.8 and 7.2 mm, and orthoquartzite between 1.8 and 8.7 mm. Different kinds of flakes recognized in the assemblage show evidence of diverse reduction sequences and chipping techniques conducted at the site. In the case of orthoquartzite, there are only interior flakes, predominantly angular, unifacial retouch (*sensu* Root 2004) and plain flakes (mainly with single, linear, and dihedral platforms). Likewise, chert registers the highest percentage in the similar kind of interior flakes and platforms, but low frequencies of exterior flakes and cortical platforms. In the case of silicified dolomite, most artifacts in the assemblage are unifacial retouch and angular flakes; unifacial and bifacial resharpening flakes were also found.

Two lithic tools were found. One, an orthoquartzite sidescraper made from a large and thick flake without cortex, has two working edges with unifacial and marginal retouch. The second tool is interpreted as the base of a broken lanceolate bifacial projectile point (Politis and Messineo 2008). Use-wear analysis suggests that the projectile point was probably hafted (Messineo and Pal 2011: Figure 1).

Discussion and Conclusions

Although most of the lithic raw materials identified in Campo Laborde come from the Tandilia Hills system, the orthoquartzite is non-local and outcrops are located more than 100 km from the site (Colombo 2011; Flegenheimer et al. 1996). The remaining rocks are considered local owing to the fact that the quarries identified in the Sierras Bayas and Cerro Negro Hills (Barros and Messineo 2006; Messineo 2008) lie less than 30 km from the site (Figure 1B). It is noteworthy that some flakes found in the site were too small and lacked macroscopic characteristic to identify the parent rock.

The scarcity of cortex indicates that the initial decortication stage of reduction did not occur at Campo Laborde. The techno-morphological analysis points out that the flakes represent the final stages of tool production and the resharpening of different types of cutting tools, which were used in processing the giant ground sloth. The final stages of the lithic reduction sequence were detected on non-local orthoquartzite and on local toolstones such as chert and silicified dolomite (Messineo 2008; Politis and Messineo 2008). Some tools chipped on the site, such as formal and multipurpose tools, probably were carried to other sites (e.g., camp sites) for further use, and only broken tools (sidescrapers and projectile points) were abandoned where the giant ground sloth was killed and initially butchered. These tools were curated items associated with individual toolkits (individual provisioning *sensu* Kuhn 1995) accompanied the hunters during a foraging trip where at least one megamammal species was hunted and butchered around a water resource. In conclusion, the high mobility of early hunter-gatherers groups in the Pampean region (Politis and Messineo 2008) and the great distance separating quarries from the site motivated hunters to employ this technological strategy.

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PART 2

Early Settlements in Eastern Tandilia, Buenos Aires Province, Argentina: Archaeological Contexts and Site-Formation Processes

Diana Mazzanti[1], *Gustavo Martínez*[1,2], *and Carlos Quintana*[1]

PART 2

➤**Keywords:** Rockshelter occupation, Pampean region, Paleoindian

Tandilia is one of the two main mountain ranges in the Pampas plain of the Buenos Aires Province, Argentina (Figure 1). The eastern part of these mountains is a group of table-like hills with flat summits, composed of lower Paleozoic subhorizontal quartzite strata (the Balcarce formation, after Dalla Salda and Iñiguez 1979). These elevations (no more than 300 masl) are east-west elongated ending at the Atlantic Ocean. The environmental diversity and richness in resources of this micro-region could have been an important factor in intensifying human occupation during the Pleistocene-Holocene transition. In this paper we summarize findings of recent archaeological research in the Tandilia range, focusing on sites spanning the end of the Pleistocene and beginning of the Holocene.

Evidence of the earliest human settlements of the eastern Pampas region has been principally found in the Tandilia Range (Flegenheimer 1994; Mazzanti 2003) and in the Interserrana Plain (Martinez 2001; Politis et al. 2004). In eastern Tandilia, most sites are caves and rockshelters, some of which were repeatedly occupied. These characteristics are typical of base-camp sites. In contrast, other sites show evidence of shorter times of occupation (Mazzanti 2003). Open-air sites (lookouts and campsites), which show evidence of Fishtail

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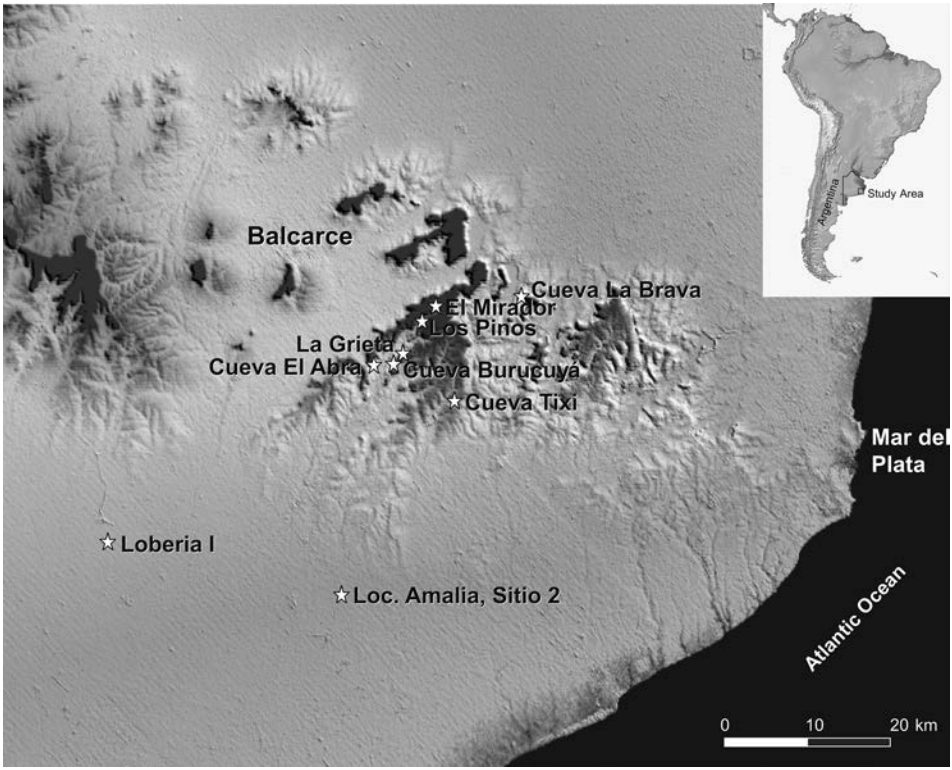

Figure 1. Locations of archaeological sites and localities in Tandilia range mentioned in text.

projectile point manufacturing, were found by Flegenheimer (1986) in adjacent areas like the Lobería hills.

The sites reviewed in this paper are Cueva Tixi, Abrigo Los Pinos, Cueva El Abra, Cueva Burucuyá, Cueva La Brava, Amalia (site 2) and Lobería I (site 1) (Table 1). Recently excavated were two new rockshelters, Alero El Mirador and Abrigo La Grieta (Figure 1), whose radiocarbon dating is currently underway. El Alero El Mirador, located near the Abrigo Los Pinos site, contains two occupations that used different types of toolstones: The lower occupation contains a wide variety of non-local lithic materials; in the overlying occupation, local lithic materials (orthoquartzites from the Balcarce formation) dominate. At the Abrigo La Grieta site, located 15 m from Cueva Burucuyá, a lithic-production industry used these same raw materials as well as allochthonous ones from the Sierras Bayas group. A specific set of activities, complementary to the functions of surrounding sites, appears to have been carried out in these two shelters.

The late-Pleistocene/Holocene transition is stratigraphically represented by an unconformity that implies a change in active depositional and post-depositional processes (Martínez 2007). Overlying this boundary are the earliest occupations, dating to ca. 10,500–9600 RCYBP. The sandy-clay silts of their context are indicative of post-glacial amelioration in the Holocene. In contrast, underlying coarser, stone-rich Pleistocene deposits (archaeologically sterile) are likely associated with cold and arid conditions characteristic of the Last Glacial Maximum.

Table 1. Radiocarbon dates from sites of the Tandilia range described in text.

Site	Radiocarbon date (material: charcoal)	Sample no.
Cueva Tixi	10,045 ± 95 (AMS)	AA-12131
	10,375 ± 90 (AMS)	AA-12130
Abrigo Los Pinos	9570 ± 150	LP-630
	10,465 ± 65 (AMS)	AA-24045
	10,415 ± 70 (AMS)	AA-24046
Cueva Burucuyá	10,672 ± 56 (AMS)	AA94640
	10,000 ± 120	LP-863
Cueva El Abra	10,270 ± 200 (AMS)	AA94641
	9834 ± 65 (AMS)	AA-38098
Cueva La Brava	10,178 ± 54 (AMS)	AA9463
	9670 ± 120	LP-550
Amalia Sitio 2	10,425 ± 75 (AMS)	AA-35499
Lobería I Sitio 1	9787 ± 81 (AMS)	AA-81063

The archaeological record of the sites in the eastern Tandilia region shows evidence of the use of different resources: local and non-local stones and mineral pigments, wild and extinct fauna, and wood used for fuel. These materials provide information about the environmental richness of the area and procurement strategies, which fostered continuous human occupation during the past 11,000 years.

Early hunter-gatherers established circuits of mobility over a wide expanse. Early inhabitants of the eastern Tandilia region, for example, exploited resources in valleys, pampa plains, and coastlines. Although most mineral resources have a local provenance, some came from the Rio de la Plata basin in present-day Uruguay (Flegenheimer et al. 2003). This wide mosaic of geomorphological environments and resources was the setting in which Paleoindian groups established webs of interaction for circulating people, ideas, and goods (Politis et al. 2004).

Two main questions guide research being undertaken on the eastern edge of Tandilia range. First, why was this area geographically significant in the initial colonizing of the Pampas region? Second, what accounts for the dense and dynamic population in the eastern Tandilia range since the late Pleistocene? Interdisciplinary studies are yielding information about the human-environment relationship during the initial occupation.

Evidence of high mobility seen in the settlements in eastern Tandilia since the late Pleistocene transition is likely the result of intense and repeated occupations of rockshelters, owing to favorable geomorphological and environmental conditions.

The Cueva Tixi, Abrigo Los Pinos, and Cueva El Abra sites show evidence of multiple long-term activities; on the other hand, the archaeological contexts of Cueva Burucuyá, Cueva La Brava, Amalia (site 2), Alero El Mirador, and Abrigo La Grieta suggest ephemeral activities (Mazzanti 2003). In most of the sites the lithic industry uses as toolstone local orthoquartzites of the Balcarce formation and from the Sierras Bayas group ca. 60 km distant.

Zooarchaeological analysis shows that these societies pursued generalist strategies in exploiting resources. Of 30 species of vertebrates represented, *Lama guanicoe, Ozotoceros bezoarticus, Lagostomus maximus*, *Myocastor coypus*, *Chaetophractus villosus*, *Zaedyus pichiy*,

Dasypus hybridus, and *Rhea americana* show evidence of human consumption. Extinct species include *Eutatus seguini, Canis avus*, and *Galea tixiensis* (Quintana 2001).

Evidence of human occupation in the eastern Tandilia range ca. 11,000–9000 RCYBP (Flegenheimer 1986; Mazzanti 2003; Mazzanti et al. 2010) has been found at 14 sites, which testifies to the role of environment in promoting settlement and begs an important question about the social dynamics: Did the early human settlers of eastern Tandilia enter from the north-east through continental routes, or did they travel along the Atlantic Ocean coast (Miotti 2006)? We cannot answer this question with data available today.

Based on research conducted in the eastern Tandilia region so far, we offer the following conclusions.

1. The axis of the Tandilia Range was an environment that attracted human settlement, thereby potentially favoring early human colonizing of the Pampas region.
2. The late-Pleistocene/Holocene boundary apparent in the stratigraphic sequences of sites in the region is a useful criterion for evaluating new sites because it separates archaeologically sterile deposits from those containing cultural evidence.
3. Tandilia sites were part of a settlement system that included contemporaneous sites in the neighboring Interserrana Plain.
4. The local settlement system established mobility patterns that made intense use of valleys, thereby enlarging the range of available natural resources.
5. Rockshelters and caves lying at high elevations overlooking surrounding plains benefited hunters seeking prey.
6. Small groups of highly mobile hunter-gatherers took advantage of multiple sites rich in local resources.
7. The intense use of valleys extended the functional diversity of the eastern Tandilia sites.

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PART 2

Early Settlers and Their Places in the Tandilia Range (Pampean region, Argentina)

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➤**Keywords:** Early hunter-gatherers, Tandilia range, landscape archaeology

PART 2

A microregional approach has been applied to studies of the early peopling of the Lobería ranges in central-east Tandilia, Pampean Region, Argentina (Figure 1). Over the years several sites in different settings have been excavated and sources for raw materials have been identified. A picture has been constructed of a mobile hunter-gatherer society occupying a space characterized by mesa hills surrounded by extensive plains and using local and exotic resources in a highly selective way (Flegenheimer 2003, 2004).

Recent research has focused on various aspects of this record. In this paper we address one of these issues, landscape archaeology. We apply the concept of place (Tuan 2008 [1977]) as a point of departure to deal with the complexities of the hunter-gatherer landscape. Thus we briefly describe different places and reassess their topographic settings in light of recent anthropological research.

Places in Central-East Tandilia

Seven different places have been described for early[2] hunter-gatherers in the central-east Tandilia microregion (Table 1). Three of these places, on the southeast slope of a small hill named La China, offer good visibility and easy intercommunication (Mazzia 2010–11). Site 1 (LCH1), a rockshelter and its surroundings, is considered a domestic setting where several activities were

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[2] We are only considering sites with dates between 12,000 and 9000 RCYBP.

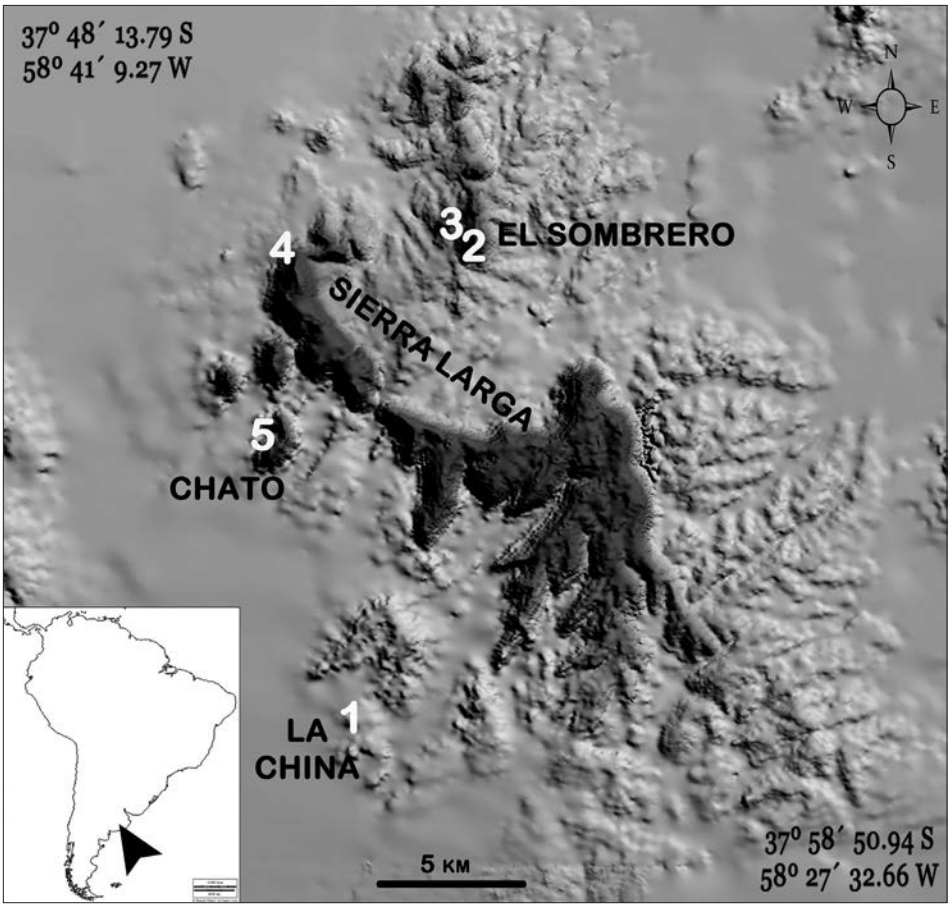

Figure 1. Localities of the central-east Tandilia microregion discussed in the text, with references to the main hills. The numbers correspond to the following archaeological sites: **1,** Cerro La China S1, S2 and S3; **2,** Cerro El Sombrero Cima; **3,** Cerro El Sombrero Abrigo 1; **4,** Cueva Zoro; **5,** Los Helechos.

carried out. Site 2 (LCH2), a narrow passageway surrounded by quartzite outcrops, is related to hunting activities. The third site (LCH3), a small protected area next to a quartzitic hilltop, was intensely occupied and yielded a diverse lithic assemblage (Flegenheimer 2004).

Another nearby hill also exhibits early places. On the western slope lies Cerro El Sombrero Abrigo 1, where a variety of activities are inferred to have been carried out, including a fresh hide-processing industry (Flegenheimer and Leipus 2007). Cerro El Sombrero Cima, on the hilltop, occupies about 25,000 m^2 and is the most extensive site in the area. Only the edges are visible from the plains; the place itself is better seen from the hilltops of Sierra Larga (Mazzia 2010–11). Activities appear to have been limited to refurbishing weapons and discarding broken artifacts (Flegenheimer 2003; Weitzel 2010). Considering these features as well as the exceptional assemblage recovered and the absence of similar neighboring places, we conclude that the places on this hill were significant during early times (Flegenheimer and Mazzia 2008).

Cueva Zoro is a middle-sized fresh and dry shelter in the north end of Sierra Larga. Several large boulders lying outside hide it from external view and also restrict visibility from its interior. An ephemeral early occupation was inferred (Mazzia 2010–11). Finally, Los Helechos, on the west slope of Cerro Chato, was visited ephemerally during early times (Flegenheimer and Bayón 2000).

Although these places are not all visible from each other, they were interconnected by pathways that also crossed the surrounding plains.

Beyond the Microregion

Another seven correlated early rockshelter sites are found eastward in the Tandillia range. Three are interpreted as domestic places (Cueva Tixi, Cueva El Abra, and Abrigo Los Pinos), and four were ephemerally occupied (Cueva Burucuyá, Cueva La Brava, Amalia 2, and Lobería 1) (Mazzanti 2003; Mazzanti et al. 2010).

Stratigraphic sites[3] and surficial Fishtail projectile points attest to the early presence of hunter-gatherers in the Pampean plains. For example, Paso Otero 5 is a special-purpose site where fauna was processed (Martinez 2006). It shares with sites in the Tandilia ranges common chronology, lithic typology and technology, and use of the same exotic toolstone. Arroyo Seco 2, on the other hand, is an extensive campsite with repeated occupations since 12,200 RCYBP (Politis 2008). El Guanaco, currently under study, is a multi-component open-air site with early dates (Flegenheimer et al. 2010). Although correlating the early assemblages from these sites with those from our study sites is by no means a straightforward task, we are confident that a certain measure of agreement can be found. Furthermore, resources identified at the early sites in the ranges connect them with such distant places as Uruguay/Entre Ríos, the Ventania ranges, the Atlantic coast, and possibly Patagonia (Flegenheimer et al. 2003; Mazzia 2010–11).

An Alternative View about the Tandilia Ranges

Anthropological fieldwork was conducted to determine whether an individual's physical conditions impairs the ability to climb hills and traverse slopes. The hills are regularly climbed by current residents with a sedentary lifestyle, including adults older than 70 years, a pregnant woman, and people with breathing problems. The record of people who collect ferns for a living is more relevant; according to them, climbing the hills requires no more effort than the rest of the work; they do not consider the 200-m ascent to the summit an arduous task. Today everyday life takes place mainly on the plains, and residents tend to regard the hills as an unconnected, remote, inaccessible, and even dangerous place (Mazzia 2010–11). These personal observations are useful when considering different attitudes towards this environment, including current preconceptions, but are not a valid analog for inferring past behaviors.

It had been commonly thought that shelters at lower elevations were preferred as domestic environments because they were easily accessible (Mazzanti 2003; Mazzia and Flegenheimer 2007) and that shelters at higher elevations were occupied sporadically or for special purposes. Recent anthropological research and landscape archaeology, however, do not sustain this notion, and we now believe that the social practices observed are independent of the altitude of shelter locations. When considering this issue, Cerro El Sombrero Cima, which has yielded an exceptionally rich assemblage, should be borne in mind. This occupation exemplifies our belief that places were laden

[3] We are only considering sites with dates between 12,000 and 9000 RCYBP.

Table 1. Characteristics of early archaeological sites in the central-east portion of the Tandilia range.

Site	Altitude (masl)	Environment	Visibility	Visualization	Excavated area (m^2)
LCH1	158	Rockshelter	Good	Zonal	18
LCH2	165	Open air protected	Good	Zonal	9.5
LCH3	178	Open air protected	Good	Zonal	11
El Sombrero A1	398	Rockshelter	Very good	Precise	12
El Sombrero Cima	428	Open air unprotected	Excellent, only restricted by hills	Restricted	37
Cueva Zoro	404	Rockshelter	Restricted	Restricted	4
Los Helechos	ca. 350	Rockshelter	Very good	Precise	4.5

with meaning and were chosen as appropriate milieus to pursue specific activities. Integrating anthropological fieldwork with data on the archaeological landscape reveals that the hills and surrounding plains were a continuous space interwoven by the movements of people.

