

World Heritage

papers

42



HERITAGE



# Human Origin Sites and the World Heritage Convention in the Americas

## VOLUME I



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Convention

Human Origin Sites and the  
World Heritage Convention in the Americas

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VOLUME I

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# Foreword

*The Americas were the last continents to be colonized, very recently in the two-million-year long history of humankind and were the culmination of a long progression of expansion by Homo sapiens from Africa. However, the process of the peopling of the Americas, while key in the history of humankind, is an area that lacks due recognition. There is comparatively little research on this topic and there is a great need for further investigation to understand the vital role of this process for our human species.*

*The last twenty years have brought about new scientific discoveries and an improved understanding of the peopling of the Americas, how they were first inhabited, how the populations survived and how their evolution led to them colonizing the continents. Much still remains to be researched and learnt.*

*The places related to the origins of humanity in the Americas are underrepresented on the World Heritage List and the importance of ensuring the future recognition, conservation and research of sites related to the process of human evolution, adaptation, dispersal and social development in the continents has never been –more pertinent. The lack of acknowledgment of these sites represents a challenge for the Americas. This publication therefore brings together the best experts in the field, to highlight this crucial process of human history, present its strengths and weaknesses and to establish the need for more scientific research, methodological innovation and improved collaboration on a national, regional and international level.*

*I encourage different institutions and research centres in this field to continue to address this topic for the benefit of future generations.*

**Mechtild Rössler**  
*Director of the UNESCO World Heritage Centre*





# Foreword

*This publication presents the most up-to-date research on the peopling of the Americas. The studies and discoveries brought to the reader in these articles review the latest developments in this field of knowledge: how the Americas were first experienced, how and where their colonization took place, and what aided the successful development of cultural diversity at the last continental frontier for the human species.*

*This book stems from the international meeting, The First Peopling of the Americas and the World Heritage Convention, held in Puebla, Mexico, from 2 to 6 September 2013. It is thanks to this meeting and the discussions arising from it that a cooperation strategy with the State Government of Puebla is being established by the UNESCO Office in Mexico; this cooperation aims to launch actions to better preserve the heritage of the first peopling of the Americas, where our species, Homo sapiens, put into practice the vast trajectory of human experience they had accumulated thus far. These volumes provide the rationale and arguments for the future recognition, conservation and research of sites linked to the processes of human evolution and diversity in the American continent. This fascinating journey investigates the scientific, cultural, ethological, geographical and historical dimensions of the earliest steps of human development in the Americas, and the earliest American evidence of human ritual, expression and practice.*

*I would like to take this opportunity to thank the invaluable assistance and cooperation of officials from the State Government of Puebla and the Municipality of Puebla for hosting this meeting at the Palafoxiana Library, which was the first public library in the Americas and is recognized as Memory of the World by UNESCO. I also extend my sincerest gratitude to the HEADS Scientific Committee and especially to Professor Robin Dennell for his never-ending dedication and fruitful cooperation in the framework of the HEADS programme.*

**Nuria Sanz**

*Head and Representative of the UNESCO Office in Mexico*

# Introduction

## HEADS in the Americas

**Nuria Sanz**

Head and Representative of the UNESCO Office in Mexico

In 1960, *Current Anthropology* devoted a special issue to the archaeology of the Bering Strait, the gateway to the Americas, with the aim of circumscribing it as the principal entry route into the American continent, opposing other theories such as Paul Rivet's who insisted, over several decades, on a southern transoceanic austral route. Almost half a century later, interdisciplinary teams came together at the recent American Archaeological Society meetings.

Beginning 15,000, and perhaps as early as 25,000 years ago, humans began to quickly disperse across the American continent, a continent that brings together all of the world's geographic landscapes and that, furthermore, involves challenges that had not, until that point, been come across. We now need to understand how humans travelled over the American territory during the initial 10,000 years of settlement. By that time, *Homo sapiens sapiens* could draw upon a wealth of knowledge and accumulated experiences they had acquired through trial and error after they began the colonization of Eurasia c. 120,000 years ago. The Americas became the last continental frontier for the migrant species *par excellence*. In the last decade, research has verified that the southern borders were one of the first destinations of this advance. While it is true that we can see the rapid occupation of the continent, we still do not understand why the phases prior to humans' arrival at the Bering Strait advanced so slowly.



Figure 1. *The First Settlement of the Americas* © UNESCO/Sarah Ranlett, 2013. Based on a map from <http://www.latinamericanstudies.org/ancient.htm>

30,000 years ago, *Homo sapiens* reached Beringia, an enormous land bridge between Asia and the Americas, and 15,000 years ago, the melting ice sheets and rise in sea level forced humans to choose between the two continents. From this moment onwards, the land bridge would gradually be submerged. Without a doubt, underwater archaeology, detailed bathymetric studies of the northern Pacific and marine geomorphologic research will provide information on the sequence of territorial advance and the early ways of life in the Americas. Future research could provide American traces linked to evidence found in

sites such as Yana in Siberia that documents the life of the mammoth hunters in the Arctic region between 29,000 and 27,000 cal BP. What we do know is that genetically the groups that arrived in the Americas were characterized by a long period of occupation in the extreme north of the continent. It is essential from now onwards to investigate records previous to the Last Glacial Maximum (LGM) in this area.

The dates of the first occupations of North and South America are contemporaneous, according to the archaeological record. Clovis began around 13,000 BP in North America and everything before this date in the Clovis culture must be researched. What we do know is that all the contemporary material culture found in South America time does not have any affinity to Clovis, and neither in North or South America is there evidence of an earlier presence related to the Clovis culture.

The Debra L. Friedkin site, the oldest proof of human settlement in the Western Hemisphere, together with the Gault site and the Meadowcroft rockshelter, and Paisley Caves, shared their dating with Huaca Prieta, Peru, 14,100 cal BP and Monte Verde, Chile, 14,500 cal BP on the southern coast of the Pacific. For the time being, this evidence makes us think of a rapid coastal advance, for which the archaeological remains at Serra da Capivara in Brazil or Arroyo Seco in Argentina leave us with significant questions to answer. The subsequent dating of Lake Charlie to



Figure 2. Radiocarbon Dating and the First Settlement of the Americas © UNESCO/Sarah Ranlett, 2013. Based on a map from <http://www.latinamericanstudies.org/ancient.htm>



c. 12,350 cal BP could make us think of a type of intermediate continental corridor open 2,000 years after the hypothetical initial coastal route. Thanks to the skeletal remains of the Anzick boy (c. 12,707–12,556 years BP), the discovery of the complete Palaeo-American genome is a large part of a puzzle that still has big pieces left to be filled.

We could mention as well that the Pre-Clovis occupation c. 14,550 cal BP at the Page Ladson site, Florida, indicates how hunter-gatherers along the Gulf Coastal Plain coexisted with megafauna for 2,000 years before this fauna became extinct (Halligan, J.J. et al., 2016).

It is also worth noting that during excavations at the Upper Sun River in the Tanana River Basin archaeological site, two infants' skeletons dated to 11,500 cal BP were found by the University of Alaska Fairbanks. Buried together at the same time and covered by a layer of ochre (Potter, B. et al., 2014), it demonstrated that their ancient DNA showed that they came from two mothers who belonged to genetically distinct population groups.

On the other hand, the discovery and analysis of 'Naia', the 13,000 year-old Late Pleistocene Palaeoamerican human skeleton with Beringian-derived mitochondrial DNA that was found in the cave of Hoyo Negro in the Yucatan Peninsula of Mexico illustrates that the differences between Palaeoamericans and Native Americans probably resulted from *in situ* evolution rather than a separate ancestry (Chatters J.C. et al., 2014). This discovery in Central America, 4000 km south-east of any other pre-10-Ka in the Americas, extends the geographical distribution of Pleistocene-age Beringian mtDNA in the Western Hemisphere.

Moreover, multidisciplinary research in the Amazon, specifically the studies on the Tapayó River show that the transformation of the Amazon ecosystems also started 13,000 years ago, an age that is attributed to the first anthropic soils.

The retreat of Arctic and Patagonian ice and change in climate gave way to other forms of flora, fauna and ecosystems. Initial human adaptation to tropical forests, to large river basins, to the largest coastal mountainous chains and deserts in the world were scenes of early colonization for the first Americans. Cultural diversity coupled with the search for solutions and answers endogenous to the tundra, the cold seas, the boreal forests, tropical rainforests, and the high valleys of the Andes were major challenges that were successfully overcome. This is why America becomes a promising research area into the environmental history of modern humans and their responses to some of the most extreme geographies of the planet: ice in its continental extremes, the cold currents from the Pacific, the Andes mountain range, the deserts of Chile, and the rainforests of the Amazon, among others. It was from this landmass that humans made the last leap to the High Arctic, to Greenland and Iceland, the last human frontiers on the planet.

Our wealth of shared knowledge is always a long-term resource, and in this long period of time we will be able to understand the cultural processes of decision-making regarding forms of consumption and productive strategies. Our answers to the best and worse conditions of the species' survival and the possibility of continuing to produce knowledge on our oldest-recorded responses is fundamental for the implementation of the United Nations 2030 Agenda for Sustainable Development. These pages give arguments for this endeavour.

The main objective of the previous pages has been to show how to frame debates on national and international policies to improve the preservation of the ancient traces of our cultural diversity in the Americas, through the international cooperation provided by the HEADS programme.





## HEADS around the World

Human evolution, and its attendant study of the processes of adaptation, dispersal and social development are part of our universal human heritage. These processes can be traced back to the earliest toolmaking members of the human lineage at least 3.3 million years ago in the African continent. As the last continental frontier for the human species, the study of the first peopling of the Americas provides a unique opportunity to view how and where the *Homo sapiens* put into practice the vast trajectory of human experience they had accumulated thus far.

In much the same way, the development of the HEADS Thematic Programme<sup>1</sup> is reaching its final continental frontier with the publication of *Human Origin Sites and the World Heritage Convention in the Americas*. Our journey, both humankind's and the programme's, has taken us across the continents of Africa, Asia and Eurasia on our way to the Americas. These volumes have endeavoured to trace the unique pathways followed in each place, to explore the universal significance of changes that have left their mark on the intellectual development of the human species.

As humankind's accumulated experience played an integral role in the peopling of the Americas, so have the cooperation of experts, governmental bodies, states parties and research and academic institutions over the past eight years contributed to the programme's success and made this moment possible. We are able to arrive to this point as a result of immense collaborative efforts and only by building on the vast body of knowledge that we have constructed so far. The following pages illustrate the journey that the HEADS programme has taken around the world and to the Americas.

As per Decision: *WHC-14/38.COM/16*, the Office of UNESCO in Mexico has coordinated the implementation of the HEADS Thematic Programme's activities since 2013 by organizing international meetings, providing technical advice for nominations, and advancing Rock Art conservation and documentation policies to the benefit of the thematic programme. As requested by the World Heritage Committee, the following report outlines the outcomes of the projects of the follow up of the HEADS Programme that have taken place between 2013 and 2015, while the Americas publication was underway.

### A. Major Results

The 2013 to 2015 period of the HEADS Thematic Programme has achieved major results in terms of the development of the awareness and promotion of research that recognises the importance and relevance of the earliest heritage related to Human Evolution to the origin of our cultural diversity across all continents. A variety of activities have taken place in support of the thematic priorities and objectives of the HEADS Action Plan.

The following figures illustrate the progress in building and reinforcing the community of interest between Science and the World Heritage Convention since the programme's inception in 2008 and the major results specifically achieved in the 2013-2015 period:

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1 <http://whc.unesco.org/en/head>s

## **2009 - 2015**

**21** International meetings

Cooperation with **265** researchers from **5** continents

**10** prehistoric sites inscribed on the World Heritage List since 2009

**4** volumes of the World Heritage Paper Series published with **2** in preparation featuring a sum total of **103** contributions

**4** site events to submit detailed results on an annual basis to the World Heritage Committee

## **2013 – 2015**

**6** international meetings

Cooperation with **173** experts from **5** continents and more than **30** countries.

**4** prehistoric sites inscribed on the world Heritage list since 2014

**2** volumes of the HEADS World Heritage Paper Series published with **2** in preparation featuring a sum total of **87** contributions

### **i. Development of the Prototype of the Rock Art World Archive in Mexico**

The project, which will implement the digital platform already developed, is ready to be implemented by 32 States in Mexico and will be led by the UNESCO Office in Mexico in collaboration with national and the academic institutions responsible for the preservation of rock art heritage in Mexico.

In Mexico, there are more than 1,000 instances of rock art manifestations that have until now remained unrecorded in a systemized documentary register.

Over the course of three years, the programme will develop a web platform that is interoperable with State and national archives, as well as archives from research centres and academic institutions. The programme's goal is to compile, by means of a digital archive, the documentary, graphic, archaeological and anthropological memory of rock art manifestations in Mexico.

The work that will be developed by archaeologists, anthropologists, institutional managers, local and indigenous communities and interoperable database management specialists in Mexico, could be replicated in more than 150 countries in the world.

### **ii. Regional and/or Thematic International Meetings**

#### **1. International Expert Meeting for the Nomination Process of Tehuacan-Cuicatlán to the UNESCO World Heritage List. The transition from hunter-gatherer societies to agricultural societies. *The Origins of Food Production and the World Heritage Convention.***

This international meeting was held in Puebla, Mexico on 18 to 22 August 2014 and brought together a group of 39 experts from 13 countries to help identify and define the Outstanding Universal Value of Tehuacán-Cuicatlan in comparison with other World Heritage sites, with the aim beginning the nomination process of the property to the World Heritage List as a mixed site.

This meeting also acted as an important step in strengthening international and regional cooperation, and deepened the comparative analysis of the origins of food production in all continents. By bringing together such a distinguished group of

scholars in the field, the meeting provided key insights into understanding the transition from hunter-gatherer societies to sedentary societies and highlighted the importance of the preservation of related archaeological sites.