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Sites	Tools	Fishtail points/ preforms	Ground artifacts	Flakes	Fauna	Date
LCH1	73	1	–	561	Yes	10,804 ± 75 (AA-8953) 10,790 ± 120 (AA-1327) 10,730 ± 150 (I-12741) 10,745 ± 75 (AA-8952) 10,525 ± 75 (AA-8954
LCH2	10	2	–	73	No	11,150 ± 135 (AA-8955) 10,560 ± 75 (AA-8956)
LCH3	96	–	–	979	No	10,610 ± 180 (AA-1328)
El Sombrero A1	34	2	–	366	No	10,725 ± 90 (AA-4765) 10,270 ± 85 (AA-4766) 10,675 ± 110 (AA-4767) 10,480 ± 70 (AA-5220)
El Sombrero Cima	617 & 794 sfc.	30 & 60 sfc.	4 & 7 sfc.	5810 & 3830 sfc.	No	
Cueva Zoro	5	–	–	42	No	10,153 ± 61 (AA-82707) 10,094 ± 62 (AA-82706)
Los Helechos	1	–	–	> 9	No	9640 ± 40 (Be-137747)

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Broken Stone Tools from Cerro El Sombrero Cima (Tandilia Range, Argentina)

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➤**Keywords:** Accidental breakage, intentional breakage, Pampean region

PART 2

Cerro El Sombrero Cima (Pdo. Lobería, Buenos Aires Province), located on a hill atop a quartzite outcrop (Flegenheimer 1994, 2003), is an open-air site that dates to the Pleistocene/Holocene transition. It has been interpreted as a place where early inhabitants refurbished weapons, replaced projectile points, and performed final stages of tool manufacture. Its location on a promontory means that the site would also have been used as a lookout (Flegenheimer 1994, 2003). Because of its prominence and the activities performed there, the site must have been an outstanding feature of the landscape that had special meaning for early people (Flegenheimer and Mazzia 2008; Mazzia 2010–11). Several unique characteristics distinguish Cerro El Sombrero Cima from other places visited by groups of hunter-gatherers (Mazzia 2010–11). This paper focuses on one of these traits: a high incidence of breakage, which affects 90% of the stone tools.

The lithic assemblage recovered from excavations and surficial finds consists of 1501 tools, with Fishtail projectile points the most diagnostic item (Flegenheimer 2003). Most of the tools were made of Sierras Bayas Group orthoquartzite (SBGO) quarried from a locality about 50 km west of the site (Flegenheimer 2004). In this paper we analyze a sample of 62 Fishtail points and 462 broken tools recovered from an area of 25 m^2 (67.6% of the total excavated area).

The high percentage of broken tools motivated a research project to characterize different types of tool fracture and to relate these types to their origin. We conducted several experiments on tool breakage including trampling (Flegenheimer and Weitzel 2007), knapping errors (Weitzel 2010; Weitzel and Colombo 2006), use of projectile points and other tools (Flegenheimer et. al 2010; Weitzel 2010), and intentional breakage (Weitzel 2010; Weitzel and Colombo 2006). Experimental tools were manufactured on SBGO.

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Experimental fractures were compared and contrasted with descriptions published by several researchers (see Table 1 for references and types of fractures considered). We then merged our results with descriptive attributes used in Argentinean lithic analysis (Aschero 1975) to obtain a detailed description of each type of fracture associated with its probable origin (Weitzel 2010, 2011).

Table 1. Fracture types considered among the Fishtail points and other lithic artifacts recovered from Cerro El Sombrero Cima.

Fracture type	Cause	References
Perverse fracture	Knapping error	Crabtree 1972; Frison and Bradley 1980; Johnson 1979; Miller 2006
Lateral snap	Knapping error	Rondeau 1981
Snap fracture	Intentional	Deller and Ellis 2001
Radial fracture	Intentional	Deller and Ellis 2001; Frison and Bradley 1980; Root et al. 1999
Complete cone fracture	Intentional	Deller and Ellis 2001
Bending fracture	Knapping error; trampling; use; impact	Fisher et al. 1984; Whittaker 1995
Bending initiating step terminating fracture	Impact on projectile points	Fisher et al. 1984; Odell and Cowan 1986
"Spin-off" fracture	Impact on projectile points, trampling, knapping error	Fisher et al. 1984
Impact flute	Impact on projectile points	Bradley 1982; Odell and Cowan 1986; Titmus and Woods 1986
Impact burin	Impact on projectile points	Bradley 1982; Odell and Cowan 1986; Titmus and Woods 1986

Analyzing Breakage Patterns

Most of the tool fractures were of accidental origin; intentional breakage accounts for only a small percentage of fractures (Weitzel 2010). Only 5% of fractures were caused by trampling; these are not considered here.

Accidental breakage Observed on 60% of the specimens, this type consists generally of bending fractures. The specific origin of accidental breakage was only identified in 18% of the cases. Most of these (14.6%) were the result of knapping errors: perverse fractures (9.6%), lateral snap (0.8%), and a single overshot fracture. Bending fractures were only considered to be the result of knapping errors on thick (>9 mm) tools (3.5%).

Perverse and lateral fractures were observed on Fishtail point preforms (Figure 1A) and on finished points with abraded stem margins (Figure 1B); knapping errors were, however, mainly associated with bifacial thinning on other tools, and they were also found on unifaces (Figure 1C). Diagnostic impact fractures were observed on 23% of finished Fishtail points; these include impact flutes, spin-off fractures, and bending-step terminating fractures (Figure 1D). Most of the Fishtail points are stem fragments broken when bent transversely where the stem widens to the shoulder. Bending fractures are difficult

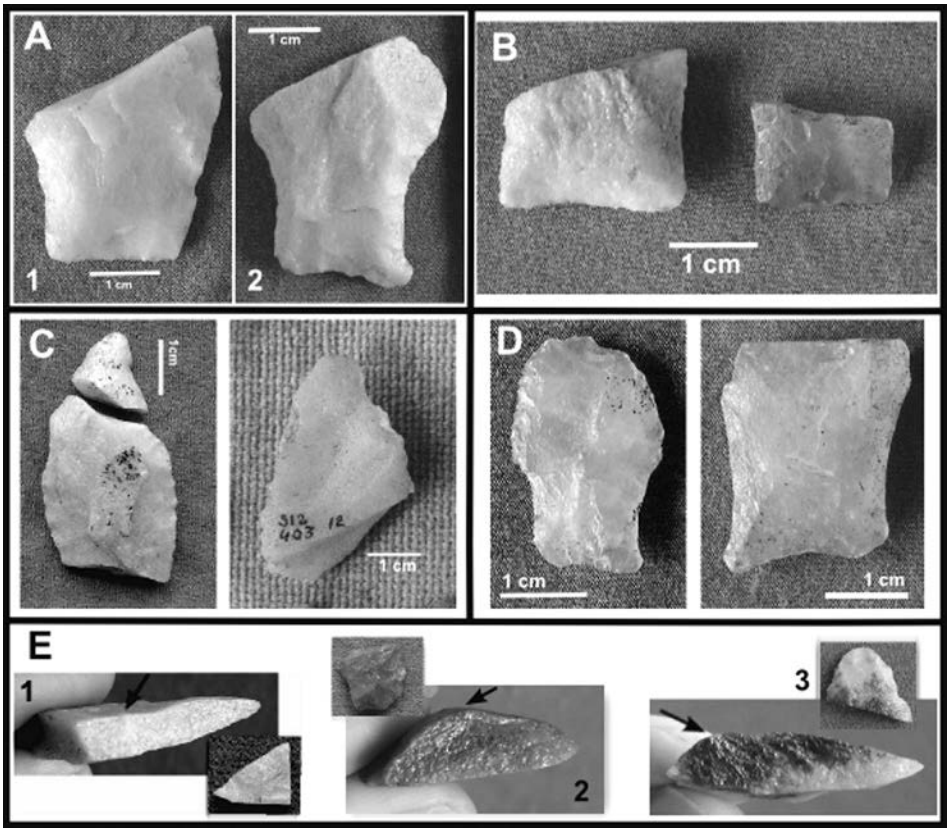

Figure 1. Fractured artifacts from Cerro El Sombrero Cima. **A1,** Fishtail point preform with perverse fracture; **A2,** fishtail point preform with lateral snap; **B,** finished Fishtail points with perverse fractures; **C,** biface (*left*) and uniface (*right*) with perverse fractures; **D,** Fishtail points with impact flute (*left*) and spin-off fracture (*right*); **E,** intentionally broken tool fragments with radial fracture **(1),** snap fracture **(2),** and undetermined intentional fracture **(3).**

to trace to a specific origin; experiments, however, showed that bending fractures in this specific location on Fishtail points frequently resulted from impact (Flegenheimer et. al 2010; Weitzel 2010).

Intentional Breakage Radial, snap, and undetermined intentional fractures were found on 8% of the sample. Intentional breakage is confined to tools with specific attributes: All are thin (5–10 mm thick), with triangular and plano-convex cross sections (Figure 1E). The thinness and cross-section profiles are recurring traits common to radial and snap fractures on SBGO tools (Weitzel 2010).

Discussion and Conclusions

These results were useful for confirming inferences about the tasks carried out at Cerro El Sombrero Cima—the final stages of manufacturing Fishtail points and other tools, and

maintaining and replacing projectile points. Our results are also relevant when considering people's choices in using and discarding stone tools.

Occasionally some tools were deliberately broken, presumably as an expedient technique to obtain obtuse angled edges and points, as has been observed in Folsom sites (Frison and Bradley 1980; Wilmsen and Roberts 1978; Root et. al 1999).

The unusually high incidence of breakage with a preponderance of accidental fractures, and the absence of tools refitted (Weitzel 2010) and deposited in a highly significant place (Flegenheimer 1994; Flegenheimer and Mazzia 2008; Mazzia 2010/2011), together lead us to propose as a working hypothesis that Cerro El Sombrero Cima was also chosen as a place to deliberately deposit certain objects, frequently once they were broken.

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PART 2

The First Occupations of the El Trebol Site during the Pleistocene-Holocene Transition (Nahuel Huapi Lake, Patagonia, Argentina)

PART 2

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➤**Keywords:** Northwest Patagonia, early settlements, El Trebol site

This paper presents analyses of the earliest levels of the Pleistocene-Holocene transition in the El Trebol site, a rockshelter located in the forest-lake environment of Nahuel Huapi Lake (41° 04′ 35″ S and 71° 29′ 25″ W, approx. 760 masl). This area underwent forest expansion around 13,000 RCYBP (Bianchi 1999) after the recession of late-Pleistocene glaciers.

Remains of extinct fauna and evidence of its use as food by groups of hunter-gatherers have been recovered from the earliest levels at El Trebol, excavated in 2002 and 2004 (Hajduk et al. 2006, 2009; Lezcano et al. 2010). These remains were dated by AMS ^{14}C to 10,570 ± 130 RCYBP (AA-65707) (by dermal bone belonging to *Mylodon*, burnt and bearing anthropic cutmarks) and 10,600 ± 100 RCYBP (AA-75678) (by a long bone belonging to a red fox with anthropic cutmarks). The pollen sequence for the area and the identified mammal species indicate the existence of a composed open forest environment.

Here we add more information by presenting analyses of stone and bone assemblages from

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new excavations conducted in 2006. After reappraising some stratigraphic units as relicts corresponding to the Pleistocene-Holocene transition, levels originally assigned to the middle Holocene have been reinterpreted and are now assigned to the earliest occupations. The cave has 110 m^2 of sheltered space, of which 15 m^2 has been excavated. The studied area, 4 m^2, is located in a deep excavation in a rocky area of roof collapse, where cultural elements were found up to a depth of 3.50 m. The sediments underlying this level up to 4.90 m are culturally sterile, although containing faunal remains.

Cultural materials are contained in sediments that form a unit of chrono-stratigraphic value (V. Outes, pers. comm.) interpreted as a simultaneous seismic-volcanic event that collapsed rocks from the roof and spread a layer of dark gray ash that filled the crevices between rocks and created a "floor-like" surface. This event is included in a sequence of loess-like sediment layers. It is important to stress that the ash fall is contemporary with the arrival of humans, as the first cultural evidence suggests. Continued accumulation of sterile ocher sediments in level 4 filled the upper parts of crevices and the lower sectors of the rock floor. In other depressed sectors, however, a relict of ocher sediment with pebbles and archaeological contents was identified, together with three structures of fire pits. This relict was initially identified as the base of level 3 (Hajduk et al. 2006, 2009), assuming it was diachronic with the rest of level 3, whose upper part is dated to 5731 ± 70 RCYBP (AA-65708).

A more detailed analysis of this ocher and pebbly sedimentary matrix, the different conditions of preservation of bone material, and a new AMS date of 10,640 ± 120 RCYBP (AA-756779) (on dermal *Mylodon* bone, burnt and with anthropic cutmarks) decided us to assign new stone and bone materials to occupations dated to about 10,600 RCYBP. The sediments containing these materials are labeled level Va and are contemporary with level V in the rockshelter. It is assumed that the sterile ocher sediment contained in level 4 was the product of fast accumulation.

Lithic materials recovered from levels V and Va include tools, including a chert point, a short chert endscraper, a large knife with a lateral cutting edge and natural back, a sidescraper, and a fragment of a double-edged knife on chalcedony. A small chert flake shows complementary

Table 1. Discarded stone flakes from El Trebol (level V and Va).

	Material	Whole flakes	Fragmented flakes with platform	Fragmented flakes without platform
Level Va	Basalt	2	–	3
	Chalcedony	19	5	9
	Quartz			1
	Obsidian	–	–	–
	Chert	27	4	14
Subtotal	**84**	**48**	**9**	**27**
Level V	Basalt	10	2	7
	Chalcedony	24	12	19
	Obsidian	1	–	–
	Chert	9	1	3
	Andesite indet.			1
Subtotal	**89**	**44**	**15**	**30**
Total discarded	**173**	**92**	**24**	**57**

macroscopic marks on a slanted beveled edge. In spite of the scarcity of tools, they suggest the inhabitants of the cave performed tasks like butchering, cutting, and scraping.

The discarded flakes (n = 173) (Table 1) include 92 complete flakes and 24 fragmented flakes with platforms. The materials more often used were varieties of chert (52% chalcedony and 35% colored chert) followed by basalt (12%) and only one obsidian flake. Complete flakes range in length from 1–2 cm (51%) to less than 1 cm (37%), 3–4 cm (11%), and 4–5 cm (1%). The fact that all the discarded flakes are small internal flakes without presence of cortex suggests that the last stages of the manufacturing activity took place at the site.

Of the discarded materials, 39% result from finishing bifacial pieces, and 2% from reactivating stone instruments. As previously noted, raw materials are not local; potential sources have been located in the steppe area, 38–127 km east of the site (Hajduk et al. 2009).

Table 2 summarizes the fauna except for micro-vertebrates found in level V from excavations in 2002, 2004, and 2006. Indeterminate deer bones were recovered from level Va. Bones in

Table 2. Faunal remains from level V of El Trebol (ca. 10,600 RCYBP). (**NTR,** total number of units; **L-H-C,** *Lama-Hippocamelus*-Cervidae indeterminate; **MNI,** minimal number of specimens; **Q,** burnt; **H,** anthropic marks of cutting; **HD,** Mylodontinae dermal bones. To make comparisons, fragments of teeth, dermal bones, and antlers were discriminated, as well as fish and mollusc remains.

Taxons	NTR	%	MNI	%	Q	%	H	%	Teeth	HD	Antlers	total
Chaetophractus villosus	1	0.13	1	5.55	0	0	0	0	0	0	0	1
Lycalopex culpaeus	2	0.27	1	5.55	0	0	2	8	1	0	0	3
Canis (Dusicyon) avus?	5	0.67	1	5.55	0	0	1	4	0	0	0	5
Canidae (> *Lycalopex culpaeus*)	2	0.27	1	5.55	0	0	0	0	0	0	0	2
Canidae	1	0.13	0	0	0	0	0	0	0	0	0	1
Lama guanicoe	4	0.54	2	11.11	0	0	0	0	0	0	0	4
Hippocamelus bisulcus	11	1.49	2	11.11	0	0	1	4	1	0	0	12
Cervidae indet. (size of *Blastocerus*)	7	0.95	2	11.11	0	0	2	8	0	0	9	16
Cervidae	1	0.13	0	0	0	0	0	0	0	0	0	1
Lagidium viscacia	2	0.27	1	5.55	0	0	0	0	0	0	0	2
Small mammal (size of *Lagidium*)	4	0.54	0	0	0	0	0	0	0	0	0	4
Medium mammal (size of *Lycalopex*)	31	4.21	0	0	1	1.12	1	4	0	0	0	31
Big mammal (size of L-H-C)	648	88.04	0	0	46	51.68	7	28	2	0	0	650
Big mammal (larger than L-H-C)	6	0.81	1	5.55	0	0	0	0	0	0	0	6
Big mammal (size of *Equus*)	5	0.67	1	5.55	0	0	0	0	0	0	0	5
Mylodontinae	0	0	0	0	40	44.94	10	40	11	228	0	239
Megamammal (size of *Mylodon*)	5	0.67	1	5.55	2	2.24	0	0	0	0	0	5
Birds (size of *Pteroptochos*)	1	0.13	1	5.55	0	0	0	0	0	0	0	1
Birds (size of *Milvago*)	17	2.30	2	11.11	0	0	0	0	0	0	0	17
Birds (size of *Cygnus*)	3	0.40	1	5.55	0	0	1	4	0	0	0	3
Total mammals & birds	**756**	**99.9**	**17**	**99.9**	**89**	**99.9**	**25**	**99.9**	**15**	**228**	**9**	**1008**
Fish (including *Percitchys*)	16	0	1	0	0	0	0	0	0	0	0	16
Diplodon patagonicus	2	0	1	0	0	0	0	0	0	0	0	2
Absolute total	**774**	**0**	**19**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1026**

general are highly fragmented, measure more than 3 cm, and are poorly preserved. Remains from level V are fragile and bear manganese stains. Those from level Va are slightly better preserved and show less presence of manganese, even though they are clearly less well preserved that those belonging to levels 1, 2, and the upper part of 3.

The number of identified specimens (NISP) calculated for 32 mammals (excepting teeth, dermal bones, and antlers) in Table 2 shows that the most common species are *Hippocamelus* (huemul, 34.37%) and indeterminate deer (larger than huemul, 21.87%), followed by cf. *Canis* (extinct canid, 15.62%), *Lama* (guanaco, 12.5%), *Lycalopex* (red fox, 6.25%) and *Lagidium* (vizcachita, 6.25%), and *Chaetophractus* (armadillo, 3.12%). The skeletal units belonging to Cervidae (antler fragments, vertebrae, metapodials, and autopodials), *Hippocamelus* (autopodial and metapodial), *Canis* (metapodial, autopodial and mandible), *Lycalopex* (forelimb), and *Lagidium* (forelimb) belong to the same individual in each case, as proved by reassembling fragments and refitting bones. These results suggest a sample reduced in time and space, perhaps collected over just a few periods of settlement. Mylodontinae are present mainly as dermal bones, with some fragmented bones and teeth. The rest of the faunal assemblage is highly fragmented and consists of a wide range of taxonomic categories and size; the predominant group corresponds in size to *Lama-Hippocamelus*-Cervidae (the three taxa with the highest minimum number of individuals (MNI)). Bird, fish, and freshwater mollusk (*Diplodon*) remains are also present, although poorly preserved.

The bones belonging to the majority of the species bear cutmarks and anthropic fractures; we also noted, in the case of Mylodontidae dermal bones, a particular pattern of burning that suggests human origin. We infer from the remains that the human occupants enjoyed an ample diet derived from different types of resources as well as different strategies to obtain them, including hunting, fishing, and gathering (plants included).

El Trebol rockshelter bears witness to the early settlement of an Andean forest-lake environment in northern Patagonia during the Pleistocene-Holocene transition, perhaps by small groups and for short periods of time. They exploited a wide variety of mammals, both extinct and extant today, including megafauna, fish, birds and mollusks. Stone tools were manufactured on local and non-local materials. The latter imply long-distance travel or trade contacts.

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Formal Variability in Fishtail Points of the Amigo Oeste Archaeological Site, Somuncurá Plateau (Río Negro, Argentina)

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➤**Keywords:** Fishtail points, Pleistocene/Holocene, north Patagonia

PART 2

Because Fishtail points (FTPs) are often associated with chronologies ca. 9000–11,500 RCYBP, these artifacts are good indicators of human populations during the Pleistocene-Holocene transition in South America. Furthermore, FTPs have a wide geographical distribution and are found in distant and very different contexts, from Magallanes basin (southernmost America) to southern Mexico (García Bárcena 1980; Miotti 1995; Nami 2010; Politis 1991).

The state of research in the Southern Cone shows that these artifacts are usually distributed as isolated artifacts or in assemblages consisting of few individuals, are found in a wide variety of environments (arid, tropical, temperate, etc.) and different landforms such as paleolakes, rockshelters, riversides, coastlines, and mountains.

In Patagonia, archaeological sites with associated FTPs are located in the Deseado Massif, the Magellan basin, and Nueva Esperanza areas, while in the Argentine Pampas they are located in the Interserrana area and Tandilia range. Until the beginning of research in the Somuncurá Plateau (Río Negro Province) a short time ago (Miotti et al. 2004, 2010), the intermediate region between these two areas posed a gap in FTP records.

This contribution is part of a study about the technologies of the first Americans, which interprets technology as social processes that combine knowledge, learning, decisions, actions, and meanings (Lemonnier 1992). In this article we present the techno-morphological

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characterization of the FTP assemblage from Amigo Oeste archaeological site, based on the description of formal attributes and other technological aspects of such artifacts.

Los Dos Amigos Archaeological Locality

The artifacts discussed here were found in the Los Dos Amigos archaeological locality (LDA), which is located around the homonymous landform formed by two bedrock hills, located at the base of the Arroyo Talagapa–Laguna de Las Vacas basin on the Somuncurá Plateau (Figure 1). In fieldwork carried out we have documented 116 FTP, 112 of them from the Amigo Oeste archaeological site (AW), the western hill at LDA. This topographical feature dominates the lower Arroyo Talagapa basin and surrounding watershed. The assemblage was collected from the AW hilltop (n = 88), slopes (n = 22), and basaltic walls (n = 2) leading up to the hilltop, while the rest come from other nearby sites LDA-5 (n = 2), LDA-AB (n = 1), and Tapera de Isidoro (n = 1).

Amigo Oeste is characterized by an abundance of surficial lithic material. There we have

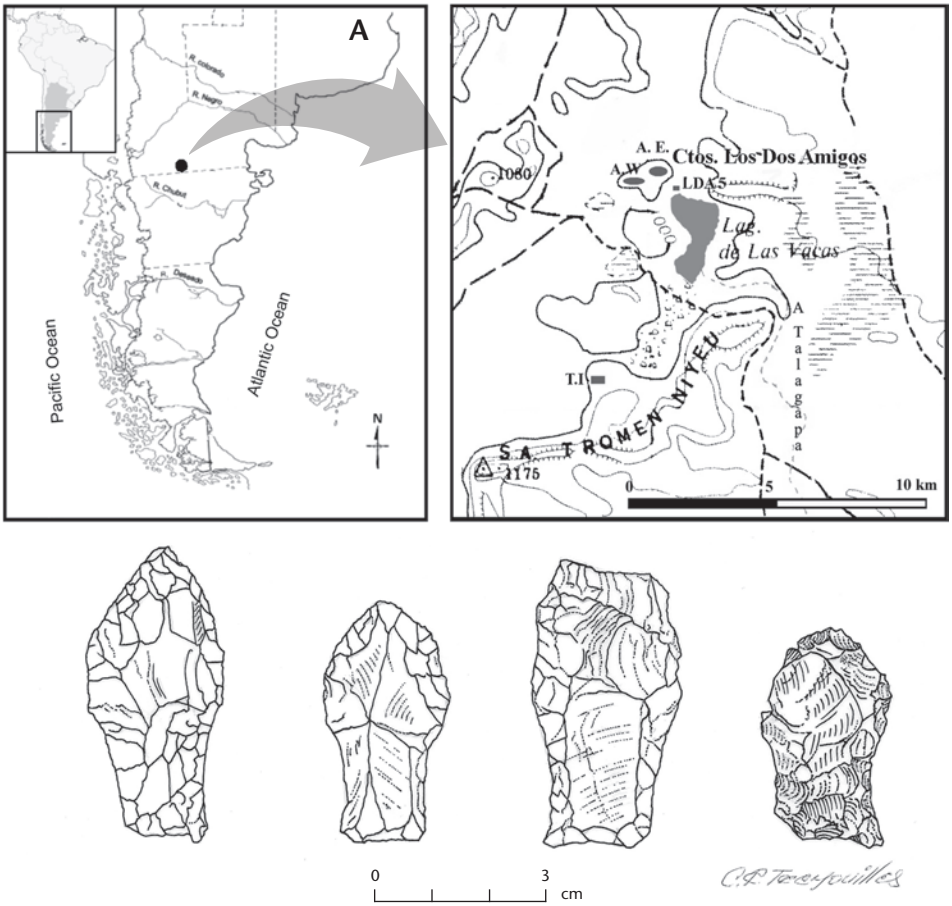

Figure 1. **A, B,** research area referred to in text; **C,** Fishtail points from Amigo Oeste.

recorded about 2250 artifacts (cores, debitage, and tools), including FTPs, which constitute 30% of the retouched artifacts. In this respect, AW is the largest and most varied FTP context in Patagonia.

The Amigo Oeste Assemblage

Most of the AW assemblage of FTPs is fractured (87.1%); only 15 items are complete (12.9%). Stems are the more represented portion (62.9%).

Raw materials on which FTPs were made are chalcedony (73.3%), followed by colored chert (15.5%), obsidian (6.9%), and quartz (4.3%). The source of chalcedony could be the Aneken site, a quarry-workshop located 15 km west of AW. At Aneken, brown chert has been found in outcrops, veins, and pebbles in little streams of the upper basin of Arroyo Talagapa. Moreover, obsidian geochemical studies suggest the possible existence of regional sources for this raw material (Miotti et al., this volume).

Local sources of the remaining varieties of raw materials such as pink and red chert types and quartz have not been identified. These raw materials have been recorded at other archaeological sites of the plateau but in much lower quantities than at AW.

The formal analysis of the Amigo Oeste FTP assemblage yielded ranges of variation and medians in size shown in Figure 2. Noteworthy is the range of variation in stem length, which is greater than the variation in other variables. This may reflect the high incidence of this part of the point in the total assemblage, or it may signify great variability in the morphology of the stems.

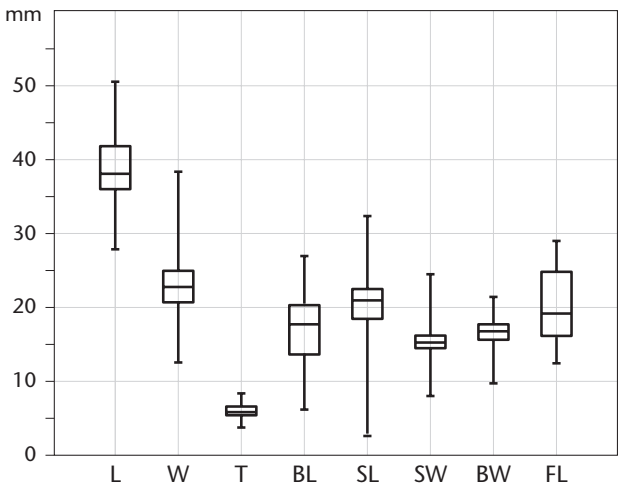

Figure 2. Dimensions in box plots for **L,** length; **W,** width; **T,** thickness; **BL,** blade length; **SL,** stem length; **SW,** stem width; **BW,** basal width; and **FL,** fluting length.

Among stem forms, straight bases (42.72%) and attenuated concave bases (41.75%) are most common. Correlation between the basal width and stem length shows low intensity but high significance ($r = 0.2918$; $p = 0.0225$). The intensity of the correlation is higher between stem width and base width, with a very high significance ($r = 0.4906$; $p = 0.00002$).

Fluting appears in high proportions (60%) on either one (36.28%) or both faces (23.89%). Fluting presence is neither directly related to any other variable, nor with the degree of completion of pieces. This suggests that fluting was an optional means to solve

hafting. Another feature observed is that the final shaping of bases was made through fine retouching (see Nami 2010 for similar remarks related to other FTP assemblages).

Conclusions

The FTP data set from Amigo Oeste yields the following conclusions.

1. Raw materials are predominantly from local or regional sources, and all are of very good quality. It is noteworthy that raw materials with a long trajectory, such as red chert and quartz crystal, are frequently present at early sites and have been interpreted as socially important or symbolic goods (Nami 2009).
2. Dimensions of the analyzed specimens show highly significant, moderately positive correlations between different parts of the stems, reflecting a degree of uniformity associated with the FTP hafting process.
3. The AW sample exhibits a high incidence of fluting, which seems to be an optional technical step related to basal thinning.
4. Retouch is the most common technique used to shape the concave base, regardless of the presence or degree of fluting.
5. The high incidence of stems recovered supports the idea that the site could have functioned as a workplace for replacing points. Based on the assemblage of flakes from AW, we propose that points were made and edges reactivated.

These observations become relevant when they recur in other FTP assemblages such as Fell (Bird 1988), La China, El Sombrero (Flegenheimer 2004), and El Inga (Mayer-Oakes 1986). This pervasiveness betokens a technological conception, constellation of knowledge, techniques, and tools shared by human groups on a hemicontinental scale.

Finally, this work was based on a specific assemblage of tools. Future efforts should be made to study techniques and sequences of manufacturing FTPs as well as other artifacts found in early contexts. They should focus especially on comparing FTP assemblages from different regions to enlarge our knowledge of which aspects of technology were shared and which were confined to local communities.

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PART 2

Geochemical Sourcing of Obsidian Fishtail Points: Studies for the Somuncurá Plateau (Río Negro, Argentina)

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➤**Keywords:** Obsidian Fishtail points, Pleistocene/Holocene, northern Patagonia

PART 2

The Fishtail projectile point (FTPP) is one of the main technological proxies used to identify early human occupations in the Americas. These artifacts have a wide but discontinuous archaeological distribution. Several specimens have been recently recovered in the Somuncurá Plateau (Río Negro Province, Argentina), particularly at the Amigo Oeste (AW) site, which sits atop one of the low hills forming the Los Dos Amigos landform (Figure 1A–B) (Hermo and Terranova in this volume; Miotti 2010; Miotti et al. 2009). So far, 112 FTPP specimens made from several raw materials have been recovered from AW; of these, 8 were made on obsidian. This record is extremely interesting because the use of this toolstone for making FTPPs is uncommon in South America. Besides the AW site at Somuncurá, only one other site, El Inga in Ecuador (Mayer Oakes 1986), has yielded them.

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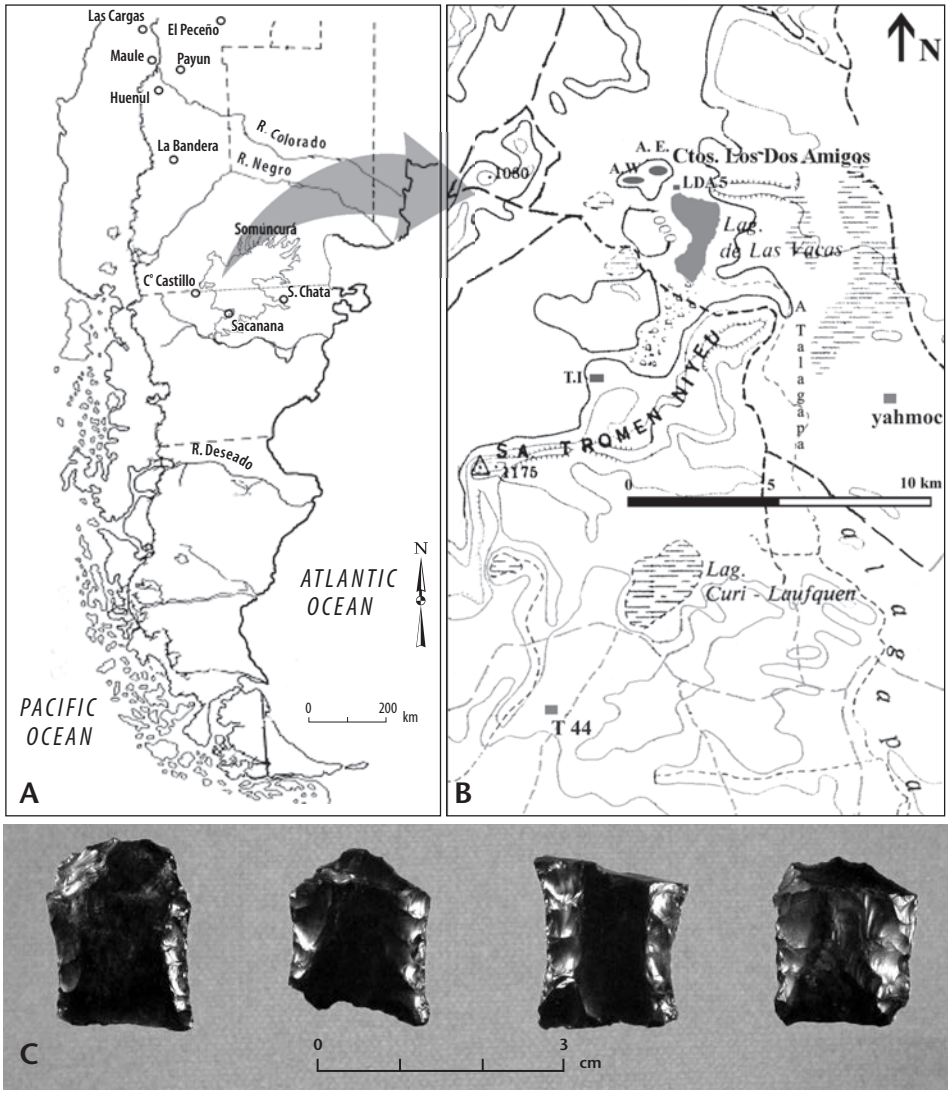


Figure 1. **A,** main obsidian sources from northern Patagonia; **B,** locations of Amigo Oeste (AW) and other archaeological sites in the study area; **C,** Fishtail projectile points from Amigo Oeste used in the obsidian source analysis.

In this paper we report the results of X-ray fluorescence (XRF) geochemical analysis of six obsidian FTPPs from AW to evaluate the diversity of chemical types represented and to assess their geographic sources. The obsidian samples were analyzed at the Archaeology Laboratory at Universidad Nacional de Cuyo with a Bruker III-V portable XRF spectrometer equipped with a rhodium anode operating at 40 kV and 17 mA. Each sample was counted for 180 seconds to obtain data for eight elements (i.e., Fe, Zn, Ga, Rb, Sr, Y, Zr, and Nb). Peak areas were

converted to element concentrations using an instrument calibrated by analyzing a series of obsidian source samples previously characterized by neutron activation analysis (NAA) and XRF in the Archaeometry Laboratory at the University of Missouri Research Reactor.

Results

We analyzed, in addition to the six FTPPs from the top of the AW site (Figure 1C), two naturally occurring obsidian nodules from Laguna Yahmoc (LY), 10.5 km southeast of AW, and two nodules from Talagapa 44 (T44), 18 km west of AW (Figure 1B). These local source samples were compared with data for north Patagonian and Cuyo sources, tested by XRF and NAA (Giesso et al. 2011; see also Barberena et al. 2011).

The source samples from Laguna Yahmoc and Talagapa are chemically different from each another. On a wider scale, these two sources are also different from the sources previously analyzed by XRF from northern and central Neuquén, Mendoza, and central Chile, and they also differ from the toolstone in specimens from archaeological sites in these regions (Giesso et al. 2011: Figure 1a, 1b). Comparisons between these results and those obtained by XRF by Stern (Stern 2004; Stern et al. 2007) for the Cerro Castillo, Sacanana, and Sierra Chata sources in the Chubut Province, located about 100 km south of AW, need further evaluation since the calibrations employed in those analyses differ from those presented here.

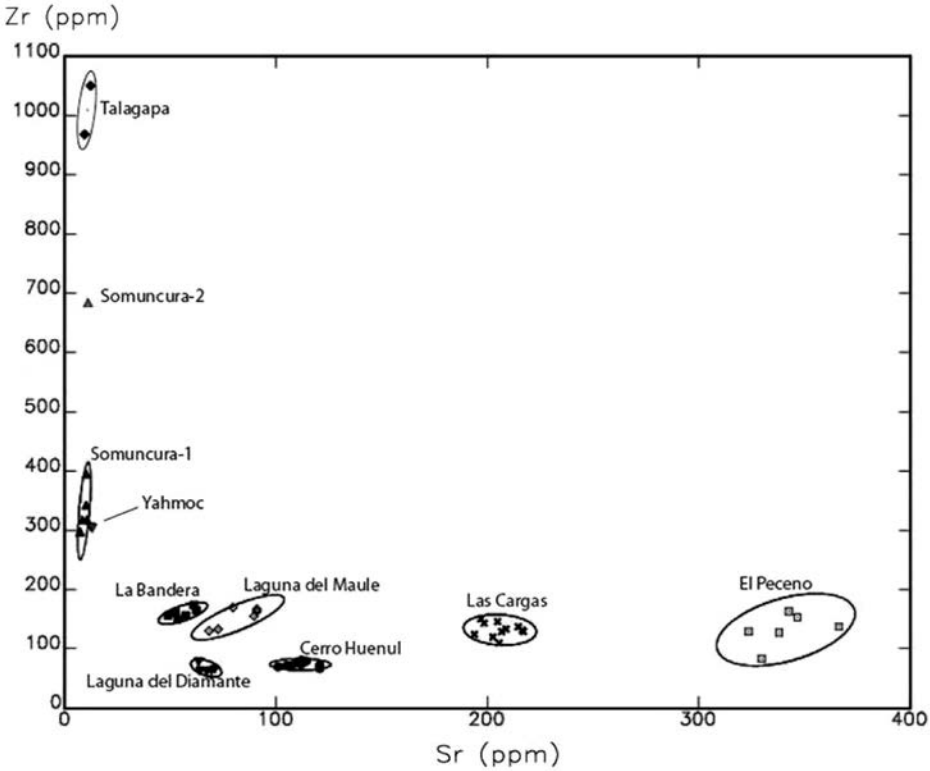
Of the six points analyzed, five are chemically similar (group Somuncurá 1) and share a compositional profile similar to the two nodules from Yahmoc, which suggests a local provenience of most of the FTPP samples studied here. On the other hand, one point (specimen 269) is chemically different and is assigned to the Somuncurá 2 group (Figure 2), being considered as coming from an unknown source.

The chemical composition of the two nodule samples from Talagapa does not match that of any of the AW artifacts. Considering that this location yields only small nodules unsuited for making tools, it is possible that Talagapa was not used as a toolstone source. The nodules from Yahmoc are also too small for making FTPPs, but their geochemical similarity to group Somuncurá 1 suggests that larger nodules were once available. By analyzing secondary geomorphic processes, we will be able to estimate the geographic range of nodules that are chemically similar, in other words, the size of the source. We are confident that the Laguna Yahmoc source is larger than currently known and that larger nodules may be present in areas of secondary redeposition of the obsidian.

Conclusions

From the results of our chemical analysis we can draw preliminary conclusions about the spatial and technological organization of early human societies in northern Patagonia. Most toolstone was quarried at local sources, which suggests that toolmakers knew the whereabouts of regional resources; their knowledge is especially remarkable considering that the obsidian sources are not ubiquitous. If the precise source of any of these materials is found to lie in the southern area of the Somuncurá Plateau, in Chubut Province, this will suggest they traveled long distances to acquire toolstone.

Our preliminary geochemical data for obsidian from the northern Somuncurá Plateau underscores important tasks for the future: 1) assess the geoarchaeology of obsidian sources, 2) expand geochemical analyses for source samples, and 3) integrate pertinent geochemical data produced by colleagues using other methods and calibrations. These refinements will further enlarge our knowledge of human mobility and social interaction in northern Patagonia.



Site	Sample	Chem. grp.	K	Ti	Ma	Fe	Za	Ga	Rb	Sr	Y	Zr	Nb	Pb	Th
Amigo Oeste (AW)	PCP-218	Somuncura-1	36664	895	297	9990	81	18	240	8	45	316	122	28	18
Amigo Oeste (AW)	PCP-229	Somuncura-1	37316	774	78	10992	106	18	241	10	46	317	116	27	22
Amigo Oeste (AW)	PCP-239	Somuncura-1	37334	758	193	11572	97	19	248	10	48	393	128	30	25
Amigo Oeste (AW)	PCP-262	Somuncura-1	39331	618	114	10710	95	18	237	10	45	341	109	24	18
Amigo Oeste (AW)	PCP-362	Somuncura-1	38397	605	81	10657	102	18	242	7	47	296	116	29	23
Amigo Oeste (AW)	PCP-269	Somuncura-2	37977	707	167	14766	147	21	259	11	59	682	133	28	25
Arroyo Talagapa	TALAGAPA-1	Talagapa	34478	1144	429	16545	174	23	226	9	63	968	152	26	27
Arroyo Talagapa	TALAGAPA-2	Talagapa	36955	955	508	16484	194	24	255	12	71	1050	162	36	31
Yahmoc	YAHMOC-1	Yahmoc	37840	503	176	10079	125	19	273	12	63	307	147	34	29
Yahmoc	YAHMOC-2	Yahmoc	38474	551	318	9684	120	19	275	13	60	305	149	32	29

Figure 2. A bivariate plot of proportions of Zircon (Zr) and Strontium (Sr) in samples, and the chemical composition of samples.

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PART 2

The Use of the Form: Functional Analysis of Lower Component Artifacts from Piedra Museo (Santa Cruz, Argentina)

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➤**Keywords:** Microwear analysis, lithic technology, Piedra Museo

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Determining the use of different archaeological tools has been a principal goal of archaeologists since the beginning of our discipline. In Argentina, especially in Patagonia, microscopic lithic analysis was launched in 1983 by the innovative work of Mansur, who focused on applying this methodology to artifacts from early contexts (Cardich et al. 1973). These studies as well as the work of Castro (1994) pioneered intensive research in regional archaeology.

Because the way tools are used reflects a complex set of social behaviors, their study reveals the social dynamics of past cultures (Álvarez 2003; Keeley 1980; Mansur-Franchomme 1983; Semenov 1964). Thus the aim of this paper is to present the results of our analysis of the processing activities of hunter-gatherers who inhabited the Deseado Massif during the Pleistocene-Holocene transition. This was done by applying use-wear analysis to lithic artifacts from the lower component of the Piedra Museo archaeological site. Another aim of this paper is to identify the degree of conservation of use traces and to determine whether differences detected by other techno-morphological and archaeofaunal analyses between stratigraphic units (U) 4/5 and 6 reveal changes in the use of tools.

Archaeological Evidence

The analysis of Piedra Museo has shown a significant difference between U4/5 and U6

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(Cattáneo 2002; Miotti 1995; Miotti and Cattáneo 1997). U4/5 is part of the soil horizon IIB32 and IIB31 with clay loam texture. The occupation of this unit dates to the late Pleistocene (10,400 ± 80 and 9230 ± 105 RCYBP) and has been associated with hunting and processing relatively few Pleistocene fauna. Flakes may have also have been resharpened during this occupation (Alberdi et al. 2001a; Cattáneo 2002; Miotti 1995). Whereas U6 occupies the soil profile (IIIC horizon with sandy loam texture) corresponding to the older occupation pulse of the site (10,470 ± 65 to 12,890 ± 90 RCYBP), it may be evidence of a short-lived occupation characterized by a differential pattern of discard and working areas related to opportunistic hunting principally of extinct taxa (Miotti et al. 1999). Techniques used to process prey in U6 (by opportunistic hunting) and U4/5 (by scheduled hunting) can be inferred from the kinds of tools and the use of lithic raw materials. Differences in the chemical composition of the stratigraphic units account for varying degrees of preservation of use traces.

Materials and Methods

Piedra Museo has been frequently studied from different perspectives (e.g., Miotti 1995; Miotti and Cattáneo 1997; Miotti et al. 1999); the functional determination of lithic artifacts, developed as part of an unpublished doctoral thesis (Cattáneo 2002), operated under a different theoretical framework from the one used here. Because of a discontinuity in traceological studies, we focus our attention on a new line of research that views stone-tool use as an inegral part of the activities and technological knowledge of prehistoric societies (Álvarez 2003). The analysis presented here consisted of microscopic examination of lithic artifacts from the lower component (U4/5 and U6) of Piedra Museo. These materials were recovered from systematic excavations carried out during the period 1990–97 by L. Miotti.

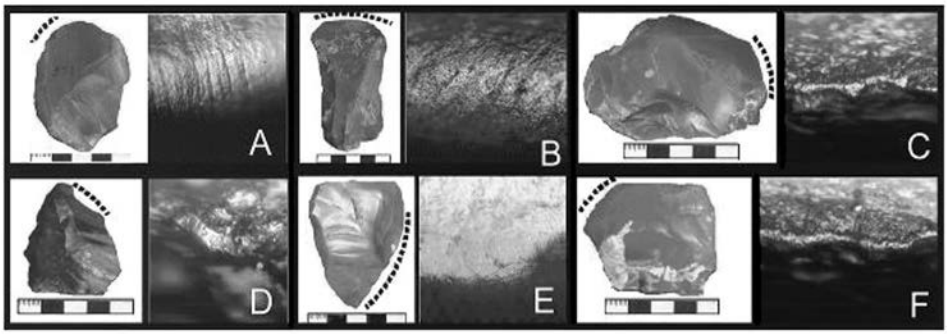
In our use-wear analysis, a Nikon Epiphoto 200 reflective light microscope with bright field illumination (from 50X to 500X) was used to inspect micropolish. Edge damage was observed under a Nikon SMZ800 stereomicroscope (10X to 63X), using the criteria established by Mansur-Franchomme (1983). To analyze lithic-artifact designs, variables related to edge morphology were considered, based on the descriptive proposal of Aschero (1975, 1983).