Press release: [http://www.unesco.org/new/es/mexico/press/news-and-articles/content/news/reunion\\_internacional\\_heads\\_en\\_puebla/#.VuMd8\\_krLak](http://www.unesco.org/new/es/mexico/press/news-and-articles/content/news/reunion_internacional_heads_en_puebla/#.VuMd8_krLak)

## **2. Settlement Dynamics in Human Evolution: Human History from Dispersals and Migrations to Adaptations to Sedentary Societies, Implications for the World Heritage Convention**

This international meeting of experts was held in Ankara, Turkey from 11 to 13 November 2014 in order to reconsider the way in which sites related to the transition from hunter-gatherers to food production are conceptualised by the UNESCO World Heritage Convention and represented on the UNESCO World Heritage List. <http://on.unesco.org/1UpMf6P>

## **3. Interdisciplinary Preservation Practices for Rock Art**

The International Meeting *Interdisciplinary Preservation Practices for Rock Art in Mexico* was held at the UNESCO Office in Mexico, Mexico City, from 5 to 6 June 2015. This meeting brought together 12 international and national experts in rock art preservation from 4 countries and 8 institutions.

During four scientific sessions, each of the invited experts presented a case study from their professional experience on integrated approaches for the preservation of rock art. In addition to the presentation of case studies, four round table discussions were organized, during which the experts discussed the main challenges facing the study, research and preservation of rock art in Mexico, how these challenges could be overcome, and how to design and implement, on a national and international level, a standardised protocol for the preservation of rock art.

Due to the impressive variety in time, space and style of rock art in Mexico, it was agreed that Mexico could serve as a pilot country for the implementation of the Rock Art World Archive (RAWA).

Press release: [http://www.unesco.org/new/es/media-services/single-view/news/la\\_oficina\\_de\\_la\\_unesco\\_en\\_mexico\\_reune\\_a\\_expertos\\_nacionales\\_e\\_internacionales\\_para\\_discutir\\_sobre\\_la\\_preservacion\\_del\\_arte\\_rupestre/#.VuBWJvkrLak](http://www.unesco.org/new/es/media-services/single-view/news/la_oficina_de_la_unesco_en_mexico_reune_a_expertos_nacionales_e_internacionales_para_discutir_sobre_la_preservacion_del_arte_rupestre/#.VuBWJvkrLak)

## **4. Exploring Frameworks for Tropical Forest Conservation: Managing Production and Consumption for Sustainability**

The International Meeting *Exploring Frameworks for Tropical Forest Conservation: Managing Production and Consumption for Sustainability* was held at the Institute of Ecology in Xalapa, Veracruz, Mexico, from 6 to 8 December 2015. This meeting brought together 40 experts in archaeology, biology, botany, historical ecology and forest management, as well as traditional and local producers, representing 8 countries and 36 institutions.

In the framework of the United Nations Post-2015 Development Agenda and in collaboration with the Institute of Ecology (INECOL), the National Commission for Knowledge and Use of Biodiversity (CONABIO) and the German Corporation for International Cooperation (GIZ), this meeting was organized to provide an interactive and interdisciplinary forum for the sharing and synthesis of research and progress in tropical forest conservation and sustainable development from social, economic, and environmental perspectives.

The meeting was separated into four primary themes, the most relevant of which was 'Interpreting the Past to Inform the Present and Implication for the Future: lessons from archaeology and historical ecology' which highlighted the very potent impact that early human populations played in the formation of tropical forest environments, especially in South and South-East Asia and South America, and the challenges of preserving sites of this kind for future appreciation and study. The meeting





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was concluded with working group sessions, one of which was dedicated specifically to 'Archaeological research toward the conservation of cultural heritage in the tropical forest'.

Press release: [http://www.unesco.org/new/es/mexico/press/news-and-articles/content/news/la\\_oficina\\_de\\_la\\_unesco\\_en\\_mexico\\_lleva\\_a\\_cabo\\_en\\_el\\_inecol\\_en\\_xalapa\\_la\\_reunion\\_internacional\\_explorando\\_marcos\\_para\\_la\\_conservacion\\_del\\_bosque\\_tropical\\_gestion\\_de\\_la\\_produccion\\_y\\_consumo\\_para\\_la\\_sostenibilidad/#.VuLzTvkrLak](http://www.unesco.org/new/es/mexico/press/news-and-articles/content/news/la_oficina_de_la_unesco_en_mexico_lleva_a_cabo_en_el_inecol_en_xalapa_la_reunion_internacional_explorando_marcos_para_la_conservacion_del_bosque_tropical_gestion_de_la_produccion_y_consumo_para_la_sostenibilidad/#.VuLzTvkrLak)

### iii. HEADS Publications

#### iii.a Four Issues of the World Heritage Paper Series

**1. World Heritage Papers 39, HEADS 3: *Human Origin Sites and the World Heritage Convention in Asia*; ISBN 978-92-3-100043-0** (<http://whc.unesco.org/en/series/39/>)

We are all familiar with iconic prehistoric sites in Africa, Latin America and Europe but less so with such sites in Asia. This must change, as Asia holds a wealth of data, which includes some startling challenges to traditional archaeological paradigms of the emergence and dispersal of modern humans. This issue of the World Heritage Paper Series tackles these questions head-on – exploring recent research programmes, ideas and debates that are lifting the profile of Asia in human evolution studies, while addressing the practical issues of site protection and management. The result is a fascinating compendium that reflects the international and interdisciplinary approach that inspires all work under the World Heritage Convention. This issue builds on the vibrant archaeological research presented at the conference, entitled *Human Origins Sites in Asia and World Heritage Convention*, held at the Jeongok Prehistory Museum in the Republic of Korea in September 2012.

**2. World Heritage Papers 41, HEADS 4: *Human Origin Sites and the World Heritage Convention in Eurasia*; Vol. 1 ISBN 978-92-3-100107-9/ Vol. 2 ISBN 978-92-3-100109-3** (<http://whc.unesco.org/en/series/41>)

The purpose of this publication in its two volumes is to present the reader with a panorama of Human Origins in Eurasia, by bringing together key papers written by leading scientists in the domain of research into human origins. The first volume focuses on the topic of Human Origins in Eurasia, whilst the second volume focuses entirely on the case of the Swabian Jura Aurignacian, which is particularly important in relation to some of the major research issues surrounding the dispersal of modern humans on the continent. The perspective of this publication is on Eurasia as a whole, transcending modern, political, cultural and regional frontiers, and thus allows for a greater and more profound study of prehistoric archaeological sites.

**3. World Heritage Papers 45, HEADS 5: *Human Origin Sites and the World Heritage Convention in the Americas*; Vol. I ISBN: 978-92-3-100140-6/ Vol. II ISBN: 978-92-3-100141-3**

The purpose of this publication is to present the reader with a panorama of Human Origins in the Americas, by bringing together key papers written by leading scientists in the domain of research into human origins. As a region, the Americas hold many properties with strong links to human origins; some of which are insufficiently represented on the World Heritage List. Thus their value is under-recognized and it is often challenging for State Parties to conserve this heritage and manage its specific vulnerability. This publication addresses many of the aforementioned properties, explaining their links to human evolution, dispersal and social adaptation.

**4. HEADS 6: *The Origins of Food Production and the World Heritage Convention*; to be published in August 2016; II Volumes**



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Sites related to the transition from hunter-gatherer societies to sedentary societies hold important links to the overall scientific narrative of Human Evolution and are often insufficiently represented on the World Heritage List. Thus their value is under-recognized and it is often challenging for State Parties to conserve this heritage and manage its specific vulnerability. This publication will address properties related to the Neolithic transition from a multi-regional platform and explains their links to human evolution. This publication will provide an important step in strengthening international and regional cooperation and capacities to understand the forager-farmer transition in general, and more specifically, the future protection and sustainability of global early sites associated with food production. It will feature the most current research from many multidisciplinary perspectives including biology, genetics and soil micro-morphology in an evaluation of the Outstanding Universal Value (OUV) of agricultural-related heritage sites.

### **iii.b Prehistoric sites inscribed on the World Heritage list since 2014**

1. Decorated Cave of Pont d'Arc, known as Grotte Chauvet-Pont d'Arc, Ardèche (France)
2. Monumental Earthworks of Poverty Point (United States of America)
3. Pre-Columbian Chiefdom Settlements with Stone Spheres of the Diquis (Costa Rica)
4. Rock Art in the Hail Region of Saudi Arabia (Saudi Arabia)

### **iv. Nominations proposed for 2016**

Massif de l'Ennedi: paysage naturel et culturel (Chad)  
Zuojiang Huashan Rock Art Cultural Landscape (China)  
Antequera Dolmens Site (Spain)  
Gibraltar Neanderthal Caves and Environments (United Kingdom)

### **v. Nominations proposed for 2017**

Dilmun Burial Mounds (Bahrain)  
Caves with the oldest Ice age art (Germany)  
Tehuacán-Cuicatlán Valley: orinary habitat of Mesoamerica

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# The Applicability of World Heritage Criteria for the First Populations in the Americas

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The colonization of the Americas was one of the great milestones in the history of humankind. In its global context, the Americas were the last continents to be colonized, and the final part of a lengthy and complex process of expansion by *Homo sapiens* from Africa, where our species is evidenced as early as 160-190,000 years ago (White et al., 2003; McDougall et al., 2005). Although there is ongoing controversy and uncertainty over when *H. sapiens* dispersed across Asia, with some (for example, Dennell and Petraglia, 2012) arguing that this may have begun c. 100,000 years during the last interglacial and others (for instance, Mellars, 2006; Mellars et al., 2013) arguing that it began only after 60,000 years ago, almost all authorities believe that the Americas were colonized near the end of the Pleistocene, and long after humans had entered Siberia, Australia, Japan and north China. Debates over the initial colonization of the Americas tend to focus on three issues: when precisely it was first colonized; whether the initial dispersal of humans into the Americas resulted in permanent colonization; and whether the Americas were colonized from more than one direction. Each of these needs to be briefly summarised before considering how the criteria of the World Heritage Convention might be applied to the type of sites resulting from the initial peopling of the Americas.

## When did humans first enter the Americas?

For many years, the prevailing wisdom was that the Clovis Complex, or Culture, represented the first peopling of the Americas. The Clovis Complex is named after a distinctive type of bifacial, pressure-flaked point (Figure 1) that is widespread over the mainland of the United States (excluding Alaska) and south into Venezuela and the northern parts of South America (see Figure 2). Radiocarbon dating has established that it lasted from c. 13,600 cal BP (calibrated radio-carbon years before present) to 13,200 cal BP (Goebel et al., 2008), or according to a re-evaluation of these dates, from 13,200-12,800 cal BP (Waters and Stafford, 2007), right at the end of the Pleistocene. The 'Clovis first' model envisaged an initial dispersal of humans into Alaska from north-east Siberia across the enormous land bridge known as Beringia; once in Alaska, they were then able to disperse into the mainland United States through a corridor that opened up between the ice sheets over the Rocky Mountains and Canada when these began to retreat in the early Holocene.

Points like these were made ca. 13,000 years ago and are widely distributed across the United States and southwards into Columbia. Typically, they are c. 15 cm long and are arguably the finest examples of craftsmanship from the Palaeolithic world. For many years, they were supposed to represent the earliest inhabitants of the Americas, but it is now clear that human arrived earlier: how much earlier remains unclear. Although Clovis is no longer first, the Clovis point is still the most iconic symbol of the earliest habitation of North America.

## The Americas in the Late Pleistocene

At the height of the last glaciation ca. 18,000 – 15,000 years ago, North America was dominated by two conjoined ice sheets – the Laurentide over most of Canada, and the Cordilleran over the Rockies. There was also a smaller but significant ice sheet over the southern Andes in South America. Because sea levels were ca. 100 m lower than at present, there were extensive coastal plains (shown by the dotted line) along the western coasts of North America, the Caribbean and South America, and the crucially important land bridge of Beringia between Alaska and Siberia.



Figure 1. A Clovis point.  
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The map shows the principal sites mentioned in the text. Most date (or are claimed to date) from before the Clovis Complex. The most unambiguous ones are Meadowcroft and Monte Verde, and specialists are still divided about the others. Two sites are part of the Clovis Complex – the type site, and Taima Taima in Venezuela. Teohuacan in Mexico is shown as a critically important American site as it was the area where maize was first domesticated.

This model has been periodically challenged by various claims for an earlier entry into both North and South America; some of these are shown in Table 1. Some of these could easily be dismissed; for example, claims on the basis of a few crude looking and poorly stratified stone tools (or geofacts) that there was a Lower Palaeolithic in North America (Carter, 1978) are unconvincing, and almost all researchers would suspect that dates of 258-295,000 BP from the Toca di Esperanza, Brazil (see Table 1) are either inaccurate and/or unrelated to any archaeological material. Doubts over the dating, stratigraphic context and identification of stone or bone as humanly modified have been sufficient to refute many claims for a pre-Clovis presence of humans in the Americas. Nevertheless, doubts persisted and two claims in particular have proved especially persistent. The first is the evidence from the rock shelter of Meadowcroft in Pennsylvania.

This site has been meticulously excavated and the lowest levels (stratum IIa) have six  $^{14}\text{C}$  dates in association with archaeological evidence from 12,88 to 16,175 BP, with an average of 14,250 BP (Adovasio et al., 1998; Meltzer, 2009, 111). The evidence seems highly compelling; indeed, it seems fair to suggest that if the same evidence was found in, for instance, France or Germany, it would be accepted without question on its own merits, irrespective of what was known from other excavations. The main weakness of Meadowcroft as definitive evidence that humans were in North America in pre-Clovis times is that even though there are over 75 publications on the site, the excavations have not yet been published in full. Whilst it is probable that if and when published in full, Meadowcroft will demonstrate that humans were in North America before 14,500 years ago, those critics who insist on full publication of any evidence contradicting the Clovis-first model can continue to doubt the veracity of Meadowcroft. There are, however, several sites in the United States that appear to contain pre-Clovis artefacts, such as Cactus Hill and Saltville, Virginia, the Topper Site, South Carolina (see Goodyear, 2005), the Debra L. Friedkin and Gault sites, Texas, the Paisley Caves, Oregon, Page Ladson, Florida (Waters et al., 2011a) and the Manis site, Washington (Waters et al., 2011b), and it is increasingly difficult to maintain a 'Clovis-first' model for the colonization of the Americas.