Design and Functional Analysis

The results of our analysis confirmed artifactual integrity. Of 18 edges observed from U6, only 37% of micropolish features were caused by hard worked material (Figure 1 and Table 1). A high percentage (58%) were not determined by alteration (NDA) owing to the high degree of post-depositional surface alteration (glossy patina and rounding [Mansur-Franchomme

Table 1. Artifacts from Piedra Museo included in the microwear analysis.

	Typological Group				
Stratigraphic unit	**Scraper**	**Sidescraper**	**Rabot**	**Retouched notch**	**Projectile point**
U 4/5 F:15 NF:6	6	6	1	–	2
U6 F: 3 NF: 8	–	3	–	1	–
Total	**6**	**9**	**1**	**1**	**2**



Use/edge	Position (%)			Secondary edge form (%)			Edge angle (degrees)			Length (mm)		
	SE	FE	SC	S	CX	SC	Mean	SD	Mode	Mean	SD	Mode
U4/5 n=25 **SM** n=7	29	71	–	17	83	–	35.7	13.36	30	54.43	16.48	–
HM n=13	33	50	17	33	50	17	36	13.3	45	33.4	22.3	22
U6 n=18 **HM** n=13	75	25	–	100	–	–	32	15.5	–	30.5	16.4	–

SM soft material **FE** front edge **CX** convex
HM hard material **S** straight **SC** semicircular
SE side edge

Figure 1. Results of microwear analysis of the Piedra Museo artifacts. **A–B,** hide micropolish with transversal motion, artifact numbers 621 and 642, at 200X; **C,** micropolish of hard material, artifact number 670, at 200X; **D,** micropolish of hard worked material on retouched notch, artifact number 59, at 200X; **E,** post-depositional damage, glossy patina, artifact number 135, at 200X; **F,** micropolish of hard worked material, artifact number 724, at 200X.

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1983, 1999]). The remaining 5% include artifacts whose traces of use wear were not sufficiently developed to assign them to some kind of worked material (ND).

Of 25 edges observed from U4/5, 52% had micropolish identified as caused by hard material (bone or wood) and soft material (hide), 28% were not determined, probably because duration of use was not sufficient to produce distinguishable wear. The rest of the edges (20%) exhibited clear evidence of surface alteration that prevented our identifying traces.

The analysis of lithic-artifact design in U4/5 showed that edges used on soft materials were mostly frontal normal edges (50%), convexly extended, with a mean angle of 35° and mean length of 54.43 mm. In contrast, artifacts used to work hard material showed a greater variability of edge morphology; there were equal proportions of denticulated, spurred, and normal edges (30%). We also observed a higher percentage of frontal edges, with a simultaneous increase in use wear observed on lateral edges.

The micropolish identified in U6 only was caused by hard material worked mostly with natural rectilinear edges, located in lateral position.[3]

[3] Primary and secondary form of the edge (Aschero 1975, 1983).

Discussion and Conclusions

The results presented above bear three interpretations. First, the uneven textural composition of stratigraphic units and probably different taphonomic histories are responsible for differential preservation of microscopic traces of use wear. Second, a relatively low percentage of the tools from U4/5 show post-depositional damage, and morphological variability of edges is associated with different kinematics (transverse and longitudinal actions [Álvarez 2003]) and worked materials (wood, hide, and bone). Third, a higher percentage of the tools from U6 show post-depositional damage (glossy patina and rounding), and the tools only bear evidence of hard worked materials (wood or bone).

Few tools of the Pleistocene-Holocene transition period exhibit diagnostic use-wear traces, and most show signs of post-depositional alteration. In tools from U6 these alterations (glossy patina and rounding) prevented our detecting use traces except those caused by working hard material (which may be wood or bone). Our results differ from those obtained by Cattáneo (2002), who detected microwear polish and striations on lithic artifacts associated with cutting meat. The uniformity detected in the manufacture and use of lithic artifacts in U6, together with radiocarbon dating results and archaeofaunal studies indicating the presence of Pleistocene fauna with cutmarks (Miotti 1996, 2000), nonetheless support the overall function proposed for this archaeological site in the early moments of human colonization of this southern area.

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PART 2

New Data on Exploited Pleistocene Fauna at Piedra Museo (Central Plateau of Santa Cruz Province, Argentina)

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➤**Keywords:** Archaeozoology, Patagonia, Pleistocene/Holocene

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This paper is an update on the archaeozoological studies of stratigraphic unit (SU) 6 at Piedra Museo; it includes analysis of the total assemblage from this unit and new evidence about exploited Pleistocene fauna. AEP-1 is a multi-component site under the rockshelter at Piedra Museo, located in the Central Plateau of Santa Cruz Province (47° 53′ 42″ S and 67° 52′ 04″ W). Previous papers summarized the analysis of lithic assemblages (Cattáneo 2002), archaeozoological and taphonomic data (Miotti and Salemme 2005; Miotti et al. 1999), and geoarchaeological characteristics of the site (Miotti et al. 2003). Two archaeological components were initially defined: the upper component, dated toward the middle Holocene, and the lower component, dating to the Pleistocene-Holocene transition. Subsequently the latter was divided into two occupational phases, the older in SU6 dated to ca. 13,000–10,500 RCYBP, the younger in SU5 and SU4 dated to 10,400–9200 RCYBP (Miotti et al. 2003). SU6 registered the greatest taxonomic diversity in the sequence, comprising specimens of *Hippidion saldiasi*, *Lama gracilis*, *Lama guanicoe*, *Mylodon* sp., rheids, and medium-sized birds. Also recovered were 39 lithic artifacts, of which 36 are flakes and debris, and 3 are endscrapers (Cattáneo 2002; Miotti et al. 1999). These remains were interpreted as the result of activities related mainly to obtaining prey and its primary butchering; previously, cutmarks had been identified on specimens of *Hippidion saldiasi*, *Lama gracilis*, *Lama guanicoe*, and rheids (Miotti et al. 1995; Miotti and Salemme 2005).

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This paper presents results from re-studying the faunal assemblage from SU6, with special emphasis on the evidence of the human use of extinct fauna. The goal is to integrate all the faunal evidence into one analysis, including specimens from excavation sectors which were not included in previous analyses.

Results

The assemblage contains 219 specimens, of which 185 were assigned to taxonomic categories. The results, which confirm the findings in previous works, indicate that camelids, including *Lama guanicoe* and *Lama gracilis,* were recurrently exploited (Table 1). It is noteworthy that a high percentage of specimens are young or sub-adult animals or are fragments of diaphyses identified as *Lama* sp. The three categories belonging to camelids constitute 57% of the NISP of the assemblage. The Pleistocene taxa *H. Saldiasi*, *L. gracilis* and *Mylodon* sp. constitute 26% of the NISP (Table 1).

Table 1. Taxonomic composition of stratigraphic unit 6, Piedra Museo.

Taxa	NISP	% NISP	Taxa	NISP	% NISP
Birds	5	2.7	*Lama guanicoe*	12	6.49
Rheidae	4	2.16	*Lama* sp.	65	35.13
Canis sp.	6	3.24	Large mammals	44	23.78
Equidae	15	8.11	*Mylodon* sp.	6	3.24
Lama gracilis	28	15.13	**Total**	**185**	**99.98**

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The frequencies of skeletal parts were estimated for all three categories of camelids (*L. guanicoe, L. gracilis and Lama* sp.). The calculated MNI is 3, and the estimates of percent survivorship and percent MAU (Lyman 1994) suggest a low representation of all skeletal parts. Attempts to correlate between these parameters and utility indexes (Borrero 1990; Lyman 1994) as well as bone mineral density (Elkin 1995) yield insignificant results. A completeness index of 0.70 (MNE/NISP) (Lyman 1994) indicates low fragmentation of the assemblage. The analysis of long bones finds that a significant number of fractures (44.89%) are of the helicoidal type.

In analyzing specimens of extinct taxa, we emphasized identifying modifications of anthropic origin to assess the degree to which humans were responsible for creating the assemblage and thereby evaluate interaction between humans and megafauna. The bone surfaces were analyzed with the naked eye and a binocular magnifier (up to 60X). Perceived patterns show that both natural and cultural agents participated in creating the set.

Among modifications identified as resulting from human processing (Figure 1) were cutmarks detected on a high percentage of specimens (24.4%). Cutmarks were observed on specimens of extinct taxa already published and in *Mylodon* sp. (16.6%), *Hippidion saldiasi* (33.3%), *Lama gracilis* (21.4%) (Figure 1), *Lama guanicoe* (14.2%), and rheids (25%).

Although modifications made by carnivores are not clearly identified and are therefore recorded less frequently, we observed possible evidence of carnivore gnawing on some specimens. Other perceived modifications were produced by thermal alterations, roots, and manganese staining.

Conclusions

Our analysis of the faunal assemblage from Piedra Museo confirms many of the tendencies and

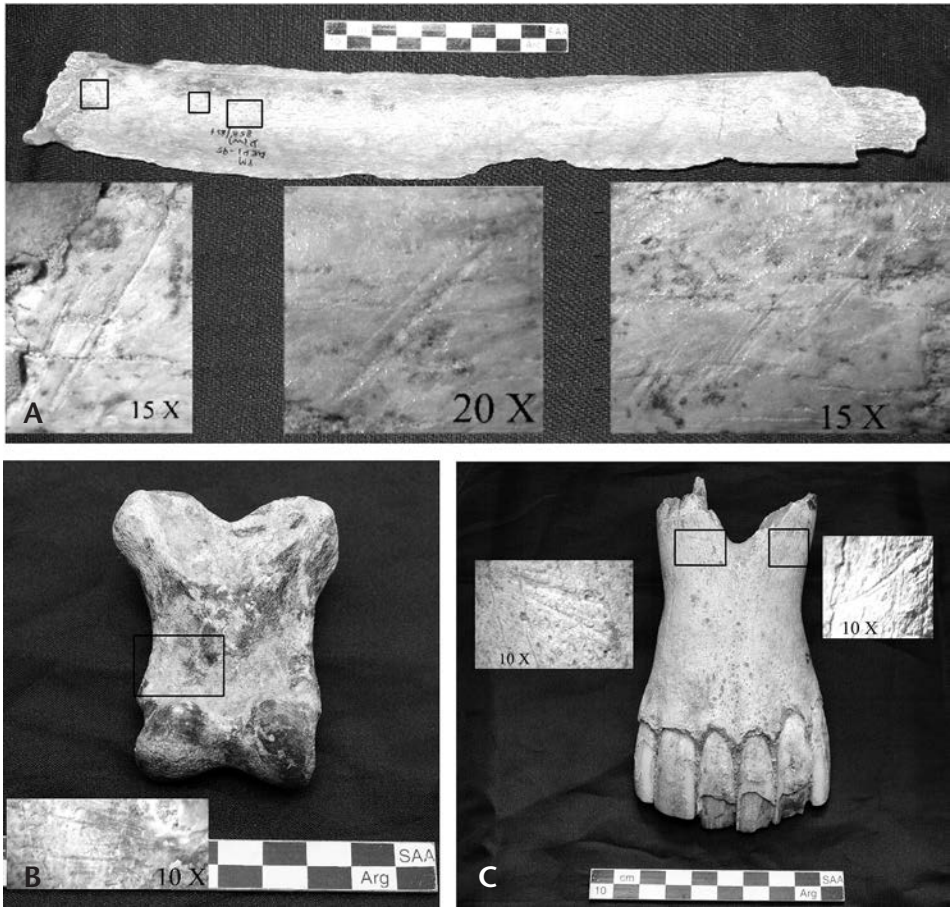

Figure 1. Faunal bones from stratigraphic unit 6, Piedra Museo, featuring cutmarks identified in this study. **A,** rib of *Mylodon* sp.; **B,** phalanx of *Hippidion saldiasi*; **C,** mandible of *H. saldiasi*.

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patterns in exploiting fauna observed in previous analyses of significantly fewer samples. We conclude that the fauna exploited in the first occupations at Piedra Museo, mostly camelids and opportunistically hunted Pleistocene mammals, coincide with a generalized pattern (Borrero 2009; Borrero and Franco 1997; Miotti and Salemme 1999). The values of taxonomic diversity calculated for SU6 indicate that camelids were the principal prey exploited. Taxa hunted to a lesser extent were native horses, rheids, and maybe occasionally mylodons. All represented taxa, both extinct and extant, show evidence of human processing, though in varying frequencies.

The taphonomic studies carried out previously recorded the presence of cutmarks on horse and *Lama gracilis* specimens, but not on the remains of *Mylodon*. This taxon is present in many locations in Patagonia; in most cases, however, the unclear nature of a human association or the absence of anthropic traces has hindered assigning it to the status of an exploited species (Borrero 2005, 2009). The presence of unambiguous cutmarks in a rib sample of *Mylodon* from SU6 (Figure 1), even though all evidence belongs to a single specimen, supports the

hypothesis of human butchering of this taxon. Overall, the incidence of verified cutmarks suggests that camelids and horses were the most intensively exploited specimens; in the case of camelids, their extensive exploitation by humans is confirmed by the high incidence of helicoidal fractures of long bones. The evidence of mylodon butchering is quite sparse, which suggests they were only occasionally exploited by humans, either by hunting or scavenging.

In summary, we conclude that humans were the principal agent responsible for accumulating faunal remains in the SU6 deposit at Piedra Museo. Evidence of carnivore damage is found only infrequently in certain isolated skeletal units; therefore, the role of carnivores as an accumulating agent is minor.

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Variability in Lithic Technological Strategies of Early Human Occupations from the Central Plateau, Santa Cruz, Argentina

PART 2

Fabiana Skarbun[1]

➤**Keywords:** Production sequences, late Pleistocene/early Holocene, Santa Cruz, Argentina

This report examines the production sequences of lithic artifacts associated with the initial peopling of the Central Plateau of Santa Cruz. These first human toolmakers used different lithic raw materials in diverse ways, based on their distribution, availability, and quality. These are reflected in the sequence of tool production, design of artifacts and their possible functions, and in the energy they invested in curating them. Lithic technological strategies are analyzed here in terms of risk management (Bousman 2005) and cost of procuring raw material (Andrefsky 1991). We consider such variables as the type of site and activities performed there, regional resource structure, mobility, and variety of occupations.

The evidence analyzed comes primarily from La María archaeological area, situated near other early sites like El Ceibo and Los Toldos (Cardich 1987), Cerro Tres Tetas (Paunero 2000) and Piedra Museo (Miotti 1992). La María includes five early components that occur at Casa del Minero 1, Cueva Túnel and La Mesada; their radiocarbon dates range between 11,500 and 9000 RCYBP (Paunero 2009).

La María is situated in the Deseado Massif, in a rocky landscape (Chon Aike formation) that has a great variety of siliceous rocks of very good quality suitable for knapping. Flint and silicified tuff outcrops are broadly distributed, while chalcedonies and silicified woods are concentrated in limited areas. Non-local raw materials are also found in the sites, such as

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translucent opals, which possibly belong to the Chon Aike formation but have not yet been found in it; and obsidians, which probably came from Pampa del Asador (Skarbun 2009).

Lithic-Production Sequences

We examined 16 different kinds of lithic-production sequences in our techno-morphological analysis of debitage and tools. Seven of these sequences exploited quarries of immediately available flints and locally available chalcedonies to obtain unstandardized cores, which were then taken to the sites to produce blanks, blades, and nodular supports (Figure 1). Different sequences are recognized for the final shaping of unstandardized blanks (flakes). In sequence 1, margins were retouched and edges were sightly regularized, but only on flints. In sequence 2, margins were also retouched, the edges were more regularized, and some tools were re-sharpened, operations that imply some degree of curation. In sequence 3 the final shaping was made by unifacial retouching, both extended and marginal; only flints were used in this

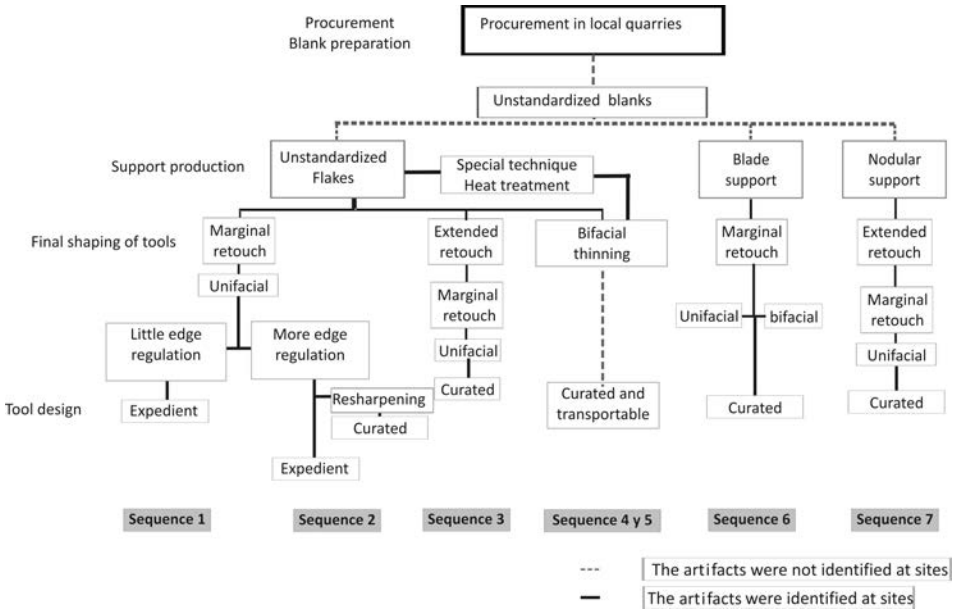

Figure 1. Lithic-production sequences of locally available raw materials and core transport for the early lithic assemblages from the La María archaeological area, Central Plateau, Santa Cruz, Argentina.

sequence. In sequence 4, final shaping was made by bifacial thinning. In sequence 5, some of bifacial-thinning flakes of flint were heat treated (Frank 2011). Although none of the finished tools from sequences 4 and 5 were recovered at the sites, the debitage evidence shows that both sequences produced curated and transportable tools. Flint blades were shaped by unifacial or bifacial marginal retouching (sequence 6). Finally, sequence 7 started with flint nodular blanks, which were shaped by unifacial extended and marginal retouching.

Seven other sequences were recognized on locally available flints, chalcedonies and silicified woods. In these sequences, however, unstandardized and blade blanks were transported to the sites (Figure 2). Final shaping involved three kinds of operations: (1) unifacial marginal

retouching; (2) extended retouching with unifacial or bifacial marginal retouching of unstandardized blanks; and (3) bifacial thinning and bifacial marginal retouching of unstandardized and blade blanks. Three designs were identified with unifacial marginal retouching: one on silicified wood with poor edge regularizing (sequence 8); the other two on flints, sequence 9 with edge regularizing, and sequence 10 with notched edges. The tools finished by extended retouching or bifacial thinning were curated and transportable (sequences 11, 12, 13 and 14).

Finally, two sequences were performed on non-local translucent opals: unstandarized blanks (sequence 15), and blade blanks (sequence 16). Sequence 15 started with blade cores,

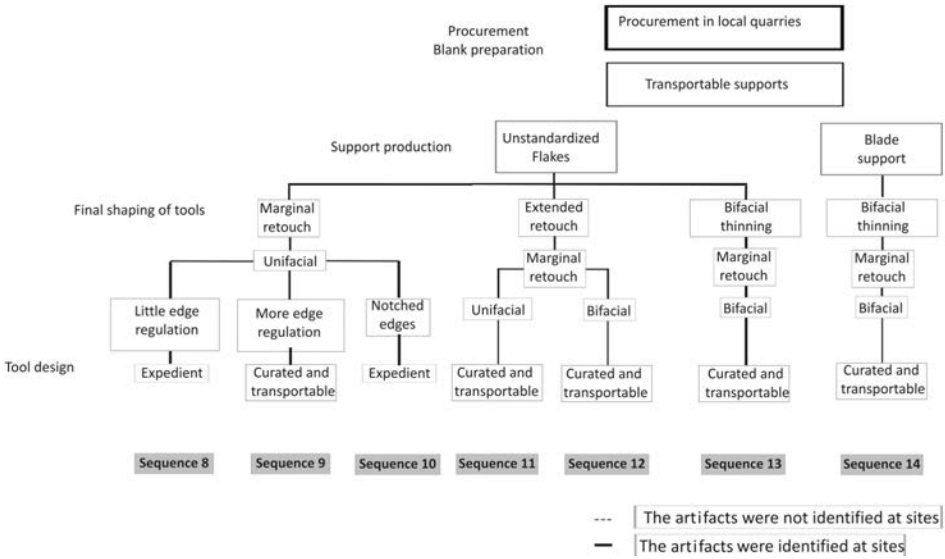

Figure 2. Lithic-production sequences of locally available raw materials and blank transport for the early lithic assemblages from the La María archaeological area, Central Plateau, Santa Cruz, Argentina.

and followed through with unifacial or alternate marginal retouching for final shaping, resulting in curated and transportable designs. Debitage analysis shows that bifacial thinning and edge resharpening were performed in both sequences.

Discussion

Two different organization modes were identified in the final-Pleistocene units analyzed. One corresponds to the lower units of Casa del Minero, defined as a multiple-activity site, possibly part of larger residential bases (Paunero 2009). Tasks were mainly related to the primary processing of prey, consumption, and secondary processing. Considering that a great variety of subsistence and mineral resources was readily available, it appears to have been an efficient workshop where different technological strategies were applied to available local resources. Little energy was invested in acquiring local high-quality toolstone. Flint was the rock most often used; cores were prepared away from the site, probably in quarries with little energy invested in producing blanks. Other strategies were involved in the final shaping of tools, with more energy invested in manufacturing processes. These strategies were related

to other factors, such as tool function and use life. Making bifacially thinned tools implies investing great energy and discarding away from the sites. Finally, other high-quality rocks were acquired from distant sources in lesser quantities. Importing exotic toolstone probably involved other strategies for transporting toolstone, economizing its use, and designing and curating versatile tools.

The lower unit of Cueva Túnel appears to have been organized in a different mode. Specific activities were performed in highly mobile circumstances while the area was being colonized (Paunero 2009). Under these conditions, the availability of raw material might have been an important concern. Consequently non-local translucent opal was the rock most commonly used, and blade cores might have been transported. Analyzing debitage, however, reveals that tools were also manufactured from high-quality local flints, although tools of this material were not found at the site. In view of the desirability of this superior toolstone, tools made from it were probably made part of curated toolkits carried on long-distance travels. Other nearby early sites like La Gruta have yielded debris of siliceous raw material not immediately available, evidence that these toolstones circulated throughout the Deseado Massif since the late Pleistocene (Franco et al. 2011).

Subsequent occupations during the early Holocene, possessing a deeper knowledge of the landscape and whereabouts of resources, pursued more advanced strategies for procuring raw material. The need to acquire lithic resources influenced many of the decisions human groups had to make. Two strategies were involved. In the most common, cores or blanks of flint were transported to the sites. Producing blanks absorbed less energy than the final shaping and bifacial thinning of tools. This strategy was used to make tools designed for specific functions. The other procurement strategy involved obsidian, a non-local toolstone probably transported about 200 km. Other early Patagonian sites also appear to have used obsidian imported from a considerable distance. Studies of Cerro Tres Tetas reveal obsidian from Pampa del Asador (Paunero 2000; Stern 2004); it likewise appears in sites from the Deseado Massif (Miotti 2006; Hermo 2008) and Patagonia (Civalero 1999; Espinosa and Goñi 1999; Stern 2004). Its ubiquity further supports our interpretation that these groups practiced highly mobile strategies (Miotti 2006).

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PART 2

Technological and Functional Analysis of Pleistocene Components from La María Locality, Santa Cruz, Argentina

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➤**Keywords:** Functional analysis, Pleistocene components, Santa Cruz

PART 2

Technological studies related to late-Pleistocene hunter-gatherers from the Central Plateau of Santa Cruz, Argentina, have historically tended to describe morphologically and typologically samples of lithic artifacts from individual sites (Cardich and Flegenheimer 1978; Cardich et al. 1987; Miotti 1996). Very few comparative studies have been done, especially in relation to early technologies (Aguerre 1979; Cattaneo 2002; Mansur 1984; Paunero and Castro 2001; Gradín et al. 1987).

Here we present a comparative analysis of samples of lithic artifacts from two different early cultural components from the Patagonia Central Plateau. We study the kinds of tasks tools were made for and analyze differences and similarities between both sites, taking into consideration the information provided by analyzing stone-tool production and use strategies. The materials we analyzed come from unit 4 (U4) of the Casa del Minero 1 site (CDM1) and from units 8, 9 and 10 (U8/10) of the Cueva Túnel site (CT). Both are multicomponent sites located in caves and dated to ca. 10,600 CALYBP (Castro et al. 2011).

Tools yield a corpus of information related to ancient societies and provide knowledge about exploiting resources, manufacturing techniques, preference for certain kinds of rock, and morphological characteristics of the edges. Analyzing goes beyond the material object and considers techniques and strategies that figure in producing artifacts (Pfaffenberger 1992).

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Our goal is to analyze the techno-morphological characteristics and use made of stone tools from two late-Pleistocene components, CDM1-U4 and CT-U8/10. A secondary aim is to compare the macroscopic characteristics of the stone tools of both sites with neighboring sites from the Central Plateau to determine whether they are technologically related.

Methodology

We described and classified the samples through an analytical approach, compatible with functional analysis, based on criteria built on regional lithic research (Castro et al. 2011). Among the technological traits considered when analyzing stone artifacts were the type of blank, platform, characteristics of blank flaking, module, and size.

For the comparative analysis with other early components from the region, we considered published papers (see above) on lithic technology. Information from sites Los Toldos (LT), El Ceibo (EC), Piedra Museo (PM), Cerro Tres Tetas (C3T), and Cueva de las Manos (CdlM) have been averaged. The lithic assemblages from these sites share certain technical and morphological characteristics such as: flakes used as blanks; predominance of angular flakes, followed by secondary backed flakes and primary flakes; production of predetermined shapes such as blades; prepared platforms and artifacts with unifacial marginal retouch predominate; marginal dorsal retouch that is mostly scalar. The preferred raw material was flint, followed by chalcedony and silicified wood. Artifacts are usually large, but there are also medium-sized and very large artifacts. The typology is dominated by scrapers, sidescrapers, and knives; morphological standardization is absent. Microscopic functional analysis was used to verify the function of the artifacts (Castro et al. 2011).

Results

We found technological similarities between the stone artifacts from CDM1-U4 and CT-U8/10. The selected raw materials were flint and chalcedony. The typological structure of the analyzed assemblages from both sites is dominated by retouched flakes and knives, followed by scrapers, sidescrapers, and retouched blades. There is also a chopper/hammerstone. All the artifacts are of large, medium, and very large size. In both assemblages the principal blanks selected are angular and primary flakes, followed by blades and cobbles. There is a prevalence of flat platforms, followed by prepared ones. No cortical platforms were recorded, which signifies that the flaking surface of the core was prepared before producing a blank. For the final shaping of blanks, marginal and extramarginal retouch and microretouch prevail. The type of retouch is in all cases scalar. This kind of flaking does not change the general shape of the blank. Bifacial retouch is less represented.

Functional analysis was done on 32 edges from 18 stone tools (Table 1 and Figure 1). The tools at CDM1 were always used applying a single movement on a single substance. Those artifacts which, according to functional analysis, were used–scraper/side scraper and retouched flakes—scraped hides and cut bones; the applied movement was transverse to the edge, in a minor proportion longitudinal movements were detected. In other cases indicators refer to a probable use, because use-wear was not diagnostic. One of these cases shows evidence of wear of a longitudinal movement; another two show transverse actions, all on unspecified substances. The remaining stone tools did not have any traces of use, in spite of having finely regularized edges (Castro et al. 2011). The stone artifacts from CT were used for up to two actions on different substances. Sidescrapers, knife/sidescrapers and a chopper-hammerstone were used to cut meat and bone, to strike stone and to crush hard substances such as bone or

Table 1. Traces of use wear detected on stone artifacts from Casa del Minero 1 and Cueva Túnel.

Stone tools	No. edges	Used? Sure	Used? Probable	Used? Unused	Action	Substance
Unit CDM1 U4						
Retouched flake	2	X			Transversal	Hide
Retouched flake	2	X			Longitudinal	Bone
Retouched flake	2			X		
Retouched flake	2			X		
Retouched flake	1			X		
Retouched flake	2					
Edge 1			X		Transversal	Undet.
Edge 2				X		
Scraper	1		X		Transversal	Undet.
Sidescraper	2			X		
Knife	3					
Edge 1			X		Longitudinal	Undet.
Edge 2				X		
Edge 3				X		
Scraper/sidescraper	2	X			Transversal	Bone
Biface	2			X		
Unit CT U8/10						
Knife	2					
Edge 1			X		Longitudinal	Meat
Edge 2			X		Longitudinal	Meat
Knife	1		X		Longitudinal	Meat
Knife/sidescraper	2					
Edge 1		X			Longitudinal	Meat
Edge 2				X		
Retouched flake	1			X		
Retouched blade	1			X		
Chopper/hammer	3					
Edge 1		X			Strike	Stone
Edge 2		X			Crush	Bone
Edge 3		X			Strike	Stone
Sidescraper	1	X			Longitudinal	Meat

wood. These artifacts performed longitudinal and punctual movements. In two other cases the indicators refer to a probable use, both knives with traces of longitudinal action on a soft substance such as meat, skin, or some other soft tissues. The remaining stone tools did not have diagnostic traces of microwear.

The technomorphological comparative analysis performed with the other contemporary sites from the region (see above) shows that there are similarities in the manufacturing techniques and in the kinds of rocks selected; therefore, we think there was a similar *way of doing* (regarding ideas and gestures) in producing lithic artifacts during the late Pleistocene in the region.

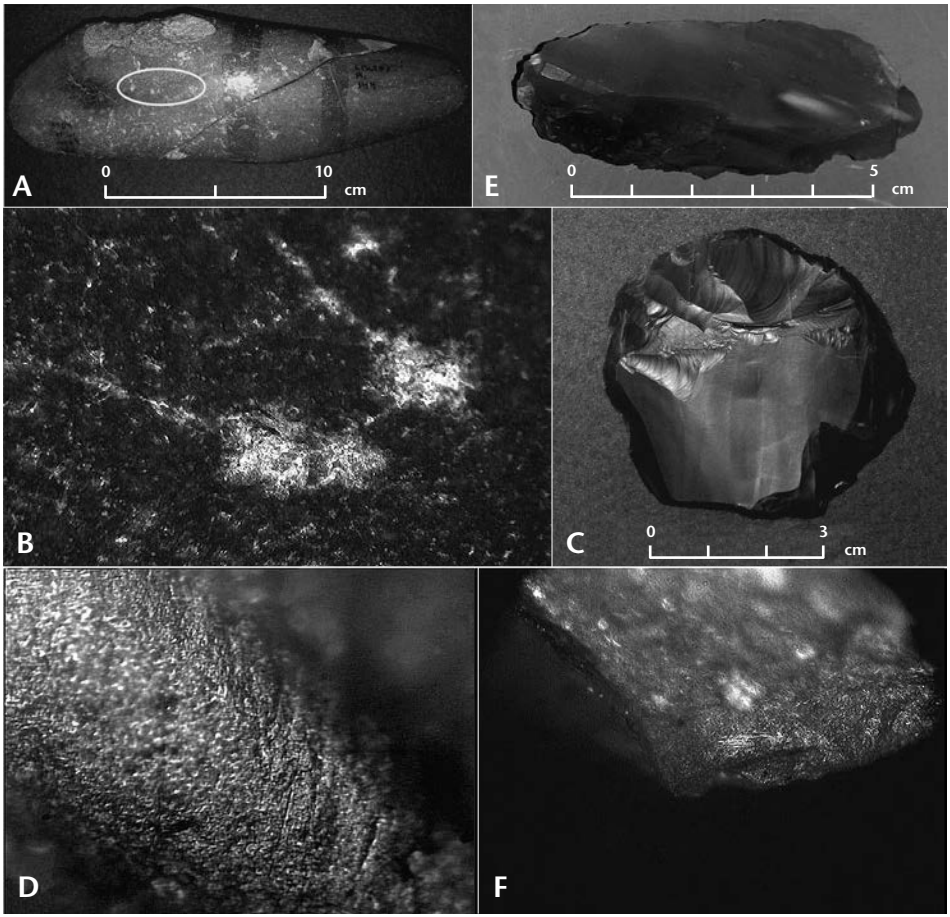

Figure 1. Artifacts and micrographs of materials from Casa del Minero 1 and Cueva Túnel. **A–B,** chopper/hammer from Cueva Túnel, magnification 70X (note rushed marks in kite-shaped oblique orientation); **C–D,** scraper/sidescraper from Casa del Minero 1, magnification 300X (microwear and transverse striations of action imply scraping of leather); **E–F,** knife/sidescraper from Cueva Túnel, magnification 150X (note longitudinal orientation of microwear implying cutting of flesh and bone).

Conclusions

Regularity is evident in the stone-artifact technology of the earliest lithic assemblages from the area, including CDM1 and CT. Tools of all the assemblages are of a size suitable for manual handling, and the toolkits are characterized by a low investment of work on good-quality rocks. The prevalence of large stone tools only marginally modified by retouch suggests that resharpening was implicit in the conception of the artifact.

Differences between CDM1 and CT arise when considering functional aspects. Stone tools of CDM1 were made to process hides, to remove fleshy matter or to tan by scraping; and to cut bone when dismembering or when separating soft tissue from bone. These activities may have been a part of the secondary processing of bones for making tools like those found in the

component. The technological repertoire and inferred activities suggest a site where primary butchering and secondary processing of prey were done and tools were given their final shaping. At CT, on the other hand, artifacts were designed for the primary processing of prey. This is evident in the retouched edges of knives and sidescrapers, which bear microwear and other traces associated with cutting hard substances such as bone and soft tissue such as meat. Percussion marks around the edge of the chopper-hammerstone suggest impacts from breaking wood or bone. We also detected evidence of percussion on rocks by marks on its working surfaces.

The evidence suggests a technology for making stone tools to perform simple and planned tasks. We wish to emphasize the importance of supplementing technological analysis with functional analysis, thereby yielding great benefits in interpreting the activities performed in settlements and the variability of contemporary sites, such as those occupied by the first societies of Patagonia.

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PART 2

Heat Treatment of Lithic Artifacts in Early Sites from the Central Plateau of Santa Cruz (Argentina)

Ariel D. Frank[1]

➤**Keywords:** Heat treatment, Patagonia, final Pleistocene

PART 2

Heat treatment consists of carefully annealing lithic material when producing tools. It makes the rocks more fragile and flaking easier, especially by pressure (Mandeville 1973). Although some scholars have claimed this technique was known by the first societies that peopled Patagonia (Cardich and Paunero 1991–92), no systematic studies have been carried out to investigate this interpretation. The aim of this article is to determine if heat treatment was applied by the first groups that colonized the Central Plateau of Santa Cruz (Argentina). I present research conducted on the lithic assemblages of the lower units of two archaeological sites, unit 4 of Casa del Minero 1 (CDM1) and unit 5 of Cerro Tres Tetas 1 (C3T1), which have radiocarbon dates ranging between 11,500 and 10,200 RCYBP (Paunero and Castro 2001; Paunero et al. 2007).

Heat treatment

Heat treatment alters the look of rocks. They acquire certain characteristics that make it possible to identify this process in archaeological remains (Domanski and Webb 2007). There are three kinds of thermal features that can be recognized macroscopically: heat damage, luster, and color change. Thermal luster develops internally when heat treatment is applied. Thus, after retouch, luster can be observed in the negative flake scars of the artifact and on both surfaces of the flakes removed from it—with the exception of the first flakes, which only show luster on the ventral surface. It is also possible to notice color changes in a treated artifact and on both faces of the first flakes removed from it. Heat damage occurs externally. Therefore it can be identified on both surfaces of the treated artifact but only on the dorsal surface of flakes

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removed from it. Hence, heat-treated debitage will not show evidence of damage on the ventral surface. If such evidence is seen, it means thermal alteration was caused by other processes (Frank 2011). As a consequence, when analyzing a lithic assemblage techno-morphologically, it is necessary to identify heat treatment, and to understand how and why it was used (Frank 2011).

Methodology

I performed a morpho-technological analysis of lithic assemblages from both CDM1 and C3T1 to study if heat treatment was applied, and, if so, to understand at which stage of the reduction sequence this procedure took place. I recorded which kind of artifacts showed traces of thermal alteration and on which surface each feature was located. When possible, refitting studies were also conducted.

The identification of thermal traces was based on published research (Mandeville 1973; Nami et al. 2000, among others) and also on my experiments conducted with local rocks from the Central Plateau (Frank 2011).

Results

There is clear evidence of heat treatment in both sites: 33% of the remains from unit 4 of CDM1 and 10% of the lithics from unit 5 of C3T1 have been treated. Luster was the most common feature, and in many cases artifacts also presented color modifications. Although heat damage was also visible in flakes (3.5% of the assemblage of CDM1 and 10.9% in C3T1), in most cases it was caused by unintentional processes. Most of the damaged flakes were less than 2 cm long and showed thermal damage on their ventral surface.

Heat treatment is most commonly found on flakes produced during the final shaping of tools (Table 1), especially in retouching and bifacial-thinning debris. In CDM1, 70.8% of the bifacial-thinning flakes were treated (Figure 1); in C3T1, 33.3% of these kinds of flakes were treated. No cores appear to have been heated. In C3T1, three heated flakes were refitted to a non-heated core (Figure 1). Treated flakes are small: 27.5% in C3T1 and 75.3% in CDM1 are less than 2 cm long.

Table 1. Heat-treated flakes from Casa del Minero 1 and Cerro Tres Tetas 1.

Site	Decortication	Blank production	Final shaping of tools	Total
C3T1	6 (15.3%)	4 (10.3%)	29 (74.4%)	39 (100%)
CDM1	11 (3.1%)	62 (17.3%)	286 (79.6%)	359 (100%)
Total	17 (4.3%)	66 (16.6%)	315 (79.1%)	398 (100%)

Heated remains were made mostly with local, good-quality flints: in CDM1, 82.4% of heated remains were made on red flint (Table 2). The source of this raw material lies 620 m from the site. Likewise, in C3T1, 70% of heated remains were made on local varieties of flint.

All the heated tools from C3T1 (n = 3) are bifacial tools (two preforms and a biface, all of them broken), while in CDM1 a knife and a unifacially retouched flake were treated. Both were retouched by pressure. The retouched flake is an expedient tool made from the same blank from which several treated bifacial-thinning flakes were recognized. There is only one bifacial preform—which does not show heat treatment—and no bifacial finished tools from this unit at CDM1 (Skarbun 2009).

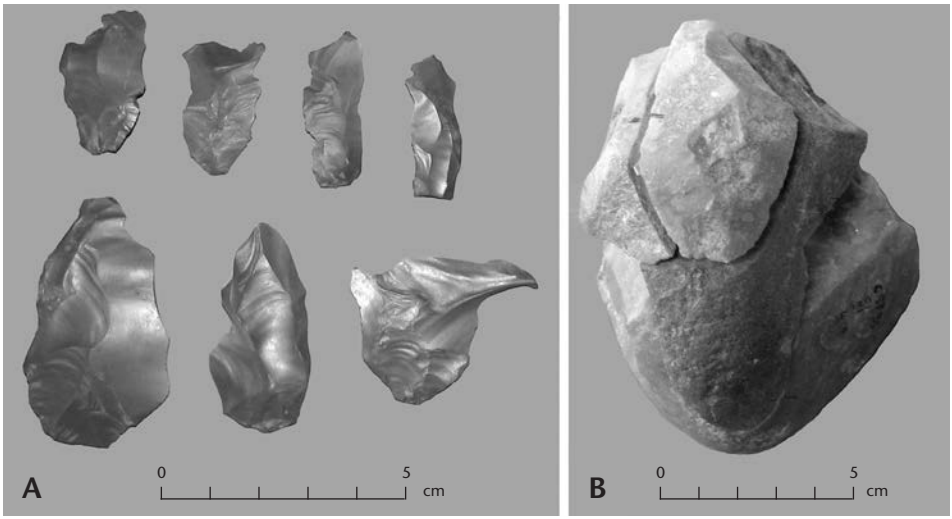

Figure 1. Artifacts from Casa del Minero 1 and Cerro Tres Tetas 1. **A,** bifacial-thinning flakes with heat treatment from CDM1; **B,** heat-treated flakes and unheated core from C3T1.

Conclusions

Results show that early groups in Patagonia applied heat treatment when producing lithic tools. This procedure was applied before the final shaping because there are no heated cores and most treated flakes are small chipping debitage. The evidence shows they heated lithic blanks mostly when producting bifacial artifacts, although some treated flakes were also retouched by pressure to make unifacial tools. Local, good-quality flints were used. This shows that the first societies that inhabited the Central Plateau of Santa Cruz knew about the different properties of these raw materials. The low incidence of heat damage seen on the treated flakes suggests they had a controlled management of fire.

Table 2. Raw material of heat-treated artifacts.

Site	Chalcedony	Gray flint	Red flint	Other flints	Silicified tuff	Silicified wood	Other	Total
C3T1	9 (17.6%)	13 (25.5%)	6 (11.8%)	16 (31.4%)	4 (7.8%)	3 (5.9%)	0 (0%)	51 (100%)
CDM1	48 (11.7%)	2 (0.5%)	337 (82.4%)	15 (3.7%)	0 (0%)	0 (0%)	7 (1.7%)	409 (100%)
Total	57 (12.4%)	15 (3.3%)	343 (74.6%)	31 (6.7%)	4 (0.9%)	3 (0.6%)	7 (1.5%)	460 (100%)

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Initial Human Exploration at the Southern End of the Deseado Massif?

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➤**Keywords:** Patagonia, human exploration, lithics

PART 2

Lithic artifacts, in conjunction with other evidence, provide useful information about the way in which humans have explored and occupied the Patagonian landscape.

According to Borrero (1994–95) exploration implies the initial radiation to new land and displacement of individuals or groups following less resistant natural routes, with repeated, widely separated camping places. As a result new territory can be incorporated. In the long run this process is one of slow expansion of human home ranges. The incorporation of new land, however, implies the operation of variable learning processes (e.g., Rockman 2003). The velocity of incorporation of new land will vary according to the degree of homogeneity between the new and original environments and other factors (see for example Steele and Rockman 2003). This is why the problem of exploration and incorporation of new land should be addressed at a regional or macro-regional scale.

Lithic characteristics are analyzed taking into account expectations derived from the perspective of technological organization and ethnoarchaeological information (Binford 1978, 1979). To do this, the structure of lithic resources should be known (Ericson 1984). Expectations for the early exploration of new land include: a) utilization of raw material of less quality than the one regionally available, except when excellent-quality raw material

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was immediately available (see Meltzer 1989); and b) discard of bifacial artifacts or bifacial flakes (basically last manufacturing stages) made on non-immediately available raw materials (Borrero and Franco 1997, Franco 2002).

The case of La Gruta 1 (previously La Gruta, lagoon 2, cave 1), located in the southern part of the Deseado Massif north of the Chico River (Figure 1, Franco et al. 2010a, 2010b) is presented here. A 1x1-m test pit produced dates corresponding to the Pleistocene-Holocene transition, between ca. 10,845 and 10,477 RCYBP (Franco et al. 2010a). The dated samples consist of small charcoal concentrations located at different places and depths within the lower deposits. Three of the dates were processed from the same charcoal concentration (indicated in Figure 2), one from a different lab [10,790 ± 30 RCYBP (UGAMS-7538)] that is consistent with those previously published.

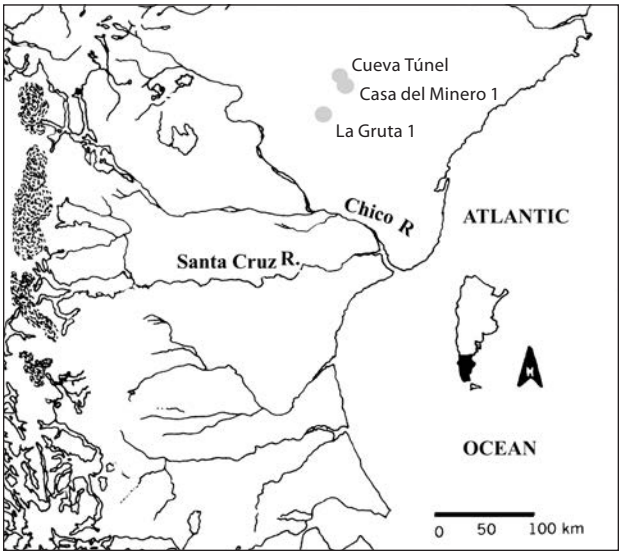

Figure 1. Location of sites mentioned in text.