Figure 2. Principal early sites in the Americas.  
Source: the author, but adapted from Meltzer 2009, Figure 1.

### Table 1: Pre-Clovis dates (i.e. pre 13,000 BP) from the Americas

When did humans first arrive in the Americas? How many of these early dates are fully secure, and how many can be rejected? Although Monte Verde unequivocally demonstrates that human had reached South America by 12,500 years ago, there is still considerable confusion over when they first arrived in both North and South America.

## A General Focus

Site	Material	Age	Source
Cactus Hill, Virginia	Clovis assemblage and hearth Fluted points, flakes, charcoal (1) Artefacts with hearth (1)	10,920 ± 250  15,070 ± 70 BP, 16,670 ± 730 BP;	Goodyear, 2005
Debra L. Friedkin site, Texas	>15,000 artefacts under a Clovis assemblage	~13,000 – 15,500 BP;	Waters et al., 2011a
Manis, Washington State	Projectile point in mastodon rib	13,800 BP;	Waters et al., 2011b
Meadowcroft IIa, Pennsylvania (2)	Artefacts, bone	12,880 to 16,175 BP;	Meltzer, 2009, 111
Paisley 5 Mile Point Caves, Oregon	Human coprolites	14,100 BP;	Gilbert et al., 2008; Goebel et al., 2008
SV-2, Saltville, Virginia	AMS date on bone tool associated with Proboscidean skeleton	14,510 ± 80 BP; (lowest horizon)	Goodyear, 2005
SV-2, Saltville, Virginia	Stone and bone artefacts, fauna and wood twigs	13,950 ± 70 BP; (middle horizon)	Goodyear, 2005
Topper site, South Carolina	Clovis horizon Underlying assemblage (3)	13,500 ± 1000 cal BP; At least 15,200 ± 1500	Goodyear, 2005
Various States	Petroglyphs, dated by cation ratios and AMS <sup>14</sup> C	12-19,000 BP;	Whitley et al., 1996
<b>South America</b>			
Brazil: Alice Boer		14,200 ± 1150	Dillehay, 2000, 313
Brazil: Caldeiro de Rodriguez		17,000 ± 400	Dillehay, 2000, 314
Brazil: Morro Furado,		16,200 ± 290, 18,570 ± 130, 21,090 ± 420	Dillehay 2000, 305
Pedra Furada, Brazil (4)	Numerous dates  ABOX 14C dating of hearths	25,200 ± 320 to 44,800 ± 1400  53,120 + 3965/-2640 55,575 + 5685/-3300	Dillehay, 2000, 316  Santos et al., 2003
Toca di Esperanza, Brazil	Layer IV, breccia	258,000 ± 84 to 295,000 ± 780	Dillehay, 2000, 317
Monte Verde I, Chile	Carbonised wood	33,370 ± 530	Dillehay, 2000, 303
Monte Verde II, Chile	Wood, charcoal	11,900 ± 220 - 13,565 ± 250 (11 dates)	Dillehay, 2000, 303
Pubenza, Colombia	Gastropods, seeds	13,280 ± 110 – 17,790 ± 120	Dillehay, 2000, 296
Tequendama, Colombia	charcoal	22,250 ± 470, 28,890 ± 840	Dillehay, 2000, 296
Huaro Cave, Peru	Bone collagen	13,160 ± 700, 13,510 ± 700	Dillehay, 2000, 298
Pikimachay, Peru	Sloth bones, zone I	14,150 ± 180, 12,750 ± 1400	Dillehay, 2000, 300
Pikimachay, Peru	Sloth bones, zone J	17,650 ± 3000, 20,200 ± 1050	Dillehay, 200, 300
Venezuela: Taima Taima,	Masticated twigs	12,890 ± 85, 13,000 ± 200, 13,860 ± 120	Dillehay, 2000, 298; Bryan et al., 1978
Uruguay: Arroyo del Vizcaíno,	Cutmarked bone	27-30,000 BP;	Fariña et al., 2014

### Notes:

- 1) Cactus Hill: these were stratigraphically below the Clovis horizon
- 2) Meadowcroft has been dated by over 50 <sup>14</sup>C dates in near perfect chronological order
- 3) The assemblage came from below this date in alluvial sands probably 16-20 ka
- 4) See Meltzer et al., 1994

The evidence from Meadowcroft and other North American sites is especially challenging to the Clovis-first model because it implies that either there was an ice-free corridor through which they could enter North America, or that they entered by a different route – for example, by taking a coastal route by which they landed south of the ice sheets. Both these suggestions are problematic. We know that there was not an ice-free corridor during and immediately after the glacial maximum c. 18-15,000 years ago, so if they did enter the United States, their first entry would have been before this time – which few are prepared to concede. A coastal route is perhaps a more attractive possibility, given that the Australian, the Japanese and Philippine islands and island South-East Asia were all colonized by sea after 40-50 Ka. Additionally, the Northwest Pacific is extremely rich in marine life and humans might easily have followed the ‘kelp highway’, as proposed by Jon Erlandson (2002). However, because the glaciers along the Northwest coast of the Rockies discharged directly into the ocean, any coastal migration along the southern edge of Beringia would have been a serious undertaking during which landfall was not possible over perhaps

hundreds of kilometres until the very end of the Pleistocene (see Dickinson, 2011). Additionally, no evidence has yet been found for colonization along the coast (Dillehay et al., 2008).

The second site that challenges the Clovis-first model is Monte Verde II in Chile, far to the south of Clovis or any site in North America. After a protracted and often acrimonious struggle lasting several years, this site is now accepted by virtually all authorities as conclusive evidence that humans were in the Americas before the Clovis culture (see, for example, Adovasio and Pedler, 1997; Meltzer et al., 1997; Meltzer, 2009). Monte Verde II is an open air site that was remarkably well-preserved in peat and waterlogged sediments. Excavation revealed a settlement with tent-like huts built with wooden frames. Because preservation was so remarkable, even the wooden stakes and parts of knotted fibres used to peg the hides covering one hut were preserved. The density of fur residue inside the structure indicated that the floor was covered with pelts from mastodons; there were even lumps of meat preserved and evidence that sea weed – obtained from several kilometres away – were likely used as medicines (Dillehay et al., 2008). In addition to thousands of stone artefacts, numerous wooden tools were also found. Radiocarbon evidence shows clearly that the site was occupied c. 14,500 cal BP – at least a thousand years before Clovis. Unlike Meadowcroft, Monte Verde II has been fully published (see Dillehay, 1989, 1997) and cannot be challenged on the grounds that only a biased selection of the evidence has been presented.

Tom Dillehay, the principal investigator of Monte Verde, is one of the few prehistorians to have successfully caused a paradigm shift in archaeological thinking: Monte Verde II provides an unequivocal demonstration that the Americas were colonized before the Clovis culture appeared. Its location in southern Chile 16,000 km south of the Bering Land Bridge furthermore implies that either there was an extremely rapid dispersal of humans from Alaska to southern South America after 14,500 BP, or that humans did indeed enter the Americas long before this time but thereafter dispersed more slowly towards South America. At present it is difficult to decide between these possibilities, although the latter seems more likely. A short but very rapid dispersal of humans throughout the Americas in the Late Pleistocene is problematic for two reasons. The first is that it is far more rapid than other comparable dispersals outside the Americas. For example, the colonization of Siberia by our species during the later part of the Upper Pleistocene probably took several millennia between 45 and 30 Ka. The environments of Siberia are also far more homogenous than those crossed by the first inhabitants of the Americas from the Arctic to Patagonia. Although there are still many substantial geographic gaps to fill and the current dating is not as precise as we would wish, it is currently thought unlikely that areas as large as Siberia were colonized in only a millennium or two. Likewise with the Australian landmass which comprised New Guinea, Australia and Tasmania when first colonized after 40 Ka (Allen and Holdaway, 1994; O'Connell and Allen, 1998, 2004) or perhaps 55-60 Ka (Roberts et al., 1994); in this instance, the earliest archaeological evidence from highland New Guinea dates to c. 49 Ka (Summerhayes et al., 2010), but in Tasmania and South West Australia dates to only c. 40 Ka, implying that it took several millennia before this enormous landmass was occupied. A second difficulty is that unlike Siberia, the first inhabitants of North and South America were encountering an enormous range of habitats from the Arctic to the Equator and southwards through South America, and rates of dispersal must surely have been reduced by the need of these early colonists to learn how to adapt to such different environments. As stated by Dillehay (2002, p. 765) 'initial human colonization could not have been a blitzkrieg movement ... but was likely a stutter-step, characterised by hesitancy followed by rapid transience through or around inhospitable environments and slow migration through hospitable ones.' On the other hand, if dispersal through the Americas took several millennia, it is hard to understand why so little firm evidence for it has been obtained; for example, in the far smaller area of western Europe, there are hundreds of caves and open air sites from the late glacial that contain evidence showing the recolonization of this area when the ice sheets retreated at the end of the last ice age.

In summary, Meadowcroft probably and Monte Verde II definitely shows that the Americas were colonized at the latest by 14,500 cal BP. How much earlier remains uncertain. Few would place any confidence in dates of >50,000 BP from Pedra Furada, Brazil (Santos et al., 2003), still less the ones in excess of 250,000 BP from the Toca di Esperanza, also in Brazil. More recent dates of 12-30,000 BP may prove less easy to dismiss out of hand. Some are listed in Table 1; these include the small open air site of Monte Verde I, dated at c. 33,000 BP, and some from Brazil, Peru and Venezuela. Additionally, some linguists claim that the present-day and recent linguistic diversity of the Americas may imply that this divergence occurred over a far longer period than 12-15,000 years, as argued by archaeologists and some geneticists. It has even been suggested that the earliest, presumably mono-lingual immigrants arrived in a single dispersal event c. 50,000 years ago, or in several dispersals starting c. 30,000 years ago (see Meltzer, 2009, p.192). On the assumption that these would have been our own species, *H. sapiens*, this would imply that north-east Siberia could have been reached around the same time as the Japanese islands and north China. Few, if any, archaeologists and geneticists would support that contention. However, geneticists differ amongst themselves as much as archaeologists over when the Americas were first colonized. For example, Bonatto and Salzano (1997) suggested humans has crossed Beringia c. 30-40,000 years ago; and in a recent paper that synthesised archaeological and genetic evidence, Goebel et al. (2008) suggested that humans migrated towards the Bering Land Bridge no earlier than 30,000 years ago and possibly after 22,000 years ago, and migrated from Beringia into North America sometime after 16,500 BP. This scenario is broadly consistent with one proposed on genetic grounds by Fagundes et al. (2008), who suggest that humans dispersed across Beringia between ~15,000 and ~19,000 years ago, but a shorter time-line of only ~13,000 BP is proposed in



another genetic-based paper by Ray et al. (2010), and ~15,000 BP for North America and ~10,000 years ago for South America (Eriksson et al., 2012). Both these imply that humans dispersed very rapidly from Alaska to Patagonia, which was definitely inhabited by 10,000 BP (Borrero, 1999) and probably reached by 11,000 BP (Dillehay, 2000, p. 214). Whilst the jury is currently deliberating its verdict on these claims for when humans first reached North America, they have implications relevant to the other two issues concerning the initial peopling of the Americas that were mentioned above.

### Failed dispersals versus successful colonization

A point that is often overlooked in discussions over when a taxon such as *Homo sapiens* first colonized a region is that not all dispersals result in successful, permanent colonization. Most in fact do not. As example, many plant and animal dispersals are transient and thus 'unsuccessful' because their presence in a region is dependent upon the prevailing climate. Many of the plants and animals in present-day Germany, for example, would have been absent during the severest parts of the last glaciation because they would not have survived prolonged periods of severe cold. Likewise, the reindeer that thrived in south-west France during the last glaciation could not do so today. In many parts of Eurasia, hominins were routinely present only during relatively short interglacial or shorter (interstadial) periods. In Britain, for example, they have probably been absent for c. 80% of the last 500,000 years (Stringer, 2006), so the most recent 'permanent' colonization event occurred at the end of the last ice age. From this perspective, the Pleistocene history of hominins in Britain is one of a series of 'failed dispersals'.

In discussions of our own species, 'colonization' normally implies a dispersal event that persists to the present, rather than its duration. For example, *Homo sapiens* were present in the Levant between the last interglacial (c. 125-100 Ka) and 70,000 years ago, when they were displaced by Neanderthals during a climatic downturn and did not return until c. 40-45,000 years ago. Their presence in the Levant between 125,000 and 70,000 years has been termed a 'failed dispersal' (Shea, 2008) because it did not persist into the present, even though it lasted longer than *Homo sapiens* has been in Western Europe, Japan, Siberia and probably Australia, and far longer than humans have been in the Americas. The point that is relevant here to the Americas is that humans may have entered several times before 14,500 BP, but without establishing populations that persisted beyond that date. Thus, even if some of the claims of a human presence in the Americas before 14,500 BP are confirmed, it would not necessarily follow that they indicate permanent colonization. They may instead indicate a 'failed dispersal' in which people died out because of, for example, climatic downturns, because they became too dispersed to maintain viable mating networks or because of disease. This might be especially applicable to any humans that might have entered the Americas more than 20,000 years ago, before the last glacial maximum.

At present, there seems little agreement over how often humans migrated into the Americas, with various researchers proposing that the present-day genetic and linguistic diversity resulted from one, two, three or even more dispersal events (see Meltzer, 2009, pp. 183-207). At present, many, perhaps most Americanists tend to favour the notion of a single dispersal event that resulted in the initial colonization of both North and South America, but without excluding the arrival of later populations across Beringia or the post-glacial Bering Straits. This model may change if pre-14,500 BP dates from American sites (such as Meadowcroft) are upheld.