The study of the lithic artifacts indicates the existence of activities related with late manufacturing stages, including tool resharpening and bifacial reduction (Franco et al. 2010a). Artifacts made on two varieties of obsidian (black and gray) were recovered. Geochemical data for south Patagonia suggest that both come from Pampa del Asador (Stern 1999, 2000), some 158 km to the northwest.

Both the location of the site—in the cliff wall of a closed depression that contains a seasonal lagoon (Franco et al. 2010b)—and the characteristics of the artifacts suggest that the site is functionally specific.

Archaeological sites dating to the Pleistocene-Holocene transition have been identified ca. 60 km north of the area, in the Deseado Massif (e.g., Paunero 2009; Paunero et al. 2007). The earliest sites are Casa del Minero 1 and Cueva Túnel (Paunero 2009, Skarbun 2009). Other sites further north in the same Massif include Piedra Museo AEP-1 and Los Toldos Cave 3 (e.g., Cardich et al. 1973; Miotti and Cattaneo 2003).

Figure 2 indicates the earliest dates obtained in southern Deseado Massif, ca. 11,000 RCYBP.

As mentioned above, the distance between the two areas with early dates is ca. 60 km which, according to ethnographic information, is within the home range of hunter-gatherers living at these latitudes (Kelly 1995). It must also be noted that there is variation in the availability of raw material for lithic tools near Casa del Minero 1 and Cueva Túnel which, in comparison with that recorded near La Gruta 1, is of better quality (Franco et al. 2012). This can be used to suggest that the earliest deposits of La Gruta 1 correspond to a logistical occupation in the context of human exploration of new space. We consider this occupation as being related to nearby places in the north. Supra-regional evidence shows that this is a time at which radiation was actively taking place, probably in accordance to a general warming trend (e.g., Mancini 2009; Tonello et al. 2009). More extensive sampling in La Gruta area and the intermediate area to the north is needed to test this hypothesis.

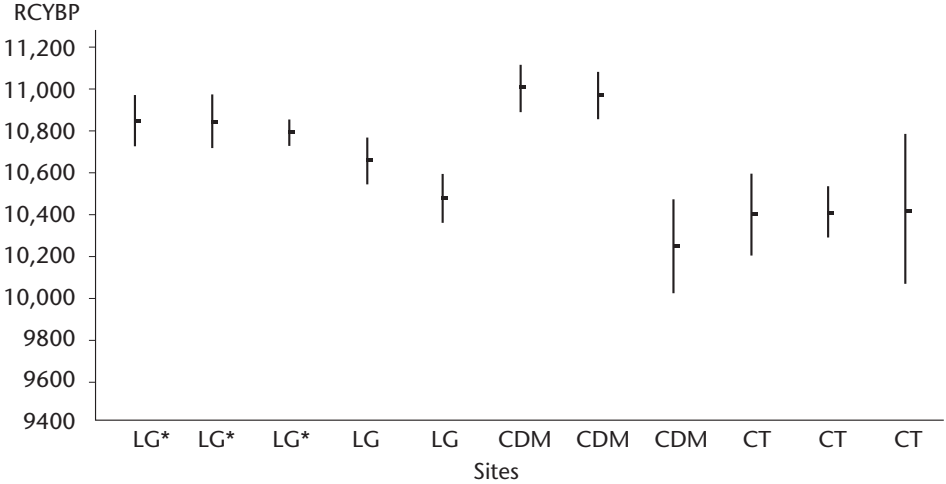

Figure 2. Early radiocarbon dates from the southern Deseado Massif, with two standard deviations (**LG,** La Gruta 1; **CDM,** Casa del Minero 1; **CT,** Cueva Túnel). Asterisks refer to samples from the same charcoal concentration.

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PART 2

PART 2

A Fossil Shark Tooth in Early Contexts of Cerro Casa de Piedra 7, Southwest Patagonia, Argentina

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➤**Keywords:** Fossil tooth, early Holocene, Patagonia

PART 2

Casa de Piedra hill is located in one of the highest glacial lake basins of Patagonia (900 masl) (Figure 1). Belgrano and Burmeister lakes are the most important ones in this basin. Cerro Casa de Piedra 7 (CCP7) is one of several caves and rockshelters located on the northern side of the hill. CCP7 has a stratigraphic sequence which begins at the Pleistocene-Holocene transition. A fossil shark tooth was found in archaeological deposits dated to about 9000–9700 RCYBP; it belongs to the genus *Isurus* (Elasmobranchii, Lamniformes, Isuridae). This species, unknown today in Santa Cruz marine coasts, lived in Patagonian seas during the Miocene epoch, at a time when there were sea ingressions. These ingressions flooded large areas within the present Patagonian territory and generated marine deposits in which abundant remains of extinct fauna (including shark teeth) can be found (Figure 1). In this paper, the recorded fossil tooth is described and its possible modification by human action is discussed.

Tooth Description

The tooth has a slender and straight crown. Both cutting edges are complete. Both mesial and distal

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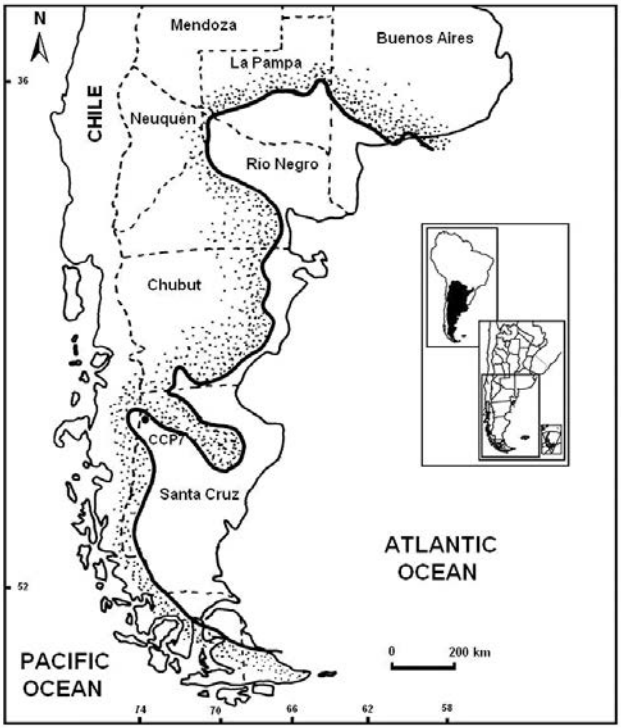

Figure 1. Map of Upper Oligocene and Lower Miocene sea ingressions in Patagonia (modified from Parras and Casadío 2006) and Cerro Casa de Piedra 7 (CCP7) location.

cutting edges are straight. At the base, the crown becomes wider and the cutting edges are concave. The labial crown base does not overhang the root. The crown labial face is transversely flat but the lingual face is slightly convex. There are no lateral cusplets. The root is badly damaged (Figure 2).

Traditionally (e.g., Leriche 1926), Cenozoic shark teeth similar to those of the living species *Isurus oxyrinchus* and *I. paucus* (i.e., lamnids without lateral denticles and serrations, commonly named makos) were included in this genus, as was *I. hastalis*, but this taxonomy is equivocal. The genus *Cosmopolitodus* recently has been used by some authors, assuming that the species *hastalis* is ancestral to the great white shark and is not closely related to the mako sharks (Siverson 1999; Ward and Bonavia 2001). Other authors, e.g., Purdy et al. (2001), continue to use the name *Isurus xiphodon* for broad-crowned specimens of *hastalis*; however, Ward and Bonavia (2001) consider *Isurus xiphodon* as a *nomen dubium*. *Cosmopolitodus*, which includes several species, is a paraphyletic taxon. A different solution could be to assign the species usually included in this genus (*I. hastalis*, *I. xiphodon*, and *I. planus*) to the genus *Carcharodon*. Until a thorough study of the different species of lamnids is done, however, we prefer to refer to these species as *Isurus* because we do not accept the paraphyletic genus *Cosmopolitodus*. Besides, Whitenack and Gottfried (2010) demonstrated morphometrically that *I. hastalis* is different from *I. xiphodon*. Morphology and size of the tooth support the genus *Isurus* assignment, but it is difficult to assign it to a certain species.

Isurus teeth are common in Patagonia in early Miocene Leonian beds (Monte León, Chenque and Gaiman formations [Cione 1988; Cione and Expósito 1980]), and the middle-late Miocene Puerto Madryn and Paraná formations (Cione et al. 2000).

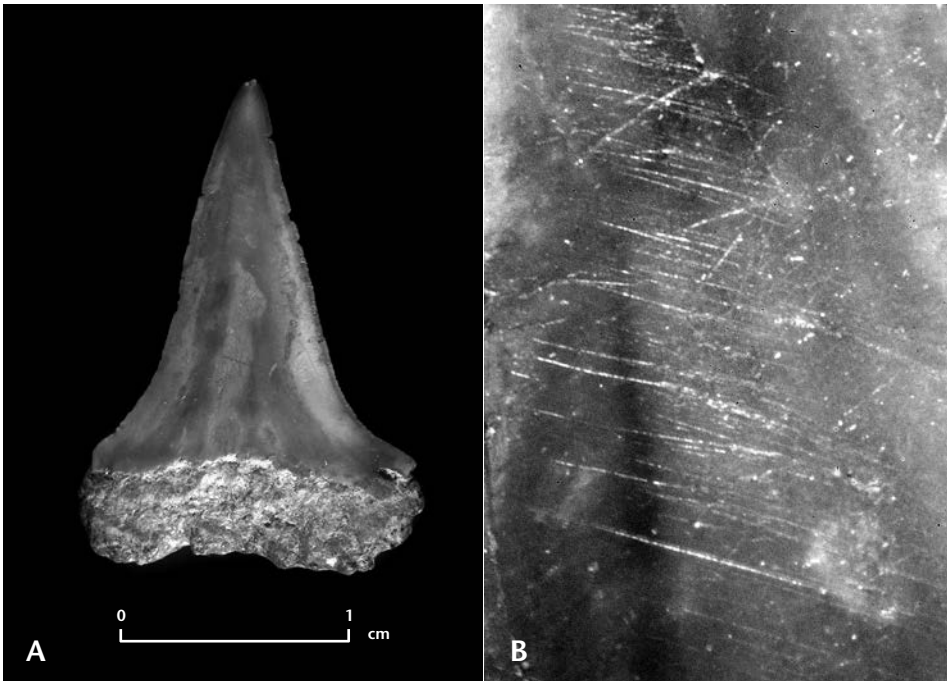

Figure 2. **A,** shark tooth (lingual view) found in CCP7 early archaeological contexts; **B,** striations observed with metallographic microscope (280X) (right).

Lamnid sharks are strictly marine fishes (Compagno 2001). The two recent species of *Isurus* are distributed in tropical and warm temperate seas, *Carcharodon carcharias* lives in a wider range of temperatures, and the two recent species of *Lamna* are cold temperate sharks.

Tooth Microwear Analysis

With the purpose of determining the possible use of the shark tooth, we analyzed it with a metallographic microscope (280X) and binocular magnify glasses. To establish possible differences and following functional protocols, distinctive paleontological shark teeth specimens, with diverse sizes and colors, were observed as comparative references. Six fossil items were analyzed: two of *Carcharias taurus* coming from Punta Indio and Río de La Plata (Buenos Aires), and four of *Isurus hastalis* coming from Bryn Gwyn, Gaiman Formation (Chubut). All these present functional or micropolish-like surface alterations most probably due to taphonomic conditions.

Alteration of the Archaeological Specimen

The archaeological specimen shares the same superficial natural aspect of the paleontological specimens examined. Nevertheless, the tooth shows structural damages on the edges and the apex, which under the microscope are seen to be microfractures. The microsurface presents an abraded surface due to natural agents; however, the occurrence of a large number of striations and multidirectional forms distinguish it from the paleontological specimens. The striations on the archaeological specimen are thin, straight, regularly parallel, and transverse standing

out from the comparative samples (Figure 2). Therefore, it is possible that the archaeological tooth may have suffered alterations that are not taphonomically natural.

Discussion and Conclusions

Even though we do not have yet a precise diagnosis, it can be said that differences between the CCP7 tool and natural specimens exist. The tooth found in the archaeological context has abraded microsurfaces and striations, probably non-natural alterations. In discrepancy with other examples in the archaeological literature (Cione and Bonomo 2003), the CCP7 tooth does not present clearly oriented modifications which could suggest its use as an ornament. The preliminary findings presented here suggest that the tooth might have been used as a tool. This hypothesis means that early humans selected certain objects that did not need further modification for use as tools because of the advantages of their morphology. These objects would have been kept as tools for future uses. Thus, the exaptation concept (Gould and Vrba 1982, adapted to archaeology by Borrero 1993) could be useful to explain the presence of the shark tooth in the archaeological context of the CCP7 site.

This unique finding in an early archaeological context of Andean Patagonia allows us to investigate more deeply human behavior towards the use of raw materials other than those usually considered.

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PART 2

Early Occupations in Tierra del Fuego and the Evidence from Layer S at the Imiwaia I Site (Beagle Channel, Argentina)

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➤**Keywords:** Hunter-gatherers, early Holocene, Tierra del Fuego

PART 2

Tierra del Fuego, the southernmost region of the World, was colonized by hunter-gatherer societies in the late Pleistocene/early Holocene (Borrero 1994–95; Salemme and Miotti 2008). The earliest occupations are located in the Tres Arroyos site (between 10,600 ± 90 and 11,130 ± 210 RCYBP) (Massone 2004) and the Marazzi site (9590 ± 200 RCYBP) (Laming-Emperaire et al. 1972), although the latter occupation has recently been questioned (Morello et al. 1999). Coastal areas would have been attractive to the first inhabitants of Tierra del Fuego, as for other regions of America (e.g., Dixon 2001; Erlandson 2002; Miotti 2006), although nowadays archaeological evidence of these environments is low (Borrero 1994–95).

Recent excavations at the Imiwaia I site have yielded new evidence for hunter-gatherer occupations in Tierra del Fuego during the early Holocene. This site is located in the eastern portion of the Beagle Channel (54° 52′ 21.85″ S, 67° 17′ 46.78″ W), at 4.6 masl. Their remains are contained in the basal layer of the site (layer S). This report presents the first information on this archaeological context.

During the early Holocene, a land bridge between the Primera and Segunda Angostura in the current Magellan Strait connected Patagonia with Tierra del Fuego (Clapperton 1992; Porter et al. 1984) and gave humans and animals a pathway between the northern and southern land areas. This connection was available until the post-glacial rise of global sea level, which

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caused the marine ingression about 8000 RCYBP, giving origin to the present Main Island of Tierra del Fuego.

The formation of the Magellan Strait may have changed the course of the evolutionary history of hunter-gatherer populations in the region. Given the formation of a natural barrier, Magellan Strait, which divided the ancestrally occupied area, Borrero (1989–90) proposes that vicariance created environmentally differentiated and isolated human populations in Tierra del Fuego with respect to the continent. Thereafter populations in the north and south of the Magellan Strait may have experienced biologically and culturally divergent trajectories until 6400 RCYBP, when different sectors of Tierra del Fuego were colonized by hunter-gatherers with navigational technology (Orquera and Piana 1999).

Investigating the possible consequences of geographic isolation is complicated by a gap in archaeological information on Tierra del Fuego between the second half of the early Holocene and the beginning of the middle Holocene. Layer S of the Imiwaia I site is a soil developed on eolian sediment accumulated above till deposits; this soil contains a high density of lithic artifacts, and a charcoal sample from it was dated to 7842 ± 53 RCYBP (AA-78551) (8420–8662 CALYBP). This archaeological record, which is penecontemporaneous with the formation of the Magellan Strait, thus fills the gap and expands our knowledge of the early occupation of Tierra del Fuego.

The technological assemblage of layer S recovered up to the 2010 excavation comprises 26 tools, 31 blanks, and about 10,600 flakes and other lithic debris taken from an excavated area of 74 m^2. Flakes are mainly distributed in four concentrations; Figure 1 shows the spatial

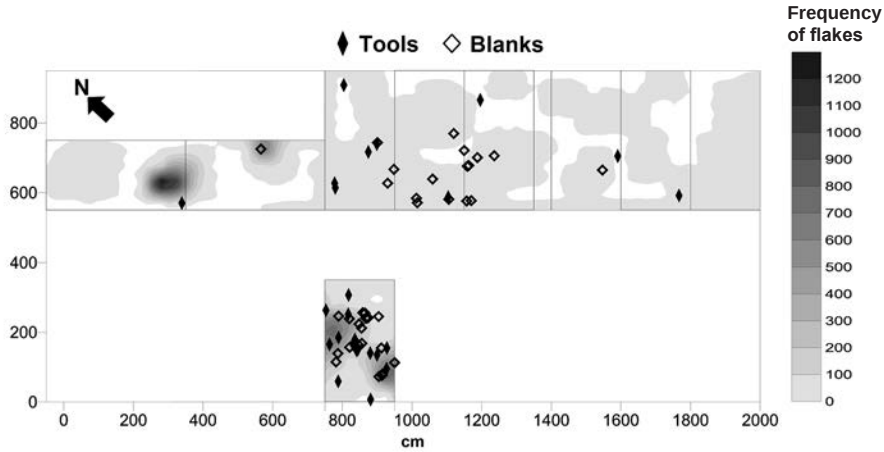

Figure 1. Plan of layer S at the Imiwaia I site (2010 excavation), showing the distribution and frequency of artifacts.

organization of these materials. Among the tools recovered were nine sidescrapers, three endscrapers, two lithic points, one hammer, one borer, one tranchet, and eight other kinds of tools (Figure 2).

This assemblage has some notable technological and morphological features. First, a high percentage (70%) of the artifacts are bifacial, blanks are abundant, and flakes are densely concentrated. Second, the single flaked stone point is 109 mm long and has a stem and a long

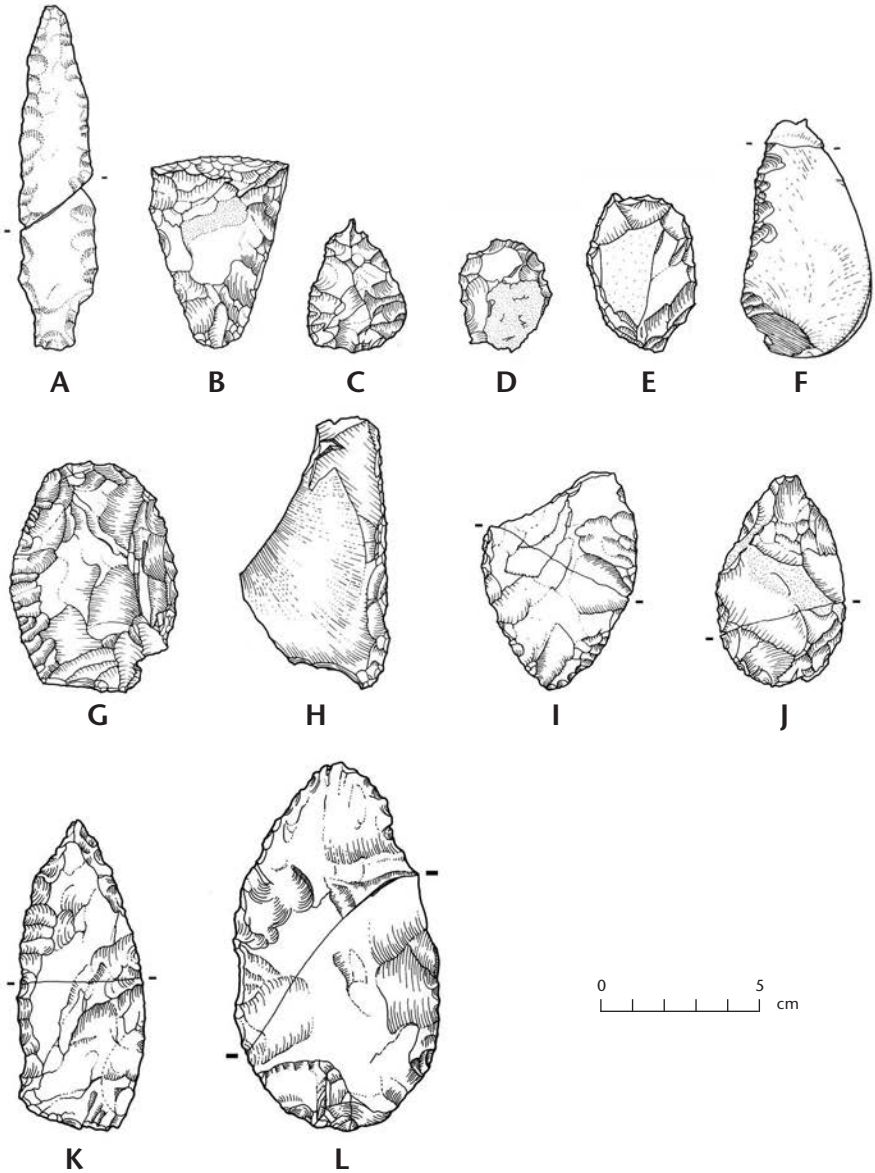

Figure 2. Artifacts from layer S of the Imiwaia I site. **A,** flaked stone point; **B,** tranchet; **C,** borer; **D–E,** endscrapers; **F–H,** sidescrapers; **I–L,** blanks.

(92.5 mm) leaf shape. Third, the borer is a rare find, being absent from other contexts of Tierra del Fuego. Fourth, the tranchet has a sub-triangular shape with a polished face, two long bifacially retouched edges converging toward a rounded base, and a short distal edge retouched with an angle of about 45 degrees. Microscopic analysis (E. Mansur, pers. comm.

2010) of this tranchet concludes that its polished areas are regular, shiny, and smooth surfaces, predominantly oriented along the longitudinal axis of the piece. Polishing has affected the microtopography of the entire artifact, especially the distal half of the ventral side, where edges of retouch scars are all obliterated. The morphology of polishing suggests it was abraded with a hard substance (not leather). Furthermore, the entire surface is cavernous, and the edges are rounded and bear some abrasive marks. The morphology suggests the artifact was altered post depositionally in situ by chemical action. Finally, its distal edge shows low rounding and very little use wear. No micropolishing was found on the distal edge, but its morphology suggests a use transverse to the edge on medium-soft materials.