### How did humans first reach the Americas?

The idea that humans first arrived in the Americas from north-east Siberia across the land bridge of Beringia is long-standing and has considerable support from geneticists (for example, Goebel et al., 2008; Eriksson et al., 2012) and physical anthropologists. Christy Turner (for instance, Turner, 1987) in particular has shown that the shovel-shaped incisors of many indigenous North Americans are derived from north-east Asia. Linguistic specialists also derive most native North American languages from north-east Asia.

The archaeological evidence for a 'Beringia highway' from Siberia into Alaska is less convincing, largely because eastern and north-east Siberia is so enormous and inhospitable. The easternmost province of Chukotka, for example, is larger than France and Germany combined, has few roads and no railways and even now has only c. 50,000 inhabitants. Unsurprisingly, there is little Palaeolithic data from this part of the world. The nearest sites with evidence relevant to the colonization of the Americas, such as Dyuktai are c. 1,500-1,750 miles west of the Bering Straits, or a distance equivalent to that between London and Istanbul (see Stanford and Bradley, 2012). Additionally, those Siberian sites containing artefacts that show some resemblance to early ones in North America tend to be younger than 11,500 BP (and thus irrelevant to the colonization of the Americas); those older tend to have only very general similarities.

## 'Across the Ice' – the Solutrean connection?

One daring hypothesis that has been advanced recently is that humans also reached the Americas from south-west Europe via the southern edge of the Atlantic sea-ice (Bradley and Stanford, 2004; Stanford and Bradley, 2012). These authors draw heavily upon similarities between the bifacial, pressure-flaked points of the Solutrean culture in south-western Europe and the Clovis culture of North America. Rather than explain these as coincidental (or 'technological convergence'), they suggest that Solutrean people exploited the rich off-shore marine resources of the Bay of Biscay from boats and gradually acclimatised to sealing and fishing along the edge of the pack-ice, and thereby some eventually reached the eastern seaboard of the United States. A point that tends to be overlooked by some of the critics of Stanford and Bradley is that they are not proposing that their model is an alternative to Beringia; only that humans may have arrived in North America from both the Atlantic sea-ice and Beringia.

Nonetheless, their views have received much criticism (see for example, Straus et al., 2005) and their critics seem to outnumber by far their supporters. One problem is that the Solutrean, dated to c. 21-18 Ka, is several millennia earlier than the Clovis. A second is the overwhelming genetic, linguistic and dental evidence favouring north-east Asia and Beringia as the main source population for the Americas. (Although Stanford and Bradley cite the genetic haplotype X [found mainly in Western Europe and in some North American populations] as evidence that supports their hypothesis, this haplotype is also found in Siberia (see Fagundes et al., 2008; Goebel et al., 2008) and might even have originated there and spread later to both Western Europe and North America). A third problem with their hypothesis is that there is no evidence that humans in southern Europe were reaching the islands of the Mediterranean until the early Holocene (Broodbank, 2006), yet Stanford and Bradley (2012) suggest that late Palaeolithic groups in south-west Europe had already crossed an ocean only a few millennia earlier.

These points aside, I (Dennell, 2013) have not dismissed their ideas as readily as some of their critics on the grounds that there is compelling evidence that Late Pleistocene humans were competent sailors and navigators, as evidenced by the marine colonization of the islands of South-East Asia, Australia, the Philippines, Japan and off-shore islands such as the Bismarcks (north of New Guinea) and Okinawa, all of which had been reached by c. 30 Ka. There is thus no intrinsic reason why Late Palaeolithic groups in Western Europe could not have used boats for offshore and even beyond-the-horizon sailing, even if they do not appear to have done so in the Mediterranean. If future discoveries indicate that the earliest evidence for humans in the Americas comes from South America (where various claims have been made of a human presence as early as 30 Ka), it would be almost inevitable that someone proposes that it was reached by people sailing from the west coast of Africa.

To summarise: Beringia remains the most likely point of entry into the Americas, but there may have been others. There may also have been 'failed dispersals' that left only an ephemeral record both before and after 14,500 BP.

These uncertainties over basic questions concerning the first peopling of the Americas impact on assessment of the evidence indicating its initial settlement. Irrespective of when, how often and from where the Americas were first settled, the archaeological evidence for its first peopling is extremely ephemeral. For a non-Americanist such as myself, whose initial training was in the European Palaeolithic record, the evidence for the early peopling of the Americas is remarkably sparse. Unlike late glacial Siberia and Eastern Europe, there are (with the exception of Monte Verde II) no major settlement sites, little elaborate material culture (such as carved bone and antler objects), few major butchery sites, very little rock or cave art, almost no mobiliary art and very little human skeletal evidence. The earliest American evidence is broadly similar to that of Pleistocene Australia, although the latter has some notable burials (for example, those from Lake Mungo), and some rock art. Closer parallels to the American evidence are the early Mesolithic of Western Europe and the early Aurignacian of Western Europe: in both cases and the Americas, there are very few high-quality settlement sites, many low-quality lithic scatters and cave/rockshelter records and little skeletal evidence.

Several have commented on the lack of human skeletal evidence for the earliest Americans (for example, Dillehay, 2000; Meltzer, 2009) and the early Aurignacian (Davies, 2001). It may indeed be the case that the earliest Americans did not bury their dead but instead either cremated them (if fuel was abundant) without subsequently burying the ashes, or left them for carrion, as with modern Parsees. The near-absence of human burials seems to be real rather than the result of insufficient survey and may indicate ideological factors – for example, if (as seems likely) the earliest colonists were highly mobile, they might have felt less affinity for the land they were temporarily occupying and more with the fauna they depended upon: so, rather than return their dead to the land, they let them rejoin the living birds and mammals around them. Nevertheless, it is hard to understand why so few human remains have been found in river deposits, as these frequently contain human (and other faunal) remains in Europe.

The overall impression of the earliest American evidence for humans is that they were highly mobile, with a rapid rate of dispersal across both North and South America, and were also extremely adaptable to an astonishingly wide range of environments from the Arctic to the tropics and south to Patagonia. In the space of what appears to have been only a few

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millennia, these early settlers accomplished a feat of colonization that took far longer in a more limited range of environments in Europe, Asia and Australia. A corollary of this model of high mobility and rapid dispersal is that the vast majority of early sites in the Americas are ephemeral and (to non-specialists at least) unspectacular.

At this point we can consider the extent to which the criteria of the World Heritage Convention are applicable to the evidence for the first colonization of the Americas.

### The criteria of the World Heritage Convention

The relevant paragraph is number 77, each part of which can be taken in turn.

'The Committee considers a property as having Outstanding Universal Value (see paragraphs 49-53) if the property meets one or more of the following criteria. Nominated properties shall therefore: :

(i) represent a masterpiece of human creative genius';

It is difficult to see how this criterion could be applied to the ephemeral evidence left by these early colonists. The one item that might be nominated under this criterion is the Clovis point. First, the best are superbly made and are among the finest examples of pressure-flaking from anywhere in the Palaeolithic world. This technique was invented near the end of the Pleistocene: briefly, instead of detaching flakes by striking a stone with a stone or antler hammer, they were detached by applying pressure via a narrow piece of bone, ivory or wood. When used successfully, extremely thin flakes could be detached, almost as though they had been squeezed off. In skilled hands, flaking could be highly symmetrical and when done on both sides of a piece, an exceptionally thin artefact could be produced. A second reason for nominating the Clovis point is their iconic significance to North American researchers. As mentioned above, the 'Clovis people' were long regarded as the first in North America; supposedly highly mobile, successful hunters who rapidly dispersed across North and Central America, leaving Clovis points from the American Midwest to Venezuela. Their descendants gradually became less mobile and more closely associated with particular territories and so the Clovis point was developed into a wide range of broadly similar but regionally distinct styles, of which the Folsom is the best known. Even though we now know that Clovis points do not represent the first inhabitants of the Americas, the Clovis point remains the most distinctive product of the earliest Americans: it has the same iconic significance as the Acheulean handaxe in Europe, as the most widely recognized artefact of the Palaeolithic.

(ii) 'exhibit an important interchange of human values, over a span of time or within a cultural area of the world, on developments in architecture or technology, monumental arts, town-planning or landscape design';

This criterion is inapplicable to the type of mobile hunter-gatherers that colonized the Americas.

(iii) 'bear a unique or at least exceptional testimony to a cultural tradition or to a civilization which is living or which has disappeared';

This criterion could be usefully applied to a number of cases. Perhaps the most obvious are the Tehuacán and Oaxaca Valleys of Mexico, where maize was first domesticated along with squash and cucurbits. This area of Central America has one of the longest records of plant domestication in the world and, as the area where the world's most important commercial cereal was first domesticated, deserves World Heritage status for that aspect alone. The fact that maize cultivation underpinned the Maya civilisation before its overthrow by the Spanish in the sixteenth century is a further justification for nominating Tehuacán and Oaxaca as exemplifying cultural traditions that are still living (with the modern local culinary and artistic traditions, and local beliefs about maize) and past civilisations (in the case of the Maya).

A second possible candidate would be the High Arctic of Alaska and northern Canada, where there were remarkable human adaptations to the Arctic. Here, the Dorset and later Thule traditions can be cited as outstanding cultural traditions, much of which persist into modern times.

A third that can be singled out in the Americas is the High Andes, where humans were adapting to high-altitude living by 10,000 years ago (Dillehay, 2000, p.172-185). Depending upon which dates are preferred for the colonization of the Tibetan Plateau above 4,000 metres, the High Andes may represent the earliest example of human adaptation to habitual life at high altitudes. Additionally, this was the area where the potato was first domesticated, which was unquestionably one of the most important domestic plants that was transplanted to Europe and Asia (along with tobacco, cotton and maize). Among many examples of this, we can mention Ireland, where the failure of the potato harvest in 1848-49 was one of the most catastrophic

events in Irish history, and the importance of potato in Indian cuisine after 1600 (Collingham, 2005). A further reason for including the High Andes is that it was in this region that camelids (llama, alpaca and vicuna) were first domesticated (Dillehay, 2011). These animals, used for their wool, meat, milk and as pack animals, were the main animals that were domesticated in the Americas, and given their importance, the area where they were first domesticated deserves recognition.

Other examples might be the American Southwest, with a very long tradition of adaptation to a desert landscape; the Northwest Coast of the Pacific; the Peruvian coast; and Patagonia, where humans equipped with only a rudimentary technology settled 'at the uttermost end of the earth' in one of the least hospitable parts of the planet.

(iv) 'be an outstanding example of a type of building, architectural or technological ensemble or landscape which illustrates (a) significant stage(s) in human history';

The Clovis culture is (as with criterion i) perhaps the obvious candidate for showing 'an outstanding ..... technological ensemble', although its significance is contentious. As noted already, it is no longer indicative of the earliest settlement of the Americas, nor is it a valid example of 'Pleistocene overkill', as proposed by Paul Martin (1984), who envisaged a 'blitzkrieg' wave of advance by Clovis hunters who dispersed rapidly and hunted many animals to extinction. A less dramatic but still worthy assessment of the significance of the Clovis culture is that it represents a conspicuous phase in the human colonization of North America.

(v) 'be an outstanding example of a traditional human settlement, land-use, or sea-use which is representative of a culture (or cultures), or human interaction with the environment especially when it has become vulnerable under the impact of irreversible change';

The outstanding American example of a traditional pattern of human land- and sea-use that is under the impact of irreversible change is the Canadian and Alaskan Arctic, where climate change is already having major and probably irreversible impacts on human settlement, the fauna, flora and coastline. The ongoing shrinkage and thinning of the Arctic summer ice is bringing benefits to commercial shipping by opening up the Northwest Passage between the Pacific and Atlantic, but is causing profoundly negative impacts on indigenous communities by eroding the coast and disrupting their use of the sea. At the current rate of shrinkage, indigenous life ways that have persisted for millennia may well disappear within a generation.

Climate change may also cause irreversible damage in the High Andes, particularly because the Andean glaciers provide much of the water for agriculture and city life in the lowlands and along the Peruvian coast. Ongoing climate change will also negatively impact on the vegetation and dependant fauna, including llama and alpaca.

A third example of an outstanding type of land/sea-use is the Peruvian coast, which has evidence of human adaptations extending back c. 13,000 years (Sandweiss, 2003).

(vi) 'be directly or tangibly associated with events or living traditions, with ideas, or with beliefs, with artistic and literary works of outstanding universal significance. (The Committee considers that this criterion should preferably be used in conjunction with other criteria)';

The outstanding example here are the Tehuacán and Oaxaca Valleys of Mexico, where maize was first domesticated and which have vibrant traditions centred on maize cultivation that extend back nine millennia. As shown so clearly in the Tehuacán Museum, maize is a recurring theme in the art and iconography of local life in the present, in the years following the Spanish conquest in the sixteenth century, in the preceding Maya and Olmec civilisation and their non-urban predecessors. This criterion could also be applied to examples cited above from the high Andes, the Arctic and the Northwest Pacific coast.

(vii) 'contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance';

The inherent weakness of this criterion is that it is subjective: and subject to change. As noted in an earlier report (Dennell, in press), 'There is no universal agreement over what is 'beautiful' and beauty is inevitably very much in the eye of the beholder. To take one example, until the Romantic Movement of the late eighteenth and early nineteenth centuries, mountainous areas in western Europe were seen by most as barren and inhospitable places that were to be avoided as much as possible, and landscape artists and poets tended to praise and select gentler, humanised landscapes such as farmlands and managed woodlands in their appreciation of nature. Only later did people regard mountains as beautiful rather than fearful, as places to explore, climb and map (as with the British obsession with the Alps and then the Himalayas). Similarly, polar regions were seen as devoid of any beauty until they became associated with heroism and competitive behaviour by Europeans (and North Americans) over who could go furthest north or south, lose the most toes and fingers, and survive the worst blizzards'.

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Nevertheless, in the current age, barren landscapes (deserts and polar ones in particular), ones with dramatic changes in altitude (notably mountain and karst landscapes) and/or with marked variation in plant and animal life (for example, the African Rift Valley) tend to be regarded as exceptional examples of natural beauty, in contrast to ones that are flat and monotonous. With the Americas, one is spoilt for choice in specifying examples of 'outstanding natural beauty'. As an outsider whose appreciation of American landscapes is largely through the media, I would specify the High Arctic, the Rockies, the American Southwest, the Grand Canyon, the High Andes, the Atacama Desert and Patagonia as prime examples.

(viii) 'be outstanding examples representing major stages of earth's history, including the record of life, significant ongoing geological processes in the development of landforms, or significant geomorphic or physiographic features';

In the broadest use of this criterion, one could single out for the Americas the 3 billion year geological record of the Canadian Shield, the Jurassic Park of Wyoming, the formation of the Panama Isthmus c. 3.0 Ma which conjoined the Americas, the Grand Canyon, the uplift of the Rockies and Andes and many others. If applied to examples of the earth's history within the brief period that humans have been in the Americas, the choice is obviously much more limited. However, one could highlight Holocene examples from the last 10,000 years, such as the formation of the rainforests of the Amazon Basin and Panama, or the formation of the grasslands of the Argentinian pampas and American Midwest; the redwood forests of the Rockies, the wetlands of Florida, the post-Pleistocene formation of the deserts of the American Southwest, all of which have associated human adaptations. Likewise, the present-day topography of the islands and coastlines of the American Arctic are a product of the Holocene, as they were previously buried under ice.

(ix) 'be outstanding examples representing significant ongoing ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals';

All the landforms mentioned above have their associated, ongoing ecological and biological processes. Particularly important ones might be the Holocene formation of the Amazonian rainforest, the Canadian Arctic, the grasslands of the American Midwest and Argentina, and the deserts of the American Southwest and Peru/Chile.

(x) 'contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of Outstanding Universal Value from the point of view of science or conservation'.

The most threatened communities in need of conservation and further scientific investigations are those in the Arctic and the Amazonian rainforest. The dominant threats are climate change in the Arctic, and human pressure through logging and forest clearance for farming in Amazonia. In both cases, indigenous communities are also under threat. Both factors are also threatening the stability of the fauna and flora of the High Andes.

## Discussion

From the perspective of the World Heritage Convention, the evidence for the initial peopling of the Americas is problematic in two respects. First – and with the exception of Monte Verde II, Chile, and Huaca Prieta, Peru - there are very few major 'flag-ship' sites that could serve as the basis for a nomination: there are no equivalents to sites such as Mezherich in the Ukraine, with its structures of mammoth bones, or Dolni Vestonice in Moravia, with a triple burial and the earliest evidence for ceramics; no cave art sites comparable to Chauvet; no cave sites with substantial and crucially important hominin or human remains, such as Atapuerca or Mount Carmel; and so on. (And unfortunately, the main occupation area of Monte Verde no longer exists [Meltzer et al., 1997, p. 660]). This dearth of spectacular evidence is entirely consistent with what one would expect of small groups of humans with a simple kit of stone tools (but probably a much more complex one made from perishable materials such as cordage, leather, fur, basketry and wood) that were highly mobile and covered large distances each year. With such groups, no single site will give a representative indication of the totality of activities that were undertaken each year. Only later, when groups became more sedentary, is the quality and quantity of evidence likely to increase. However, because the earliest American sites are so ephemeral, it is hard to apply criteria i) 'masterpiece of human creative genius', or ii) developments in architecture or technology, monumental arts, town-planning or landscape design'. A second problem with the Americas is that major sites that could serve as the basis for a World Heritage Convention nomination also require full publication. Again, Monte Verde II is the one obvious flag-ship site that has been fully published. Hopefully, Meadowcroft will follow suit, and if its claims for occupation before 14,500 BP are upheld, there would be a major flag-ship site in North America. Until more sites and surveys are published in full, issues of authenticity (paragraph 80: 'The ability to understand the value attributed to the heritage depends on the degree to which information sources about this value may be understood as credible or truthful') are largely irrelevant, as interim reports and conference presentations are insufficient to demonstrate that a claim is 'credible or truthful'. (Paragraph 81 states that 'cultural heritage must be considered and judged primarily within the cultural contexts

to which it belongs' when establishing authenticity; in the context of discussions on the first peopling of the Americas, the 'cultural context' has surely to be that of a rational, Western scientific tradition in which data can be verified or disproven).

The criteria with perhaps the greatest scope for application to the Americas are numbers (iii) ('exceptional testimony to a cultural tradition'), (iv) 'outstanding example of a ..... technological ensemble or landscape'; (v) ('outstanding example of a traditional human settlement, land-use, or sea-use', (vi) ('events or living traditions, with ideas, or with beliefs, with artistic and literary works of outstanding universal significance'), (vii) ('exceptional natural beauty and aesthetic importance' ); (viii) ('outstanding examples representing major stages of earth's history' ); (ix) ('significant ongoing ecological and biological processes' ) and (x) ('most important and significant natural habitats for in-situ conservation of biological diversity' ). Somewhat paradoxically, all but two of the WHC criteria have potential applicability to the earliest sites in the Americas, even though the archaeological evidence for the initial peopling of the Americas is so meagre. It is clear from this list that a landscape approach is probably the best one to develop if the sparse evidence for the colonization of the Americas is to be appreciated at a World Heritage level. The Americas are not unique in that respect. The same point would apply to other areas of the world, such as mainland and island South-East Asia, where the colonization of rain forest was a major development in global history, but not one that left much in the way of eye-catching archaeological evidence. Likewise, with Palaeolithic evidence from the Lower and Middle Palaeolithic, a landscape approach is the most appropriate way of integrating the archaeological evidence into a coherent picture.

The World Heritage Convention provides additional guidance on the requirements of nominations under criteria (i) -(vi) and (vii) - (x) that are worth further attention.

Paragraph 88 states: 'Integrity is a measure of the wholeness and intactness of the natural and/or cultural heritage and its attributes. Examining the conditions of integrity, therefore requires assessing the extent to which the property:

- a) includes all elements necessary to express its Outstanding Universal Value;
- b) is of adequate size to ensure the complete representation of the features and processes which convey the property's significance;
- c) suffers from adverse effects of development and/or neglect'.

Paragraph 89 states: 'For properties nominated under criteria (i) to (vi), the physical fabric of the property and/or its significant features should be in good condition, and the impact of deterioration processes controlled. A significant proportion of the elements necessary to convey the totality of the value conveyed by the property should be included. Relationships and dynamic functions present in cultural landscapes, historic towns or other living properties essential to their distinctive character should also be maintained'.

These are problematic for assessments of the earliest evidence from the Americas. Open air archaeological sites from the Late Pleistocene and early Holocene are inherently fragile, rarely if ever in 'good condition', and when exposed by erosion, 'deterioration processes' are hard to control. (The same is true of course of Early and Middle Pleistocene open air sites). It is easier to demonstrate 'good condition' and control deterioration with cave sites, and long-term, these may offer better potential as candidates for nomination.

Paragraph 90 of the World Heritage Convention concerns properties nominated under criteria (vii) - (x). Here, it states that:

'bio-physical processes and landform features should be relatively intact. However, it is recognized that no area is totally pristine and that all natural areas are in a dynamic state, and to some extent involve contact with people. Human activities, including those of traditional societies and local communities, often occur in natural areas. These activities may be consistent with the Outstanding Universal Value of the area where they are ecologically sustainable'.

These comments are applicable to all of the Americas, since there are no areas 'totally pristine' and all are dynamic: indeed, environmental archaeologists have been at the forefront of demonstrating just how dynamic most landscapes have been in the last 12,000 years. Indigenous 'traditional' societies persist in many parts of South America and the Arctic, even if often substantially transformed after European contact.

Paragraphs 93 to 95 are primarily relevant to nominations under the IUCN as they focus exclusively upon 'natural' habitats in which humans are excluded or irrelevant. These are cited below:



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Paragraph 93: 'Properties proposed under criterion (viii) should contain all or most of the key interrelated and interdependent elements in their natural relationships. For example, an "ice age" area would meet the conditions of integrity if it includes the snow field, the glacier itself and samples of cutting patterns, deposition and colonization (e.g. striations, moraines, pioneer stages of plant succession and so on); in the case of volcanoes, the magmatic series should be complete and all or most of the varieties of effusive rocks and types of eruptions be represented'.

Paragraph 94: 'Properties proposed under criterion (ix) should have sufficient size and contain the necessary elements to demonstrate the key aspects of processes that are essential for the long term conservation of the ecosystems and the biological diversity they contain. For example, an area of tropical rain forest would meet the conditions of integrity if it includes a certain amount of variation in elevation above sea level, changes in topography and soil types, patch systems and naturally regenerating patches; similarly a coral reef should include, for example, seagrass, mangrove or other adjacent ecosystems that regulate nutrient and sediment inputs into the reef'.

Paragraph 95: 'Properties proposed under criterion (x) should be the most important properties for the conservation of biological diversity. Only those properties which are the most biologically diverse and/or representative are likely to meet this criterion. The properties should contain habitats for maintaining the most diverse fauna and flora characteristic of the bio-geographic province and ecosystems under consideration. For example, a tropical savannah would meet the conditions of integrity if it includes a complete assemblage of co-evolved herbivores and plants; an island ecosystem should include habitats for maintaining endemic biota; a property containing wide ranging species should be large enough to include the most critical habitats essential to ensure the survival of viable populations of those species; for an area containing migratory species, seasonal breeding and nesting sites, and migratory routes, wherever they are located, should be adequately protected'.

The distinction in paragraphs 93-95 between the human and the natural worlds may seem self-evident to many, and is clear-cut in some cases: for example, coral reefs and ice fields and glaciers are 'natural' phenomena in which human presence and agency can be excluded. In many cases, however, the distinction between the human and natural is hard to maintain. For example, volcanic landscapes might seem at first sight 'natural', yet volcanic soils are often highly fertile, and in many regions of the world (for example, Hawaii, Italy, Indonesia), volcanoes occasionally threaten but more usually sustain communities, many of which become extremely prosperous because of their access to fertile, well-drained volcanic soils. Or, to take another example, the tussock-grass páramo is the dominant vegetation in the High Andes above the forest-line, and have been seen as a type of 'natural' vegetation that is controlled principally by rainfall and temperature. However, as humans have lived in the region for 10-11,000 years and frequently deliberately burnt vegetation to increase research productivity (as in many other areas of the world), the páramo is more likely to be a man-made type of vegetation (White, 2013).

## Summary

Although the colonization of the Americas occurred very recently in the two-million-year long story of our genus, it was one of the most important events in that story and deserves to be celebrated as a vital part of our global history as a colonizing species. However, because the evidence for the initial peopling of the Americas is (with the exception of a very small number of sites) very meagre, a different approach is required when considering the World Heritage Convention than in areas where the late Palaeolithic record is much richer, as in Europe, Siberia, the Levant and South Africa. In these areas, the most obvious route to selecting candidates for nomination for World Heritage status is to build a nomination around a site or group of sites that have outstanding features in terms of their human skeletal, artistic and/or artefactual evidence. In the case of the Americas, it is probably more useful to build a nomination around a particular type of landscape that was colonized at an early date and which contains a representative range of unspectacular sites as proof of human presence.

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## The First North Americans: the State of the Art, 2014

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Twenty years ago, in the early 1990s, almost all North American archaeologists were convinced that the question of the continent's peopling had been resolved. The first arrivals possessed the Clovis lithic technology, an assemblage including large, fluted, trianguloid projectile points, bifaces often as large as dinner plates, end and side scrapers, graters, notches and occasionally burins. This technological package is almost ubiquitous from the southern margins of the terminal Pleistocene glaciers to northern Colombia (Ranere, 2006), seemingly marking it as the trace of the Hemisphere's first colonists. Clovis points were often found in mammoth kills, which consistently dated to nearly 13,000 cal BP. No other technology could be found to reliably predate Clovis. Clovis also approximately coincided with the mass-extinction of most of the continent's megafauna (Martin, 1973). In addition, linguists linked all of the hemisphere's older languages to the Amerind group (Greenberg et al., 1986), further corroborating a single colonization event.

The story was a simple one, repeated in nearly every textbook. Sometime around 13,500 years ago, the Laurentide and Cordilleran ice sheets had receded far enough to open an ice-free corridor from Beringia to temperate North America. As few as 100 big game hunters migrated down that corridor and found an unoccupied land filled with large game that had no innate fear of them. Free of constraints, they expanded rapidly, reaching the southern tip of South America within only a few hundred years. Through this blitzkrieg, as Paul S. Martin (1973) called it, they annihilated most of the continent's large herbivores and caused the native predators to follow them to extinction. Clovis was listed first in every regional chronology.

This Clovis-first paradigm, as it is now known, became scientific orthodoxy. Its staunchest adherents readily and, in most cases, quite convincingly dispensed with any suggestion of a pre-Clovis discovery. By the mid-1990s, only one strong contender for a pre-Clovis reality had come forward. In large part due to the meticulous stratigraphic work and tenacity of James Adovasio (Adovasio et al., 1990; Adovasio and Page, 2002), Meadowcroft Rockshelter in Pennsylvania (Figure 2) remained a viable contender despite numerous attempts to question its chronology and palaeoecological record (summarized in Adovasio et al., 1998). Believers in American cultures that predated Clovis occupied the fringe of the discipline. Alternatives to the single migration story were not welcome.

Archaeological opinion has since turned almost 180 degrees. More than a dozen unquestionably archaeological North American sites now convincingly predate Clovis times. Improvements in our understanding of glacial histories have opened up the possibility of alternatives to the ice-free corridor as a migration route to account for the early arrivals. We now have better evidence that the earliest human arrivals in the Americas, Clovis foremost among them, did indeed contribute to megafaunal extinctions. It is now clear that a second technological tradition coexisted with Clovis in North America. New horizons of research are being explored and geologists and archaeologists explore below water, both on the continental shelf and the drowned karst systems of the Caribbean rim. Finally, we have recovered and studied enough of the skeletons



Figure 1. Locations of major sites mentioned in the text. Glacial ice and coastlines are shown as they would have been circa 20,000 and 12,000 cal BP.

of the earliest human occupants to speak effectively about the lives they led. The story of the earliest colonists, although less certain than it once was, is now much more interesting.