The highly diverse assemblage recovered in layer S of Imiwaia I suggests that multiple activities were pursued. The assemblage shows morphological affinities with other archaeological assemblages of Patagonia and Tierra del Fuego; however, some morphologically specialized tools (e.g., the tranchet and the very long leaf-shaped blade with stemmed point) are unknown in Patagonia, and tools similar to the borer appear elsewhere in later contexts. These morphologies are also unknown in the Fuegian occupations previous to the opening of Magellan Strait (initial occupations of Tres Arroyos and Marazzi I). Four polished tranchets and several lozenge-shaped lithic points were found in another archaeological assemblage of the Beagle Channel region (the first component of Túnel I, 6680 ± 210 and 6980 ± 100 RCYBP, 7590–7942 CALYBP); these differ from the ones from S layer of Imiwaia I and from assemblages of other sites across the area. Túnel I was reoccupied but a few centuries later by hunter-gatherers with navigation technology.

Although in both layer S of Imiwaia I and the first component of Tunnel I no evidence of littoral adaptation (sensu Orquera and Piana 1999) was found, these records appeared in coastal settings in a period when geographic changes may have spurred human populations in isolation to create innovative tools (Borrero 1989–90). The coasts and their resources may have attracted human colonizers since the early Holocene in Tierra del Fuego.

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PART 2

Part 3
Paleoenvironments of Latin America

PART
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PART 3

A New Pleistocene-age Archaeological-Paleontological Deposit in Santiago Chazumba, Oaxaca, México: An Initial Appraisal

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➤ **Keywords**: Megafauna, Rancholabrean, México

The International Project titled "Biodiversidad y Sociedades Cazadoras-Recolectoras del Cuaternario de México" ("Biodiversity and Hunter-Gatherer Societies from the Mexican Quaternary"), co-directed by the National Institute of Anthropology and History (INAH by its Spanish initials) of México and the Catalan Institute of Human Paleoecology and Social Evolution (IPHES by its Catalan initials), focuses on searching for new archaeological and paleontological localities in México to address the controversial issue of the early peopling of the region (González and Huddart 2008; Sánchez 2001). A component of this program was

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reconstructing the paleoenvironment of early humans, which was accomplished by excavating over three field seasons, May–June 2007, September 2008, and May 2010, at the paleontological locality Chazumba, Oaxaca. Personnel from INAH and IPHES participated, as well as scientists and students from the National School of Anthropology and History (ENAH by its Spanish initials), and paleoecologists from the Ecology Institute at the National University (UNAM by its Spanish initials). Laborers from the nearby town helped during the excavations. The three seasons were funded by the Spanish Agency for International Cooperation and Development (AECID by its Spanish initials), and partially at different stages by INAH, IPHES, and the Municipality of Santiago Chazumba, Oaxaca, México.

The Chazumba deposit lies at the base of a meander of Barranca del Muerto (Death Creek) in the southwestern foothills of Cerro Yacuza, near the town of Santiago Chazumba, Oaxaca. During heavy rains, water eroded the deposit, causing partial slumping of both sediment and bone fragments, which exposed a 12-m wall with a bone bed in a middle stratum (about 5.5 m above the modern creek floor).

Excavations revealed a complete stratigraphy, roughly composed of a minimum of 7 layers, with the surface layer (to a depth of about 30 cm) containing few archaeological materials from the Holocene (mainly ceramics and a few quartz flakes). Five archaeologically sterile layers follow to a depth of about 5 m, where the archaeo-paleontological deposit is found. In fact, fossils occur in a 3-m-thick gray-green deposit composed of slime, sand, gravels, lime nodules, and gypsum crystals ("desert roses"), interpreted to represent fluvial and lacustrine sediments formed by periodic drying and evaporation phases of a "paleolake" and swampy areas inside a tropical deciduous forest.

Excavations were undertaken with strict stratigraphic control. A 30-m^2 grid was set up, and 1-by-1-m units were defined for excavating; so far 8 units have been dug (to depths of 2–3 m) from the initial starting point, itself 5 m below the original surface. Excavation records were extensive, and most materials were found in situ; furthermore, all sediments were collected and water-screened. Samples from strata were collected for various studies in laboratories in México and Spain. Particularly, bone remains were collected and processed at the Archaeozoology Laboratory at the *Subdirección de Laboratorios y Apoyo Académico*, INAH, where they are being preserved and studied. Initially water-based polyvinyl was applied to preserve the bone, but more recently RECONOS®, a re-mineralizing substance, has been used. Samples were submitted to Beta Analytic AMS laboratory for radiocarbon dating; assays have not been successful yet.

Associated with megafaunal remains were lithic materials that look like poorly defined flakes and cores, but their association with the fauna and the presence of possible anthropic marks on some flat bones could signify the presence of hunter-gatherers along with the extinct fauna. A total of 71 lithic pieces were recovered from the first two field seasons, most of them (n = 53) from the surface and non-layered sediments. Moreover, 18 lithic objects were recovered in situ from different depths between 54 and 230 cm; most (n = 12) were from the 200- to 230-cm depth interval. The usual raw material is flint (n = 11), although a few were made of jasper, quartz, and limestone. Among the excavated materials are six retouched flakes, five regular flakes, five fragments, and a flake core. The retouched flakes include two sidescrapers with simple lateral retouch and four pieces with strong retouching, including a point and a distal truncated plate. The flake core was knapped using high-quality black flint and may be a fragment of a larger core, with removals reflecting a primarily orthogonal strategy of flaking. Although this collection includes examples from all the structural categories within

the operative chain to produce tools, the sample is nonetheless small, and consequently no interpretation of the utilized production systems has been proposed.

Besides the 18 lithics from the excavation, 53 objects were collected from surveying. This sample is dominated by flint (n = 45) and includes 15 regular flakes, 20 fragments, 9 retouched flakes, and one unknown piece. Among the retouched pieces are four sidescrapers, two of which have denticulate retouching. Furthermore there are two pieces with abrupt retouching (one of those denticulated), two points, and one endscraper.

Thus far, the Chazumba locality is known for late-Pleistocene fauna with tropical elements, including the presence of a diverse Xenarthran (*sensu lato*) fauna composed of the giant ground sloth *Eremotherium laurillardi*, mylodont *Paramylodon harlani*, glyptodont *Glyptotherium* sp., and proboscidean *Cuvieronius* sp. Also present are remains of Columbian mammoth, *Mammuthus columbi,* as well as Pleistocene horse *Equus* sp., pronghorn cf. *Antilocapra* sp., woodrat *Neotoma* sp., vole *Microtus* sp., mud turtle *Kinosternon* sp., and desert tortoise *Gopherus* sp. (Cruz et al. 2009). Several of the above taxa are known from the Rancholabrean Land Mammal Age (RLMA) (Ferrusquía-Villafranca et al. 2010).

Recently, Jiménez-Hidalgo et al. (2011) reported a faunal assemblage from a locality in northwestern Oaxaca to the west of Chazumba but still within the same physiographic region; the authors named this faunal association *Viko vijin* ("cold epoch" or "period" in Mixteca language), also assigned to RLMA. This and the Chazumba faunal assemblages share at least five taxa, including both proboscideans, horse, glyptodont, and sigmodontine rodent.

Such a faunal association indicates environmental conditions quite different from those currently found at Chazumba. Today's climate is dry and warm and vegetation-defined as shrub land, while several of the identified fossil animals likely represent humid and cool conditions, suggesting the presence of a tropical forest near a grassland or savanna, where mammoth and horse could survive, as well as a nearby temperate forest.

Although the Chazumba deposits have not yet been radiocarbon dated, their late-Pleistocene age is supported by comparison with another paleontological locality, San Juan Raya, Puebla, located about 10 km from Chazumba. At San Juan Raya, a similar faunal assemblage yielded an AMS ^{14}C age of about 19 KyBP (J. Medina, pers. comm. 2012), providing a possible time marker for the Chazumba deposit, lithics, and extinct fauna, and thereby creating much interest. Certainly the Chazumba deposit will be an important one for describing the past environments and early peopling of the Mexican territory.

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PART 3

Extinct Birds and Early Humans in the Basin of México

Eduardo Corona-M.[1]

➤**Keywords:** First Americans, bird extinction, Pleistocene/Holocene transition

This paper summarizes identified birds from late-Pleistocene localities in the Basin of México and explores the probable relationships of these birds with early humans in the area. The discussion about the role of early humans on the extinction of birds has two classic opposing points of view (Grayson 1977; Steadman and Martin 1984), which in recent years have been deadlocked. The data from Mexican localities should energize the discussion.

The Pleistocene bird record presented here comprises localities compiled from the literature as well as those studied by the author; all the identifications were previously reviewed (Corona-M. 2008), and the current distributions largely follow Howell and Webb (1995). All species in the record were considered to be of Rancholabrean North American Land Mammal Age (NALMA), based on absolute or relative dating methods (Table 1). The origins of respective deposits were hypothesized to be cultural when human remains were recorded, and natural when not.

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Table 1. Localities of Rancholabrean NALMA age in the Basin of México, based on data compiled in Corona-M. (2008) and references therein.

Locality	Date	Ntax	Locality	Date	Ntax
Chimalhuacán*	Late Pleistocene	6	Tocuila	11,188 ± 76 RCYBP	3
Tepexpan*	Late Pleistocene	3	Tequixquiac	Late Pleistocene	10
Tlapacoya*	10,200 ± 65 RCYBP	15	San Juan Aragón	Early Holocene	1
Peñon de los Baños*	10,775 ± 75 RCYBP	1			

*Cultural deposit

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Results

Ten extinct birds from seven localities were recorded, either totally or locally, and were also denominated extirpated (Table 2). Seven were from aquatic and three from terrestrial environments. The aquatic extinct birds are a stork and grebe. Besides this, five extirpated birds were found, notably the American flamingo and sandhill crane. The terrestrial birds include three diurnal predators: the golden eagle, extirpated; and two extinct eagles.

Table 2. Extinct birds in Basin of México localities. Notation: ■ = cultural deposit; **e** = extirpated; **x** = extinct. See text for details.

Identified taxon	Common name	Chimalhuacán■	Tepexpan■	Tlapacoya■	Peñón■	Tocuila	Tequixquiac	San Juan
Podiceps parvus	Extinct grebe	x		x				
Gavia cf. *G. immer*	Great Northern loon			e				
Branta canadensis	Canadian goose			e				
Phalacrocorax auritus	Double-crested cormorant		e	e				
Ciconia cf. *C. maltha*	Extinct stork						x	
Phoenicopterus ruber	American flamingo	e	e			e		
Breagyps clarki	Extinct eagle						x	
Aquila chrysaetos	Golden eagle						e	
Spizäetus grinnelli	Extinct eagle						x	
Grus canadensis	Sandhill crane							e
Extant bird (not listed)		4	1	11	1	2	6	0

These records show some characteristics of the paleolakes of the Basin of México. The record of flamingoes at three eastern localities associated with the Texcoco Lake corroborates the presence of a highly saline environment. Probably salinity levels changed over time, since at the Tepexpan and Tocuila localities bird diversity is low, while in Chimalhuacán diversity increases.

Another particular case is Tequixquiac, the only western locality, and its reported taxa suggest a completely different paleocommunity from the eastern localities, with waters with lowest levels of salinity and an open forest. The extant bird records also suggest different profundity levels because of the presence of diving, swimming, and wading birds (Corona-M. 2008). Further studies, however, will be necessary for a detailed characterization of the different waterbodies.

To determine if early humans in the Basin of México affected bird populations, a comparison of the number of extirpated and extinct birds from natural versus cultural localities was made. A chi-square test ($\chi 2 = 0.93$, $p = 0.334$; $n1 = 8$, $n2 = 6$, 1 degree of freedom) does not indicate a statistical difference between the natural and cultural cases. This result suggests that humans were not the main cause of extinctions.

Table 2 shows that Tequixquiac, a natural deposit, has the highest number of extinct birds, while Tlapacoya and Tepexpan, both cultural deposits, have most of the extirpated birds. Moreover, none of the identified cultural deposits shows evidence of a systematic use of bird populations, i.e., a high number of remains of the same species or selectivity of certain body parts. This absence of evidence, however, does not rule out certain use of birds, such as an occasional resource or small-scale hunting.

Discussion

In light of the general framework of the debate about faunal extinctions in late Pleistocene

America, the results presented here indicate that it is not easy to identify a single agent responsible for extinctions (Burney and Flannery 2005). Likely, they resulted from a combination of contemporary factors, such as environmental changes produced by subsequent glaciations and warming, local geomorphological changes produced by intense volcanism in the region, and last but perhaps significantly, early human migration.

The paleoclimatic evidence, mainly in the record of diatoms and pollen, suggests a significant environmental change during the late-Pleistocene/Holocene transition. Some especially noteworthy events were the predominance of cold climate between 34,000 and 23,000 RCYBP, and great variation from humid to dry climates. From 23,000 to 22,000 RCYBP, intense volcanic activity in the Basin of México produced changes in lake levels, and in Chalco Lake salinity levels changed from high to lowest. Renewed volcanic activity occurred 14,000 to 10,000 RCYBP; at the same time a humid and cold climate period changed to a dry and warm one, which became more intense by 6000 RCYBP (Lozano-García and Ortega Guerrero 1998; Metcalfe et al. 2000).

Conclusions

The data presented here suggest an intensive ecological transformation of the Basin of México in the late Pleistocene that contributed to the extinction of ten bird taxa, four totally and six extirpated. Early humans may have inhabited the region at this time. Surely they did not dominate the environments of the area, however, because the activities of hunting and consumption did not have a significant impact on bird populations, and the evidence shows that predation by human hunters was not the main cause of their extinctions. These results, however, are preliminary, and further studies on the localities of the Basin of México are needed to clarify the origin and changes in the bird populations of this area.

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PART 3

Late Quaternary Ecosystems and Humans in Northern Patagonia: New Results from Cueva Huenul 1 (Neuquén, Argentina)

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➤**Keywords:** Human ecology, northern Patagonia, late Quaternary

The Cueva Huenul 1 (CH1) archaeological site has one of the first sequences of stratified sediments dating to the late-Pleistocene/early-Holocene transition in the northern end of Patagonia (Figure 1). Preliminary stratigraphic and chronological data previously reported define two sets of layers separated by an erosive unconformity. The late-Pleistocene layers (units VIII–V), mainly composed of fossil dung, are bracketed between dates of 13,844 ± 75 and 11,841 ± 56 RCYBP; the Holocene layers (units IV–I), composed of aeolian sediment, are bracketed between dates of 9531 ± 39 and 1416 ± 37 RCYBP (Barberena et al. 2010). The 9531 ± 39 date comes from a hearth directly on top of the unconformity and therefore is evidence for the earliest human presence at CH1. In this paper we report the results of a preliminary palynological and archaeological study of the stratigraphic units spanning the Pleistocene-Holocene transition

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(units VIII–IV, Quadrat A1, 2 x 1 m). The excavation was done using 10-cm extraction levels (the stratigraphic units discussed here correspond to extraction levels 8–5).

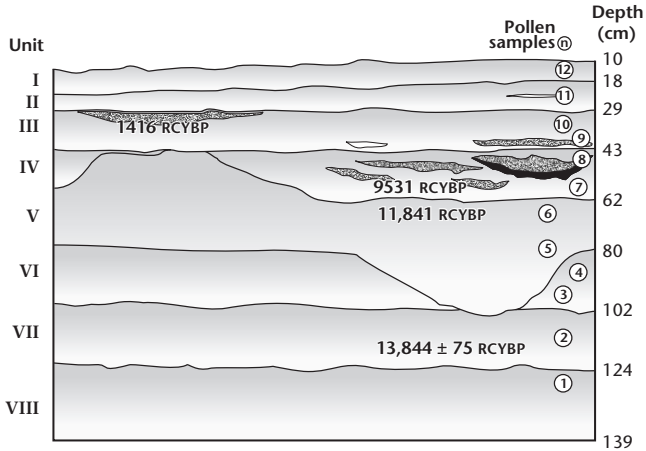

Figure 1. Stratigraphic profile of square A1 (profile W) at Cueva Huenul 1, showing archaeological units (layers), provenience of pollen samples (each represents a stratigraphic level), and radiocarbon dates.

Ecosystems: The Contribution of Palynology

CH1 is located near the Patagonia-Monte ecotone dominated by transition shrub steppes mainly composed of Verbenaceae, Asteraceae subf. Asteroideae, *Larrea*, *Prosopis* and *Prosopidastrum*. The fossil pollen record of CH1 was interpreted assuming that the Patagonia-Monte ecotone migrated in the past in response to climatic changes (in temperature and precipitation). Therefore the predominance of Patagonian-like vegetation implies colder and wetter conditions, whereas Monte-like vegetation is just the opposite.

Preliminary pollen analysis of CH1 suggests that shrub and grass-shrub communities were present around the cave since 13,800 RCYBP. Even though the pollen assemblages show no major plant community changes since then, some differences in composition are evident. Between ca. 13,800 and 9500 RCYBP, the pollen assemblages indicate the presence of a Patagonian grass-shrub steppe integrated with shrubs (*Schinus, Lycium*), dwarf shrubs (*Nassauvia*, *Ephedra*), and grasses, which at present lie between 2000 and 2200 masl, suggesting colder local conditions than present. During the last 1500 years, however, the pollen record indicates the presence of a Monte-Patagonian transition shrub steppe dominated by *Schinus*, *Lycium*, Asteraceae subf. Asteroideae, Verbenaceae, and dwarf shrubs and grasses in minor proportions similar to the modern vegetation, suggesting that present environmental and climatic conditions prevailed.

The Archaeological Record

Table 1 lists the proportions of lithic and faunal materials. Figure 2 graphically displays their relative presence throughout the CH1 sequence (including the late-Holocene layers). We introduce the presence of small carnivore scats measured by weight as a proxy to evaluate the intensity of human occupation of the site. Units VIII and VII did not yield any lithic artifacts or bone remains.

The lithic assemblage of the units VI–IV (extraction levels 8–5) includes 119 artifacts, of

Table 1. Lithic assemblages from the Pleistocene-Holocene transition levels in CH1.

Artificial level	Level 5 (50–60 cm)	Level 6 (60–70 cm)	Level 7 (70–80 cm)	Level 8 (80–90 cm)	Level 9 (90–100 cm)	Total
Stratigraphic unit	**Unit IV**	**Unit V**	**Unit VI**	**Unit VI**	**Unit VI**	
Lithic artifacts	100 (84%)	7 (5.9%)	10 (8.4%)	2 (1.7%)	0	119 (100%)
Faunal remains	108 (65.9%)	32 (19.5%)	17 (10.4%)	5 (3%)	2 (1.2%)	164 (100%)
Carnivore coprolites	315 gr.	562 gr.	428 gr.	123 gr.	20 gr.	1428 gr.

which 87% (N = 104) are made of obsidian; XRF analysis of a sample of lithic artifacts recovered from the site verifies that the chemical composition matches local Huenul obsidian (Barberena et al. 2011). Basalt (N = 8), chert (N = 6), and chalcedony (N = 1) toolstones are also present.

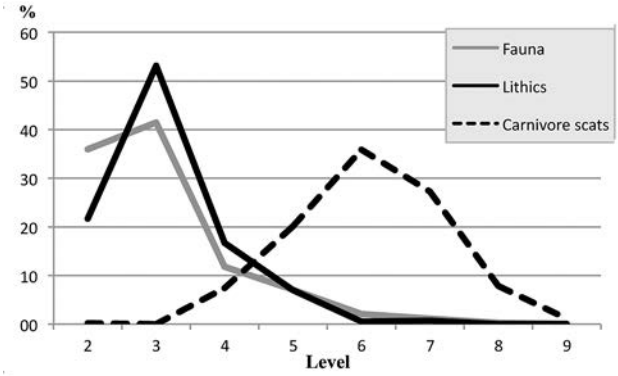

Figure 2. Incidence of bones, lithics, and carnivore scats (scats measured by weight) at Cueva Huenul 1.

Most artifacts of the assemblage (N = 100) come from early-Holocene level 5. Late-Pleistocene levels 8–6 yielded 19 artifacts in a different sedimentary context.

Flakes and debris constitute the largest part of the assemblage (98.3%, N = 117), complemented by the presence of two obsidian cores. No tools were recorded. Of all the artifacts, 93% (N = 111) are smaller than 15 mm and 80% (N = 95) of the assemblage do not show cortex, which suggests the predominant activity was late stages of lithic reduction (i.e., tools were sharpened or resharpened here and discarded elsewhere).

A large part of the faunal assemblage, like the artifact assemblage, comes from level 5. Of the total faunal assemblage, 66.5% (N = 109) consist of undetermined bone fragments; ca. 20% of the assemblage are guanaco bones with helical fractures, indicative of human processing (confirmed by the presence of six bone flakes). Most of these guanaco bones come from early-Holocene level 5 (unit IV). Finally, 13% of the bones are those of small mammals, including plates of Dasypodidae.

Conclusions

The preliminary palynological analysis shows no major changes in plant communities. Grass-shrub communities have been present since 13,800 RCYBP. Between ca. 13,800 and 9500 RCYBP the pollen assemblages indicate a Patagonian grass-shrub steppe, which suggests colder conditions. This is consistent with the results of the analysis of the small-mammal as-

semblage from CH1, revealing relative taxonomic stability during the Pleistocene-Holocene transition (Fernández et al. 2011). We suggest this testifies to the high ecological resilience of the Monte ecosystem.

Archaeological evidence indicates very brief human occupation of the cave during the early Holocene: The negative correlation between the incidence of archaeological materials and carnivore scats confirms the low intensity of human presence. The lithic assemblages suggest that the site served as a workshop and that tools were discarded elsewhere. The evidence is consistent with a strategy of provisioning individuals.

The earliest date for human presence in CH1 is consistent with data available for northern Patagonia, which cluster after 10,000 RCYBP. The macro-regional dataset shows a brief temporal pulse when human occupations are first recorded at a number of distant places. This may suggest human settlement radiated to ecologically marginal regions from areas colonized earlier.