## The Pre-Clovis Record

Waters and Stafford (2007) critically evaluated existing radiocarbon dates for Clovis assemblages and re-dated many of them using refined bone pre-treatment methods and accelerator mass spectrometry. They concluded that Clovis occupies only a brief window of time between approximately 13,100 and 12,700 cal BP and used the result to support the argument that cultures existed in the Americas before Clovis. Although their inference is disputed (Haynes et al., 2007), the argument may be moot because three groups of sites and another currently isolated locality clearly demonstrate the presence of humans in North America before Clovis. The site groups, which I refer to here as the ice-margin kills, the Mid-Atlantic Complex, Gault and Friedkin; and the isolated site of Paisley Caves, are distributed throughout North America (Figure 1), indicating widespread human presence before 13,100 cal BP.



*Figure 2. General view of documentation procedures at Meadowcroft Rockshelter facing southeast; colored pencils which represented different combinations of silt, sand, and clay-sized materials were employed to produce microstratigraphic profile maps of all parts of the excavation.*  
© J. M. Adovasio

## Ice margin kill sites

Claims of pre-Clovis megafauna kills, based solely on purported cut marks on the bones, such as the Ayers Pond bison (Kenady et al., 2011) and Lindsay Mammoth (Davis and Wilson, 1985), are numerous but few pass close inspection. Even rarer are associations between these palaeontological remains and unquestionably human-produced artefacts. To be convincing, cut marks must meet stringent criteria for production by stone tool edges (Johnson et al., 2013), and artefacts must be in direct contact with and preferably beneath the bones, with both in primary context. The Manis Mastodon in Washington, Schafer and Hebior mammoths in Wisconsin and Firelands Megalonyx in Ohio meet these criteria.

The Manis site, Washington, discovered in 1977 (Gustafson et al., 1979) (Figure 1) consists of the cut-marked skeleton of an aged adult mastodon, one side of which remains articulated while the other lies scattered nearby. This pattern of incomplete carcass use is characteristic of Clovis proboscidian kills, reflecting a subsistence strategy that emphasized immediate food return (Haynes and Hutson, 2013). A bone splinter, identified through a high resolution CT scan as a bone projectile point made from the rib of another mastodon (Waters et al., 2011a) was found embedded in the right 14<sup>th</sup> rib. Four radiocarbon dates on this rib and the mastodon's tusk averaged  $11,960 \pm 17$  rcy BP, or approximately 13,800 cal BP. The site is situated near the Strait of Juan de Fuca and lay fewer than 100 km from the retreating margin of the Juan de Fuca lobe of the Cordilleran ice sheet.

Schaefer and Hebior are similarly situated in newly deglaciated terrain near the shores of Lake Michigan, south-east Wisconsin (Joyce, 2013). Each consists of the disarticulated remains of a single adult mammoth bearing multiple cut marks and associated with lithic tools. The Schafer specimen exhibits 30 cut marks primarily on longbone, which indicate the animal was butchered while fresh. Two chert flakes were found directly beneath the pelvis (Figure 3), confirming the cause of the cut marks. Fifteen radiocarbon dates on purified collagen place the death of this animal between  $12,290 \pm 60$  and  $12,570 \pm 45$  rcy BP (Joyce, 2006), approximately 14,200 cal BP. The Hebior mammoth exhibits stone tool cut marks on nine elements, primarily those of the feet, but more advanced weathering of much of the skeleton precluded identification of such marks on most elements. Associated tools include two bifaces, an unmodified flake of chert and a weathered dolomite fragment labelled a 'chopper'. One biface lay beneath a thoracic vertebra; the other chert implements were also associated with skeletal elements. Three radiocarbon dates

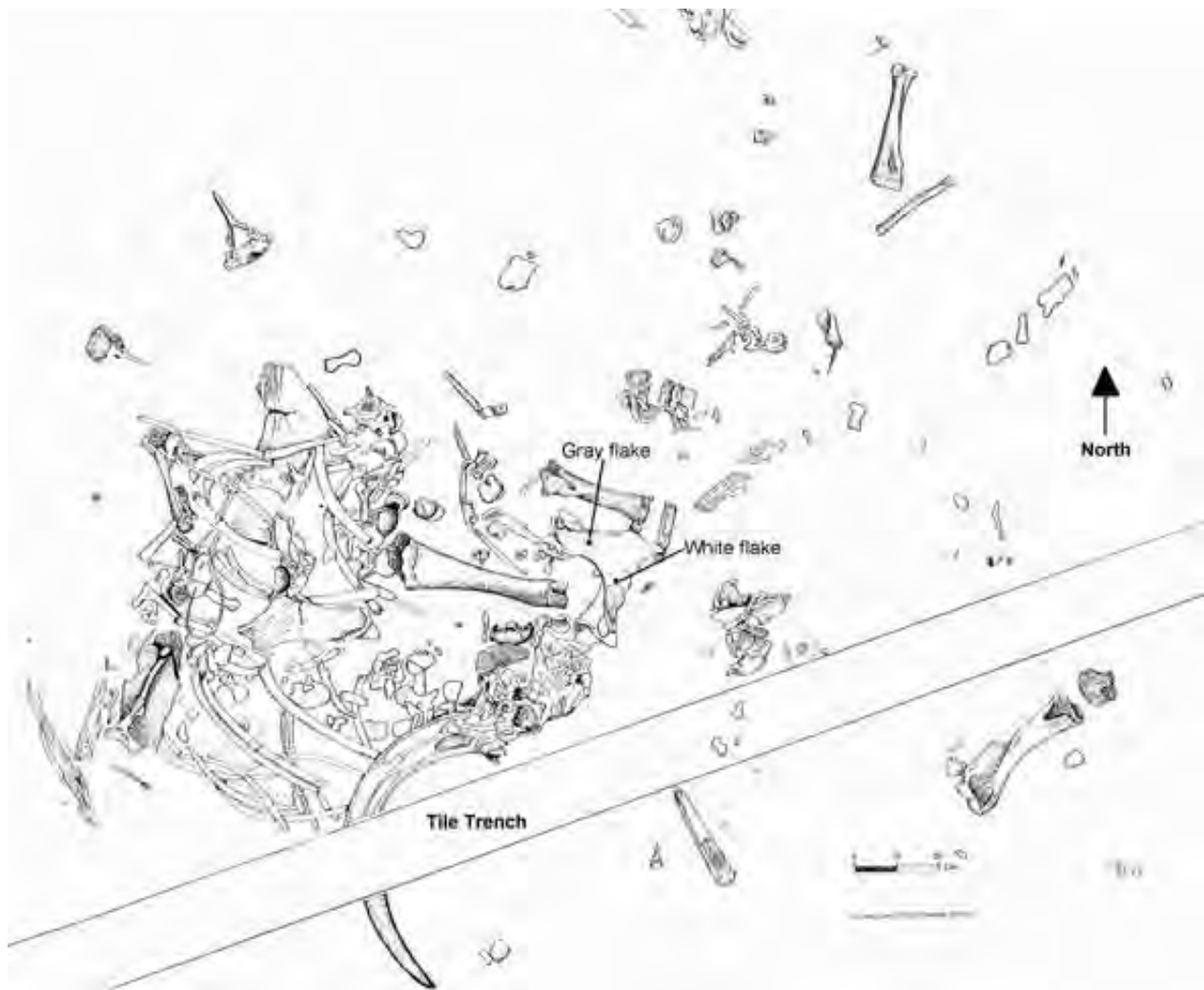


Figure 3. A plan map of the Schaefer mammoth, showing the location of lithic artefacts found in association with the skeleton. © Daniel Joyce.

on purified collagen place this kill between  $12,480 \pm 60$  and  $12,590 \pm 50$  rcy BP (Overstreet and Kolb, 2003), or around 14,800 cal BP.

The final convincing pre-Clovis megafaunal kill is the Firelands *Megalonyx*, the partial remains of a giant ground sloth found in northernmost Ohio, in a swamp near the shore of Lake Ontario (Redmond et al., 2012). From a local museum collection and lacking comprehensive records about its recovery, the Firelands *Megalonyx* lacks the detailed provenience of the Manis or Wisconsin specimens, but its validity is nonetheless convincing. Among ten skeletal elements is a complete left femur with multiple cut marks. The antero-distal aspect of this element exhibits 47 linear and arcuate incisions apparently resulting from the effort to remove the large quadriceps muscles. Casts of a sample of these were studied by scanning electron micrography (SEM) and, based on a stepped or “shouldered” cross-section (Johnson et al., 2013), they represent stone tools cuts. A parallel series of multiple cuts change from one-shouldered to two-shouldered as they progress along the shaft, from which Redmond et al. infer the butcher switched from a unifacial to a bifacial tool. Given the continuous parallel orientation of the cuts, it is more likely that the addition of a shoulder in later cuts is evidence for progressive dulling of a single unmodified flake by removal of small chips, which is the most convincing evidence for butchery. A single radiocarbon date on collagen from this specimen,  $11,740 \pm 35$  rcy BP places it at around 13,600 cal BP. This is the first confirmed evidence for ground sloth hunting in North America. It could, however, benefit from additional radiocarbon dating to confirm the age of the kill event.

These four sites, stretching across the North American continent south of the glacial ice, convincingly demonstrate that humans were living near the ice margin between 14,000 and 15,000 cal BP, well before the invention and spread of Clovis technology. Lacking here, however, are details of the technology and settlement patterns of these early peoples.



## Middle Atlantic complex

Evidence is building for a potentially very early human presence along the eastern seaboard, where at least 5 sites have produced similar artefact assemblages dating as early as 20,000 cal BP. In the early 1970s, the Meadowcroft Rockshelter, in western Pennsylvania, produced a small number of artefacts and human remains well beneath a classic Clovis assemblage, sealed from it by a thick layer of roof fall (Adovasio and Page, 2002). In this unit, called Stratum IIa, were multiple hearths, along with fibre and lithic artefacts. Among hundreds of waste flakes were two small, trianguloid, straight- to slightly concave-based projectile points, retouched flake tools, and retouched and unretouched bladelets. Adovasio named this assemblage the Miller Complex and its projectile point the Miller lanceolate. Radiocarbon dates on the Clovis assemblage placed it within the appropriate 13,000 cal BP time range, but the underlying assemblage dated between 20,500 and 14,100 cal BP (Adovasio et al., 1990). For many years, this small collection stood alone amidst heavy criticism, but since the late 1990s a similar superposition of Clovis projectile points above an assemblage closely similar to the Miller Complex has been found repeatedly in sites around Chesapeake Bay.

The same small, trianguloid projectile points and bladelets of the Miller Complex, as well as polyhedral bladelet and flake cores, burins and a variety of retouched flake tools have been found at Cactus Hill, Virginia and across the Chesapeake Bay on the Delmarva Peninsula at Miles Point, Oyster Cove and Cator's Cove (Lowery and Wagner, 2013; Stanford and Bradley, 2012). At Cactus Hill, this assemblage was found beneath an eolian deposit containing Clovis artefacts, separated from them by a palaeosol. Geochemical tests on sediment within sub-Clovis artefact concentrations showed accumulations of phosphorus, indicating the artefacts had not been relocated from an overlying stratum (McAvoy et al., 2000). On the Delmarva Peninsula, Miller Complex-like artefacts occur as small clusters within a well-developed palaeosol, named the Tilghman (Lowery and Wagner, 2013). The surface of the Tilghman Paleosol has been truncated by wind erosion and is overlain by loess dated to the Younger Dryas. Clovis artefacts are frequently encountered between the two, having been deflated onto the B Horizon of the wind-resistant palaeosol. Some of the Miller Complex-like artefacts were firmly incorporated into peds of this B Horizon, indicating they were present when the soil was forming. Charcoal from one apparent hearth in the Miller component at Cactus Hill radiocarbon dated  $15,070 \pm 70$  or  $18,450$  cal BP<sup>1</sup> (McAvoy et al., 2000); organic material from the Tilghman Paleosol ranges between 16 and 24,000 years old (Lowery and Wagner, 2012). In a recent presentation, Lowery conservatively gave age of the pre-Clovis components on the Delmarva Peninsula as at least 14,000 years. The Miller Complex of the Mid-Atlantic region is thus a fully replicated pre-Clovis phenomenon.

One additional discovery that highlights the pre-Clovis presence of humans in the mid-Atlantic region is known as the Cinmar biface. In 1970, a scallop dredge working 100 km off the coast of Virginia brought up a mastodon skull and a 19 cm long, laurel-leaf biface (Stanford and Bradley, 2012). The objects came in a single dredge haul from a depth of 75 m below sea level near the outer edge of the continental shelf. Geochemical analysis of the biface and the tooth and tusk saved by the discovering fisherman indicated they had lain in a freshwater bog for some length of time before rising sea level inundated them around 14,500 years ago. The mastodon bone radiocarbon dates to around 27,000 cal BP (Lowery, 2010), so the biface likely dates to sometime after that but before inundation took place. The antiquity of this find is, however, contested (Boulanger and Eren, 2015).

## Gault and Debra L. Friedkin sites

These two sites are located in central Texas at a major source of high quality Edwards chert that has been used throughout prehistory. Both sites contain uninterrupted but properly superimposed sequences of artefacts ranging from Clovis through Palaeoindian and Archaic (Collins et al., 2013). At both, large assemblages of artefacts have been found beneath the Clovis horizon. Of these, the findings at Friedkin have been more completely described (Waters et al., 2011b). The assemblage consists of over 2,300 pieces of macro-debitage and 56 tools distributed within a 20 cm thick zone underlying a 2.5 cm thick Clovis horizon. Tools include blades and bladelets, what appear to be unfinished bifaces, edge-modified flakes and a discoidal core. Blade cores were not found but are inferred from the large number of blades and bladelets. Waters et al. (2011b) have named this small assemblage the Buttermilk Creek Complex, but more excavations are needed to clarify its technological composition and lithic reduction trajectory.