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Diatom Analysis in Santa Cruz Central Massif (Patagonia, Argentina): Preliminary Results

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➤**Keywords:** Palaeoenvironments, diatoms, early Holocene, early peopling of South America

Cueva Maripe (47° 51′ 05″ S; 68° 56′ 03″ W; 560 masl) is located near a wetland identified as La Primavera in the Deseado Massif (Santa Cruz, Argentina). It is a large cave (26 m by 24 m) with two chambers separated by a rock wall (Miotti et al. 2004, 2007) (Figure 1). Its main walls and roof bear negative hand paintings (Carden 2008). The cave was occupied by humans recurrently from 9500 to 1000 ^{14}C RCYBP, the earliest events in the southern chamber having been dated to 9518 ± 64 (AA-65175) and 8333 ± 63 RCYBP (AA-65174), whereas in the northern chamber they took place at 8992 ± 65 (AA-65179) and 8762 ± 50 RCYBP (AA-65178) (Miotti et al. 2007).

The stratigraphy of Cueva Maripe shows a varied lithology in the 45 m^2 excavated; different sedimentation rates and post-depositional processes in each sector affect the degree of preservation of archaeological materials. Agents including roof land sliding, waterlogging and water percolation in different parts of the cave, rodent activities, cattle trampling, a thick level of dung in surficial strata, and human activity until as late as A.D. 1950 have seriously impacted the archaeological context (Miotti et al. 2007).

The main aims of this article are to determine the degree to which human activities or post-depositional processes in Maripe Cave have influenced the conservation of siliceous remains, and to understand the habitability conditions of each sector of the cave during different periods.

PART 3

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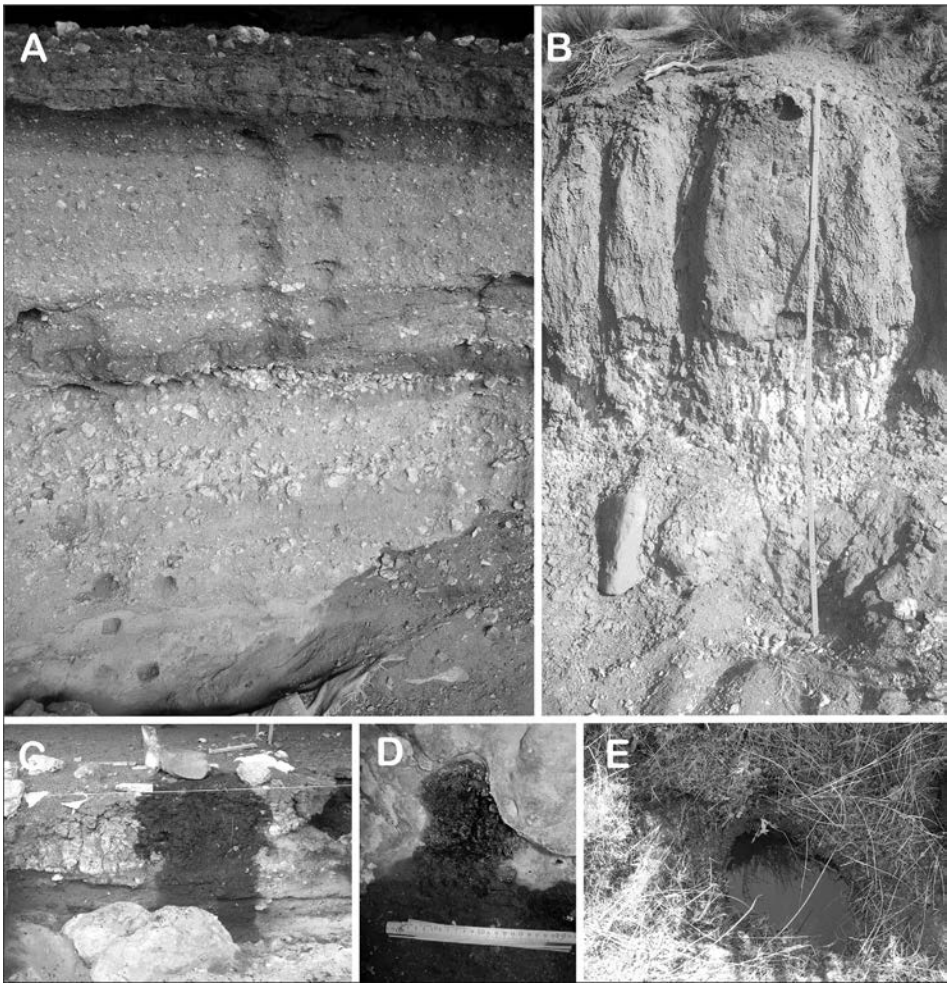

Figure 1. Main sampling locations at Cueva Maripe. **A,** square D5 (northern chamber); **B,** gully near the cave; **C,** square A11 (southern chamber)—note percolation on the profile (black spot); **D,** innermost sector of the cave in an active spring; **E,** active spring.

Here we explore both problems through diatom analysis and compare results with phytolith studies.

Methodology

Sediment and water samples were taken from different locations, inside and outside the cave (Table 1). Inside the cave (Figure 2, **A, C, D**), samples were collected from squares D5 (northern chamber, A) and A11 (southern chamber, C), as well as from the innermost sector of the cave in an active spring (D). Outside the cave (Figure 2, **B, E**), samples were collected from a 1.3-m-deep gully (B), two ponds (La Primavera and La Playita), and an active spring nearby the cave (E).

Table 1. Location of samples collected in the excavated area and surroundings of Cueva Maripe.

Sample level	Description	Sample No.	Depth (m)	Anthropological feature	RCYBP	Diatoms species
D5-2	Burned dung	1	0.84			*Pseudostaurosira brevistriata, Staurosirella pinnata, Denticula elegans*, indet. fragment
D5-3	Gravels with sandy matrix	2	0.99			*Nitzschia sp., Staurosirella pinnata,* indet. fragment
D5-3 microlayer	Microlayer of dung	3	1.11			*Pinnularia borealis, Achnantes* sp., indet. fragment
D5-4a	Large charcoal particles	4	1.21			*Pinnularia borealis, Diat. Degradadas,* indet. fragment
D5-4b	Angular clast of ignimbrites	5	1.4			*Pinnularia borealis, Denticula* sp., indet. fragment
D5-4c	Light brown-gray; little charcoal	6	1.5			*Pinnularia borealis, Achnantes* sp., indet. fragment
D5-4c	Sand and very angular clast of ignimbrite	7	1.63	Hearth	N/D	*Pinnularia borealis, Achnantes* sp., *Fragilaria* sp., *Denticula* sp., indet. fragment
D5-4d	Very fine sand	8	1.73			*Pinnularia borealis, Nitzschia* sp., indet. fragment
D5-5b	Ash, charcoal, and dung	9	1.48	Hearth	8992 ± 65 (AA 65179)	*Pinnularia borealis, Achnantes* sp., *Nitzschia* sp., indet. frag.
D5-5c	Clast of ignimbrites	10	1.81			*Denticula* sp., *Staurosirella pinnata,* indet. fragment
D5-5c	Clast of ignimbrites	11	1.99			*Denticula* sp., *Nitzschia* sp., *Diploneis* sp., *Fragilaria pinnata,* indet. fragment
D5-5d	Silty-sandy sediment	12	2.1			*Denticula* sp., *Staurosirella pinnata, Pseudostaurosira brevistriata, Pinnularia microstauron, Deiploneis elliptica,* indet. frag.
A11-1	Charcoal lens	1	0.5			*Pinnularia borealis, Denticula* sp., indet. fragment
A11-2	Whitish silty lens	2	0.89			*Denticula* sp., indet. fragment
A11-3	Silty sandy sediment	3	0.92			*Denticula* sp.
Gully	Sandy sediment	1	0.15			*Pinnularia* sp., indet. fragment
Gully	Sandy sediment	2	0.3			*Achnanthes* sp., *Pinnularia borealis,* indet. fragment
Gully	Sandy sediment	3	0.75			*Nitzschia* sp., *Rophalodia* sp., indet. fragment
Gully	Sandy sediment	4	0.9			Sterile
Gully	Silty sand sediment	5	1.3			Indet. fragment

To preserve the water samples, formaldehyde was added. Water temperature was measured in situ. Permanent slides were made to analyze the samples by means of an optical microscope with ocular objectives exceeding 750X.

Results

Results of the diatom analysis are presented below, by sampling area.

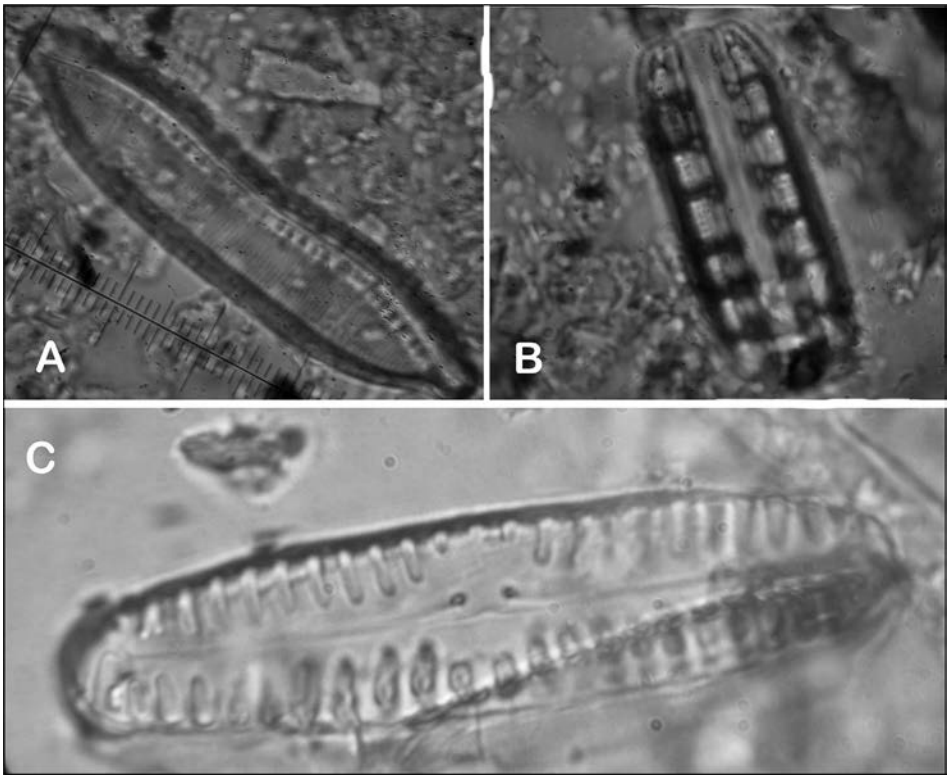

Figure 2. Microscopic photographs of diatoms. **A,** *Hantzschia* sp., valvar view; **B,** *Denticula* sp., girdle view; **C,** *Pinnularia borealis,* valvar view.

Square D5. A few diatom valves were identified (more than 70% of them are only fragments); some are very badly preserved. Among the identified diatoms, the following taxa are dominant: *Staurosirella pinnata* (Ehr.) Williams and Round, *Achnanthes* sp., *Denticula* sp., and *Nitzschia* sp. In the deeper samples (11 and 12), however, dominant taxa are *Pseudostaurosira brevistriata* (Grunow) Williams and Round, *Denticula* sp., *Diploneis elliptica*, and *Pinnularia* sp.

Square A11. Among a large number of indeterminate fragments, only a few complete valves, mainly of *Pinnularia borealis*, *Denticula* sp., and *Nitzschia* sp., were identified.

Innermost sector of the cave. Valves of *Staurosirella pinnata*, *Denticula* sp., *Nitzschia* sp., and *Aulacoseira* sp. were recorded, as well as a significant amount of *Fragilaria* sp.

Gully. A few valves belonging to *Achnanthes* sp., *Nitzschia* sp. and *Pinnularia* sp. were identified, as well as several indeterminate fragments.

Water samples. The largest diversity and quantity of diatoms came from the sample taken from a pond 100 m north of the cave. *Staurosirella pinnata*, *Pseudostaurosira brevistriata*, *Denticula* sp., *Gomphonema* sp. and *Staurosira construens* Ehr. were identified. No fragmented diatoms were recorded.

Variable frequencies of sphere or crysophytes cysts occur in all samples; moreover, most of the studied samples contained charcoal particles and phytoliths.

Discussion and Conclusions

Preliminary diatom analyses in Cueva Maripe enlarge the existing knowledge of the Deseado Massif diatom flora. Siliceous remains within the archaeological contexts in both chambers are unevenly preserved (Miotti et al. 2007). A large number of fragmented valves and low frequencies of complete diatoms hindered the characterizing of possible environments inside the cave for periods of occupation; this may be due to variable depositional and post-depositional processes.

The samples from deeper layers, however, coincidentally the ones that present the largest diversity and best preservation, provide an important measure of environmental conditions existing before the earliest human occupation in the cave. Considering the diatom flora, the cave may have been flooded by shallow and quiet waters, which deposited a large quantity of periphytic species associated with palustral vegetation. The water samples collected in La Primavera and La Playita ponds, in the surroundings of Cueva Maripe, show significant diversity. Moreover, they show a flora characteristic of an oligotrophic (i.e., clear-water) environment.

At the Piedra Museo archaeological site (47° 53′ 42″ S; 67° 52′ 04″ W), samples from the upper 1.0 m of paleo-lake sediments from in front of the site contained fragmented diatoms as well. There, geological and taphonomic processes might be strongly related to the conservation of the siliceous frustules; as in Maripe Cave, valves that are complete show excellent preservation. Most of the samples contain phytoliths and a remarkable amount of clay. Nonetheless, the first results of the Piedra Museo phytolith analyses suggest a regional environment characterized by grassland vegetation around 8700 RCYBP (Miotti et al. 2008), in agreement with available pollen analyses (Borromei 2003; Paez et al. 2003).

The results from Deseado Cave and Piedra Museo confirm the value of diatom analyses in reconstructing prehistoric environments. Our future plans include analyzing samples from other sites of the Deseado Massif, mainly ponds and sediments from the paleo-basins, to compare with the preliminary results presented in this study. Comparing phytolith analysis (e.g., Miotti et al. 2008) with the results presented here will contribute to the paleoenvironmental knowledge of the region at the time of the early human colonization of southern Patagonia.

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Early Human Occupation and Environment South of the Deseado Massif and South of Lago Argentino (Argentina)

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➤**Keywords:** Pleistocene-Holocene transition, Patagonia, paleoenvironment

In the area of La Gruta, south of the Deseado Massif in southern Argentina, radiocarbon ages indicate human occupation ca. 10,845 to 10,477 RCYBP (12,895–12,141 CALYBP). The presence of small hearths as well as characteristics of artifacts suggest that during the Pleistocene-Holocene transition, La Gruta 1 was occupied repeatedly for short periods of time by a few to several people (Franco et al. 2010). The cave is located in a cliff close to the shore of a seasonal lagoon. Old shorelines around the lagoon, up to a few meters above present lake levels, suggest that the lagoon was much larger and possibly more permanent in the past. In this relatively dry environment, variations in the availability of water in lagoons similar to that at La Gruta 1 may have affected human populations over time and possibly at the Pleistocene-Holocene transition.

A 1-by-1-m test pit excavated in La Gruta 1 cave floor revealed four stratigraphic-sedimentological units. At the base, Unit 1 is 10–15 cm of reddish brown silty clay varying laterally into brownish sandy silt. It contains human artifacts as well as charcoal concentrations. It is overlain by unit 2, consisting of up to 20 cm of gray sandy silt, and then Unit 3, a light brown to gray sandy silt up to 15 cm thick. Unit 4 at the top of the sequence consists of 5–10 cm of dung above a 2- to 3-cm-thick layer of ash, both layers resting on an almost continuous

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4- to 5-cm-thick layer of charcoal. Flakes, hearths, or charcoal concentrations occurred at different depths within the sedimentary sequence. Radiocarbon ages for sedimentary Unit 1, at the base of the excavation, date it to the Pleistocene-Holocene transition (Table 1).

Table 1. Radiocarbon and calibrated ages from La Gruta 1 and Chorrillo Malo 2 archaeological sites. Ages were calibrated with CALIB version 6.0 (Stuiver and Reimer 1993; Stuiver et al. 2010) and the INTCAL04 atmospheric data set of Reimer et al. (2009).

Site	RCYBP	CALYBP (2σ)	Laboratory sample	Material
La Gruta 1	8090 ± 30	9123–8986	UGAMS 7540	Charcoal
	10,477 ± 56	12,579–12,141	AA–84225	Charcoal
	10,656 ± 54	12,706–12,438	AA–76792	Charcoal
	10,790 ± 30	12,792–12,577	UGAMS 7538	Charcoal
	10,840 ± 62	12,893–12,594	AA–84223	Charcoal
	10,845 ± 61	12,895–12,597	AA–84224	Charcoal
Chorrillo Malo 2	9690 ± 80	11,237–10,776	CAMS 71152	Guanaco bone*
	9740 ± 50	11,247–10,884	GX–25279 AMS	Guanaco bone*

*Guanaco bone with cutmarks and lateral blow (Franco and Borrero 2003)

Pollen spectra for samples from Unit 1 have very similar percentages of grass, shrub and dwarf shrub pollen (Figure 1). The pollen data reveal that in the very late Pleistocene, at the time of the first human occupation of La Gruta area, there was steppe vegetation dominated by grass with low shrubs, mainly *Nassauvia*. These same shrubs are common in the present-day dwarf-shrub vegetation of the Deseado Massif (Figure 1). During the early Holocene, grass became even more dominant in the steppe vegetation, which suggests higher moisture than during the late Pleistocene and certainly more than today.

By consolidating pollen data from different sites in the extra-Andean central plateau region we can infer regional paleoenvironmental conditions prior to and contemporaneous with human use of La Gruta rockshelter. Before 11,000 RCYBP, pollen sequences from Los Toldos show a dwarf-shrub steppe with high values of *Ephedra,* suggesting more arid conditions than present with annual precipitation less than 200 mm (Paez et al. 1999; de Porras 2010). Pollen records from La Gruta 1, Los Toldos, La María (de Porras 2010), and Piedra Museo (Borromei 2003) archaeological sites dating to ca. 11,000 RCYBP indicate grass steppe with local variation in the proportions of shrubs and dwarf shrubs. At a regional scale, these plant communities suggest semi-arid conditions and increased available moisture than during earlier periods.

Although grass steppe covered a greater area of the central plateau near the end of the Pleistocene, human populations in the Patagonia extra-Andean area had to deal with a great variety of environmental conditions as temperature increased and shrinking glaciers allowed human occupation of areas closer to the Andes (Civalero and Franco 2003). In this region, pollen records from the archaeological site Chorrillo Malo 2 (Mancini 2002) and from the peat bog Cerro Frías (Mancini 2009) suggest the predominance of grass steppe and the start of forest expansion during the early Holocene. During the Pleistocene-Holocene transition (12,000–10,500 CALYBP) there was an increase in mean annual precipitation from 200 mm to ca. 300–350 mm (Tonello et al. 2009). The initial occupation of Chorrillo Malo 2 around

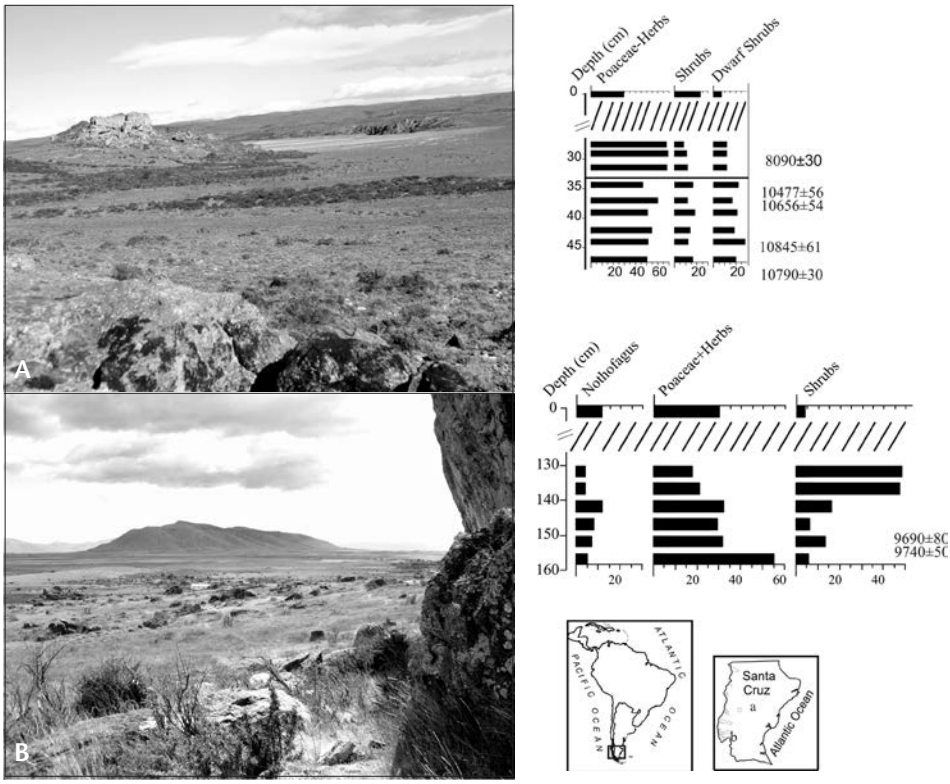

Figure 1. Views of the site areas and pollen diagrams in percentages for **A,** La Gruta 1, and **B,** Chorrillo Malo 2. The location of the study area is shown at bottom right.

9700 RCYBP (Franco and Borrero 2003) probably records the first human exploration of these now accessible spaces close to the Andes (sensu Borrero 1994–95).

In conclusion, pollen records from the Deseado Massif indicate drier conditions than present before ca. 11,000 RCYBP, followed by an expansion of steppe dominated by grass; this was most likely due to an increase in available moisture with increased temperature. In the southwest, there was also an increase in precipitation possibly related to the direction and intensity of westerlies and the establishment of a west-east precipitation gradient. During the early Holocene, the influence of the westerly winds would have been localized between 45° and 50° S. The pollen-derived environmental information from La Gruta 1 and Chorrillo Malo 2 suggests that the initial occupation of areas south of the Deseado Massif and south of Lago Argentino coincides with improved environmental conditions resulting from increased availability of moisture.

After ca. 9000 CALYBP the plant communities inferred from pollen analysis became increasingly heterogeneous. Variations in the availability of moisture undoubtedly affected the distribution of plant and animal resources, which in turn influenced the occupation and mobility of small groups of humans within arid and semiarid environments.

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