The Friedkin site lacks organic material suitable for radiocarbon dating, so Waters et al. (2011a) established a chronology using optically stimulated luminescence (OSL). The 49 OSL dates form two columns formed a stratigraphically consistent sequence from the Early Archaic to Buttermilk Creek horizons. Two samples from the Clovis horizon ( $14,350 \pm 910$  and  $14,070 \pm 910$  cal BP) overlap the radiocarbon-established age range for that technology (Waters and Stafford, 2007) at two

1 A date on a second 'hearth' has too high a standard error to be considered here.



*Figure 4. Excavation in the Paisley Caves, Oregon, from which coprolites dating over 14,000 cal BP produced human DNA and Western Stemmed Tradition artefacts coeval with Clovis were discovered. © Dennis Jenkins.*

standard deviations. A conservative age estimate based on the minimum ages of the 18 measurements from the Buttermilk Creek horizon, which range from  $14,000 \pm 890$  to  $16,515 \pm 1075$  places the age of the complex between 13,200 and 15,500 cal BP. The researchers use detailed soil chemistry and micromorphology to establish that the artefact assemblage did not migrate down from the denser lithic concentrations in overlying levels.

Similar artefacts are found beneath the Clovis horizon at Gault and preliminary OSL results indicate a similar age range (Collins et al., 2013). Analysis of the bifacial reduction trajectory in this assemblage by Bruce Bradley shows it to be distinct from the Clovis pattern (See **Clovis Contemporaries**, below). Bladelets and the unfinished bifaces may indicate similarity to the Miller Complex, but small, split stem projectile points, which differ markedly from any other early assemblages in North America, also have been found, raising the possibility that more than one distinct lithic tradition existed in North America at this early date (Collins et al., 2013).

### **Paisley Caves**

The earliest human presence in western North America has been established not by artefacts but by faeces. Dry sediments in the Paisley Caves of south-central Oregon (Figure 4) have produced numerous coprolites found by the research team to contain human DNA (Gilbert et al., 2008; Jenkins et al., 2012, 2013). The dry sediments of the cave, which contain copious amounts of well-preserved plant materials sometimes cemented together with packrat urine, have been meticulously documented and dated with 203 radiocarbon analyses. Coprolites dating between 14,000 and 15,000 cal BP were collected from the deepest levels of the cave and are interpreted as evidence for human presence in the Great Basin by this time in prehistory. No unquestionable artefacts have been found in association with them, however, leaving the human identification of the coprolites in question. Cultural layers above the coprolite deposit, however, have provided solid evidence for occupation by people contemporary with Clovis but using a non-Clovis technology (See **Clovis Contemporaries**, below).

## Pre-Clovis occupation of America

Collectively this series of sites documents the presence of humans in North America by at least 15,000 years ago - and possibly much earlier in the case of the Mid-Atlantic findings. Artefacts representing this early occupation, where sufficient material exists for characterizing lithic technology, show a combination of core-and-blade and biface industries that, although lacking the distinctive lithic reduction approach that distinguishes Clovis, is not markedly dissimilar from it. This similarity has led one Clovis-First proponent to recognize a proto-Clovis culture in the Americas (Haynes, 2002; Haynes and Hutson, 2013).

## Alternative routes of colonization

For many years, opponents of the Clovis-First model argued that the first Americans could not have entered via an ice-free Corridor in Western Canada because such a corridor did not exist (for example, Dixon, 1999). Evidence for such a corridor was equivocal. Either the Cordilleran and Laurentide ice masses had not parted by 13,500 years ago, in time for the Clovis progenitors to enter or massive melt-water lakes blocked the path of any prospective migrants. Given this inference and final acceptance of human presence more than 14,200 years ago at Monte Verde in southern Chile (Dillehay, 2000; see also this volume) archaeologists began seeking alternative routes. Two principal routes have been proposed: A circum-Pacific route, often called the Kelp Highway Hypothesis (Erlandson et al., 2007) and the Solutrean Hypothesis, which proposes immigration around the north Atlantic (Stanford and Bradley, 2012).

### The Kelp Highway hypothesis

Long thought to have remained under glacial ice until well after an interior corridor opened up, the mountainous coast of British Columbia and south-eastern Alaska is now known to have been largely free of ice by 16,000 cal BP. Caves along this coast have produced palaeontological collections indicating the presence of terrestrial animals, including bears and caribou, by this early date (References in Dixon, 1999). A growing number of researchers has embraced the long-discredited notion first proposed by Fladmarck (1979; See also Gruhn, 1994) that the first Americans entered not as hunters of terrestrial big game but as coastal and maritime foragers who emphasized food from the sea (for example, Dixon, 1999; Erlandson et al., 2007). The idea has a great deal of merit from a theoretical standpoint and is indirectly supported by archaeological evidence from around the Pacific Rim. As articulated by Erlandson et al. (2007), the Kelp Highway Hypothesis asserts that people occupying the coast of eastern Siberia and the Japanese islands, in possession of simple watercraft and a technology for exploiting shellfish, bird, sea mammal and near-shore fish resources could have expanded onto the southern rim of Beringia in the late glacial. Once the ice melted from the north-west coast of North America enough that coastal patches became available, they could have continued their expansion without any change in their basic adaptive strategy. The same kind of resources can be found and exploited in the same ways along this entire coastal 'megapatch,' regardless of the adjacent terrestrial ecosystem. Coastal-adapted colonists could have followed this megapatch down the Pacific Coast, entering the interior along major rivers like the Columbia, Sacramento and Colorado, or continuing south into Central America. At Panama, some would cross the isthmus while others continued south to Tierra del Fuego. The group that crossed could have split again, some proceeding north along the Gulf and Atlantic Coasts and others proceeding south toward Brazil and the Amazon River delta. In North America, those who entered via the Sacramento or Columbia would give rise to the Western Stemmed Tradition; migrants up the Colorado or up the Mississippi or other south-eastern rivers would be the progenitors of Clovis (Anderson et al., 2013) (see **Clovis Contemporaries**, below).

Much of this remains conjecture because postglacial sea level rise has obliterated or inundated the evidence, but there is some archaeological support for the idea in the Terminal Pleistocene lithic technologies of the Pacific Rim. Stemmed projectile points represent the earliest cultures along the west coast of the Americas and the Amazon lowlands and can also be found in Late Pleistocene assemblages from north-easternmost Asia (Erlandson and Braje, 2011; Gruhn and Bryan, 2011). The 16,000 year old Incipient Jomon on Sakhalin Island, Ushki VII from Kamchatka, Lind Coulee and Cooper's Ferry sites in Washington, and the earliest occupations of the Channel Islands off southern California all include small, thin contracting-stemmed and often barbed projectile points of remarkably similar form. The Channel Islands' Amol and Channel Island barbed (Erlandson et al., 2011), and the Lind Coulee style projectile points from Cooper's Ferry (Davis and Schweger, 2004) are remarkably similar to specimens from Ushki Lake (Dikov, 1996). These are associated on the Channel Islands with a subsistence emphasis on birds, fish and shellfish (Erlandson et al., 2011). The mere presence of people on the Channel Islands nearly 13,000 years ago demonstrates that at least some of the earliest Americans were producing seaworthy watercraft, substantially supporting the coastal migration hypothesis. People following big game across interior



## A General Focus

steppes are unlikely to have retained such know-how, nor are their descendants likely to have developed it within a mere 200 to 300 years after their arrival.

### The Solutrean hypothesis

Stanford and Bradley (2012) observe numerous close similarities between Clovis assemblages and the Solutrean assemblages of the Iberian Peninsula. The two are said to share multiple technological and artistic traits, including cylindrical bone projectile points with bevelled, sometimes zig-zag incised bases, eyed needles, incised stone tablets, spurred end scrapers, multi-pointed graters, a blade technology that emphasizes bladelets, indented-based trianguloid points, sometimes flaked only uniaxially (plane-faced points), use of exotic, aesthetically pleasing lithic material - including quartz crystal - often from hundreds of kilometres away, heat treatment to improve flaking of raw materials and *outré passé* thinning of large bifaces. *Outré passé* flaking thins stone by taking broad, thick flakes completely across a preform, removing a portion of the edge opposite the striking platform. The method enables production of very broad, thin finished implements and was used to produce both Clovis projectile points and Solutrean laurel-leaf bifaces. According to Stanford and Bradley, these are the only two cultures to have ever systematically applied this technique. The authors see the Solutrean people, who were partially coastal/maritime adapted, seasonally occupying pack ice, from which they exploited a rich diversity of birds, sea mammals and fish in a rich food web supported by a nitrate infusion from glacial ice. Living on the ice and moving by boat, they ultimately expanded across the North Atlantic to the east coast of North America. Stanford and Bradley see the Mid-Atlantic pre-Clovis manifestation (which I group under the Miller Complex here) as descendants of this Solutrean expansion. They point to the close similarity between the Solutrean and Miller Complex assemblages in bladelet technology, small, trianguloid, often indented-based projectile points and large, leaf-shaped bifaces, including Cinmar, that have been dredged from the submerged continental shelf, as firm evidence for their hypothesis.

The Solutrean Hypothesis was heavily criticized by Solutrean expert, Lawrence Strauss, (2000; Strauss et al., 2005) even before it was fully explicated. In his 2000 critique, Strauss points to the nearly 6000-year disparity between the youngest Solutrean and oldest Clovis discoveries as making a relationship between the two cultures impossible. Strauss et al. (2005) argue that Solutrean-like components of Clovis can be found across Eurasia in the Middle and Upper Palaeolithic, so a Siberian origin for Clovis technology is not ruled out. The age of the Miller Complex (see Pre-Clovis: Record: *Middle Atlantic Complex*) narrows the gap somewhat, but the hypothesis has gained few adherents.

Ancient DNA findings seem to further weaken the Solutrean Hypothesis. Both nuclear and mitochondrial DNA (mtDNA) of an 18 month-old infant from the Anzick Site indicate a primarily Asian, not European ancestry, although European Upper Palaeolithic progenitors are indicated to a minor degree (Rasmussen et al., 2014). The infant's remains were found along with a large cache of Clovis artefacts, leading Rasmussen et al. to conclude that Clovis could not be descendant from the Solutrean. However, the human skeleton consistently dates 400 years younger than two bone foreshafts from the Clovis cache leading Waters and Stafford (2007) to conclude the two are not associated. A second probably Clovis-age female skeleton from the Hoyo Negro site on the Yucatan Peninsula also has an Asian-derived mitochondrial genome (Chatters et al., 2014). Clovis is the earliest documented archaeological manifestation in Central America (Ranere, 2006), suggesting that the Hoyo Negro woman could have been Clovis. The Yucatan, however, has yet to produce a single late Pleistocene-age archaeological site, so the cultural affiliation of this individual remains a mystery. The genetic background of Clovis people cannot yet be definitively identified, nor the Solutrean Hypothesis entirely ruled out.

### Reconsidering the ice-free corridor

The question of whether or not an ice-free corridor predated the appearance of Clovis was long plagued by a lack of geochronological data from the vast and often-inaccessible region the corridor transected. With new information coming from as far north as the upper McKenzie River basin south to the US-Canadian border, however, the chronology of the corridor is finally becoming clear (Ives et al., 2103). The northern Cordilleran ice sheet was in retreat by 13,500 to 14,000 cal BP. The northern clade of Bison that gave rise to modern American *Bison bison*, had moved as far south as north-eastern British Columbia by 13,100 cal BP, indicating habitable steppe existed from the Yukon to north-eastern British Columbia/north-western Alberta by that time. The north-western Laurentide ice sheet had begun retreating by around 15,300 cal BP and by 13,700 bison grazed in the lower McKenzie Valley. The south-western Laurentide ice sheet had receded far enough by 13,200 cal BP that horse and bison were grazing east of Edmonton, Alberta. Collectively these findings indicate that steppe ecosystems supporting big game did indeed form a continuous band from eastern Beringia to the US border by a few centuries before Clovis.

Archaeological evidence does not, however, support a pre-Clovis southward expansion along that corridor. Survey of fluted projectile points shows such artefacts are common in the southern part of the corridor and extend northward to north-eastern most British Columbia (Ives et al., 2013). Some of these artefacts are classic Clovis, but as one progresses northward, they take on the multiple-fluted and more deeply concave bases of Alaskan fluted projectile points, which are known to postdate Clovis by several centuries (Smith et al., 2013). It appears that Clovis and their descendants migrated north through the corridor, not south.

## Megafaunal extinctions

Paul Martin's idea of a Clovis 'blitzkrieg' expansion causing extinction of most the Western Hemisphere's megafauna came under intense criticism early in the twenty-first century, with the most intense attack coming from Grayson and Meltzer (2002, 2003). These authors question the possibility that human hunting could have led to the extinction of 33 large mammalian genera within only a few thousand years of their arrival for two primary reasons: 1) the timing of extinctions did not (in their view) shortly follow the 13,000 cal BP arrival of Clovis hunters in the Americas, rather, extinctions occurred over several thousand years of the last deglaciation and 2) direct evidence existed for only two genera, *Mammuthus* (mammoth) and *Mammot* (mastodon), although there was indirect, but equivocal evidence for *Equus* (horse) and *Camelops* (giant camel). They assert that climatic change and its impact on the habitats of megafauna is the most likely explanation. Better radiocarbon dating of extinct North American species and new evidence of human-megafauna interactions, along with substantiated evidence for human presence in the Americas by nearly 2000 years before Clovis has proven both of these assertions wrong.

## Timing of immigration and extinction

Radiocarbon chronologies place the extinction of most of the now-missing North American mega-herbivores, and with them their mega-predators, between 15,000 and 12,000 cal BP, after humans had resided on the continent for up to 3,000 years (Waguespack 2013). Most North American megafauna were in decline by around 13,000 cal BP (Feidel, 2009; Guthrie, 2006) with most disappearing by 12,000 cal BP. Although some authors assert that the span of human-megafaunal coexistence is too long for a rapid anthropogenic event, others see it as evidence that sustained pressure on ecologically-weakened animal populations is more likely than Martin's blitzkrieg to have eliminated most large mammals (Waguespack, 2013). In fact, most extinctions appear to have occurred within the Clovis time period, a much more rapid event than the period of overlap would suggest (Barnosky et al., 2004; Haynes, 2009). Ecologists, palaeontologists and wildlife biologists see a human hand in the extinctions (Alroy, 2001; Barnosky et al., 2004; Brook and Browman, 2004), although the Younger Dryas climatic cooling episode, which also coincides with the events, probably played a major role in further reducing already vulnerable populations. Reversing the habitat changes that were already under way due to the rapid warming of the terminal Pleistocene, this event would have delivered a second blow to many species.

## Patterns of predation

The earliest human hunters in North America did not kill only mammoth and mastodon, as Grayson and Meltzer (2002, 2003) assert, but hunted many of the now-extinct megafauna. This is now evident in three discoveries made since the beginning of the twenty-first century: the Firelands *Megalonyx*, Ohio; Fin del Mundo, Sonora, Mexico; and the Wally's Beach Site, Alberta. The Firelands *Megalonyx*, discussed above (**Preclovis Record: Ice Margin Kill Sites**), provides proof that this species of ground sloth (*M. jeffersonii*), at least, was hunted by Palaeoamericans. At Fin del Mundo, remains of two butchered subadult lowland gompothers (*Cuvieronius* sp [probably *C. tropicus*]) have been found in association with Clovis projectile points (Sanchez et al., 2014), adding a third proboscidean genus to mammoth and mastodon in the list of Clovis prey. It is the Wally's Beach site, however, that has provided the greatest blow to those who believe humans did not play a major hand in the extinctions.

Wally's Beach is located in south-western most Alberta, in the drawdown zone of the St. Mary's irrigation reservoir. Since 1999 erosion of denuded eolian sand deposits has exposed megafauna trackways and concentrations of large mammal bone. Among the finds are the partial skeletons of Mexican horse (*Equus conversidens*) and giant camel (*Camelops hesternus*). Each of the horses has been found in association with lithic artefacts and dates a few centuries before the Clovis window. The single giant camel, which dates 11,440±25 rcy BP (13,255-13,313 cal BP), consists of two sets of articulated vertebrae, beside which lie three large flakes of a local quartzite, one of which was found directly between the articular processes of a cervical vertebra (Kooyman et al., 2012; Waters et al., 2015). Cut marks made by stone tools have been

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identified on the specimens. The ribs heads show clear evidence of having been chopped free of the bodies, which were removed from the area, demonstrating the animal was methodically butchered, leaving little behind at the kill location. Eight horses are represented in seven bone clusters scattered over an area more than 600 m long. Each is associated with from one to eight flakes or retouched tools, most of them also of local quartzite (Kooyman et al., 2006). At least one horse exhibits cut marks on its hyoid bone. This group dates between  $11,410 \pm 30$  and  $11,470 \pm 35$  rcy BP (13,215 to 11,360 cal BP) (Waters et al., 2015). Clovis projectile points have been found in the site, although none is directly associated with any of the megafauna. Thus, Wally's Beach provides evidence of human predation just before the Clovis era of two now-extinct mega-herbivores never before seen in a kill site.

The Wally's Beach horses and trackways are most informative about the process by which humans could have brought about the extinction of so many mega-herbivores. Kooyman et al. (2006) note that the species of horse found at the site, *Equus conversidens*, is taxonomically closest to a subgroup of horses that today maintain small, stable groups of mares defended by a single stallion. When threatened by pack predators, such horses form tightly bunched defensive clusters, which is no defence at all against human predators with long distance projectiles, such as the Clovis hunters possessed. From the broad distribution, and usually isolated occurrence of individual horses, it appears the hunters picked off their prey one-by-one, as needed. Modern camels and musk oxen behave in similar ways; whereas modern North American herbivores that have survived the Pleistocene do not (Gregory Green personal communication). Extinction was thus selective, which we would not expect if habitat deterioration were the primary cause of species losses. Trackways provide a second line of information. Tracks have been found of mammoth, camel, bison and caribou, all of which we know from this and many other sites to have been hunted by early Americans. Mammoth tracks show very few infants walking with older individuals, suggesting that recruitment was low. McNeil et al. (2005) see this as evidence that the mammoth population was under ecological stress, yet they also interpret the density of other tracks at the site as an indicator of a rich mammoth steppe ecosystem, not a shortage of food. Perhaps the young mammoths were being selectively taken by the Clovis hunters and this selective predation led to a rapid decline in mammoth numbers, as well as those of other of the largest herbivores.

An additional line of evidence suggesting humans of the Clovis era played a major role in the extinction process is the Clovis subsistence emphasis on large herbivores. Some authors assert that the earliest Americans were faunal generalists rather than megafauna specialists (for example, Cannon and Meltzer, 2004, 2008; Dixon, 1999). Their argument is threefold: 1) the record is biased toward big bones; 2) the presence of some small game in sites attests to a broader, more generalized subsistence base; and 3) theoretically (in their view) a generalist strategy would transfer more easily from one ecosystem to another than would one specializing in big game. The evidence does not support this point of view. Even accepting that all of the animals Cannon and Meltzer (2004, 2008) assert were eaten by Clovis people, including small rodents such as gophers, packrats and deer mice, were in fact eaten, there is a decided emphasis on large animals both in the frequency of occurrence and the number of identified specimens in each assemblage. Extinct species are found in 90 percent of the archaeological faunal assemblages from the period of human/megafaunal coexistence (Waguespack, 2013). Furthermore, when prey animals are grouped by size and tabulated by occurrence, it is evident that the largest animals – proboscideans – occur most commonly (Waguespack and Surovell, 2003; see also Haynes and Hutson, 2013). Species in the *Bison* size range – camelids, horses and bison – are second, and deer-size animals (among which they include ground sloths, which belong in the bison category) are third. Smaller animals are rarely found. This is opposite the pattern that would be expected if Clovis hunters simply took prey in the frequency in which they encountered them; animal populations are inversely proportional to animal size (Waguespack and Surovell, 2003).

Clovis hunters were also inefficient in their use of prey, particularly the largest kills (Haynes, 1982). Carcasses of proboscideans, like the Manis mastodon described above (**The Pre-Clovis Record: *Manis Mastodon***) are often only partially disarticulated. Longbones, including those found at Wally's Beach, were rarely broken for the marrow. People took only the meat they could consume immediately, making no effort to extract all available meat and fat (Haynes and Hutson, 2013). This strategy required new kills to be made frequently, adding to the stress on prey populations.



Figure 5. The cervical and thoracic vertebrae of a human-butchered giant camel (*Camelops hesternus*) from the Wally's Beach Site, Alberta. The letter A is just below and to the right of a quartzite core, which lays partially under a cut-marked cervical vertebra. Rib heads seen articulated with the thoracic vertebrae, to the right, were severed during butchering. This is the first example of a *Camelops* kill in North America. © B. Kooyman.

## Extinction was (in part) anthropogenic

People were present in North America when most of the late Pleistocene megafauna became extinct. New kill sites demonstrate that Clovis hunters preyed upon mammoth, mastodon, gomphothere, Mexican horse, giant camel and Jefferson's ground sloth: more than one-quarter of the North American mega-herbivores that became extinct at the end of the Pleistocene. Those hunters took, and may have focused on, animals that make defensive stands when threatened, which are many, if not most, of the species that are now extinct. They emphasized the largest prey for their subsistence and were wasteful in the use of their kills. The evidence is increasingly strong that humans, particularly Clovis hunters, played an important role in the extinction of many large herbivores.

## Clovis contemporaries

Whereas Clovis appears to be the technological underpinning in the prehistory of most of North America, the American West, comprised of the Great Basin, California, Colombia Plateau and Snake River Plain have a different history. In those regions, the Western Stemmed Tradition (WST) held sway from the terminal Pleistocene through the early Holocene. It is becoming increasingly evident that the WST was distinct from the Clovis Tradition in its technology and subsistence emphasis. Evidence has also come to light that the Clovis and WST shared North America during the terminal Pleistocene, both having evolved from the continent's earlier colonists.

## Technologies

Beck and Jones (2010, 2013 and elsewhere) describe the WST and Clovis technologies in detail. Clovis technology included a blade component over parts of its range, but the principal strategy was based on reduction of large bifacial cores by the *outré passé* technique. The ultimate product of biface reduction was the large, fluted lanceolate Clovis point (Figure 6 a), but the large thinning flakes produced by *outré passé* were used as blanks for other retouched tools, including end and side scrapers, graters, notches and occasional burins. Projectile points and other tools were thus made from the same materials, which often appear to have been selected for their beauty and frequently were transported over great distances. The technology was, overall, conservative of lithic raw material, an indicator of the high mobility lifestyle of Clovis hunters. WST followed separate trajectories and ordinarily used different materials for projectile points and other lithic tools, producing the two from different materials. Projectile points, rather than being reduced from bifacial cores, were made from side-struck flakes, usually of fine-grained volcanic material. Primary bifacial reduction followed a broad-collateral flaking method rather than *outré passé*. The waste flakes from this process were rarely used for tools. Other lithic implements were produced on flakes reduced from bifacial cores of chert or chalcedony. Blade technology is not indicated, despite occasional objects being identified in WST assemblages as 'blades.' The process thus lacked the conservatism of the Clovis system.

Toolkits differed as well. Clovis implements included the large, trianguloid, fluted Clovis projectile point (Figure 6 a), along with end and side scrapers, graters, notches and burins. Bone implements included cylindrical, bevelled bone projectile point and fine, eyed needles (Stanford and Bradley, 2012). WST assemblages contained similar tools, including the bone points and needles (for example, Daugherty, 1956; Greene et al., 1998), but the projectile points, rather than being thin, fluted specimens are often thick in cross-section and have elongated, tapering stems (Figure 6 b). Evidently, Clovis tool makers hafted their projectile points on split foreshafts whereas WST artisans socketed theirs. In addition to this difference, the WST includes the enigmatic 'crescent,' a bifacially flaked implement of unknown function found almost exclusively in the earliest dated WST contexts (for example, Daugherty, 1956; Erlandson et al., 2011).

## Subsistence emphases

Subsistence emphases of the two groups also differed. The content of faunal assemblages strongly indicates Clovis people systematically sought and killed mega-herbivores as their primary food supply (Haynes and Hutson, 2013; Waguespack and Surovell, 2003) (see **Megafaunal Extinctions: Patterns of Predation**, above). This does not appear to have been the case for WST foragers. There is certainly evidence that WST hunters did kill megafauna: proboscidian blood residue has been identified on a Haskett projectile point from Utah like that seen in Figure 5 (b) (Yost cited in Haynes and Hutson, 2013); the Lind Coulee (Daugherty, 1956) and Sentinel Gap (Galm and Gough 2008) sites in Washington contain primarily bones

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of butchered *Bison antiquus* (an extinct form)<sup>2</sup>. However, most evidence indicates a more generalized foraging pattern emphasizing marine, riverine and littoral resources. WST sites are typically found concentrated along the now-dry shores of pluvial lakes in the Great Basin (Grayson, 2011) and California (Moratto, 1984), along the Columbia River system on the Columbia Plateau (Chatters et al., 2012) and on islands off the California coast (Erlandson et al., 2011), suggesting the importance of fish and perhaps seaweed and marsh plants. In the earliest sites that contain faunal remains, birds, fish and shellfish play important roles. Birds often rank within the top four animal groups on the Columbia Plateau (Chatters et al., 2012); gulls, cormorants, eagles, condors and salmon dominate the faunal collection from WST levels of the Five-Mile Rapids site (Cressman et al., 1960). Geese, shellfish and nearshore marine fish comprise nearly all of the 12,000 year-old WST faunal assemblages from the Channel Islands, off southern California (Erlandson et al., 2011). Blood residues on some of the earliest stemmed projectile points in Paisley Caves indicate the use of fish and waterfowl (Jenkins et al. 2013), which, along with small mammals, are common in WST sites in the Great Basin (Grayson, 2011).

Further evidence for different subsistence emphases comes from the distribution of finds of Clovis-like fluted projectile points in the Great Basin. Although Clovis is absent from this region, a smaller, more deeply concave-based, fluted form known as Great Basin Fluted (GB Fluted) is not uncommon. GB fluted points often co-occur with WST assemblages along lakeshores. The two styles of projectile point are often determined by obsidian hydration analysis to be approximately the same age, but they are made from different materials, indicating distinct patterns of lithic resource use (Beck and Jones, 2013). At the Dietz site, Oregon, where GB Fluted and WST projectile points are found to be coeval, the fluted points are made from a smaller number of material types, from less far-flung sources than the Western Stemmed. This suggests that although WST and fluted point makers sometimes occupied the same lakeshores, they represented different ethnic groups. It is possible that these groups occupied distinct niches - the fluted point makers seeking megafauna, the WST people concentrating on smaller game and littoral resources.

### WST/Clovis chronology

Although some researchers continue to assert that Clovis predates the WST in the American West, multiple lines of evidence suggest otherwise. Classic Clovis projectile points are only found in the west across a span from Wyoming through the Snake River Plain and into Washington and Oregon (Miller et al., 2013). The one radiocarbon date purportedly associated with Clovis from that region is  $10,880 \pm 260$  rcy BP from the Heil Pond Site on the eastern Snake River Plain (Reid, 2011). Beck and Jones (2010, 2013) point to this age, at the young end of the Clovis window, and to the distribution and content of Clovis Caches as evidence that Clovis originated in the southern Plains or south-east (see also Stanford and Bradley, 2012), from which they moved onto the central and northern Great Plains and thence to the west across the Rocky Mountains and east along the margin of glacial ice. They also moved to the south, as far as Colombia (Ranere, 2006). Fluted point styles descended from but younger than Clovis are found in the Great Basin (GB Fluted), the newly deglaciated Northeast (Northeastern Fluted) (Miller et al., 2013) and through the ice-free corridor into northern Alaska (Alaskan Fluted) (Smith et al., 2013). As noted above, obsidian hydration dating indicates GB Fluted and WST projectile points tend to be the same age when they co-occur. However, the oldest dated GB Fluted finds are all younger than the oldest WST (Beck and Jones, 2013: Tables 16-1, 16-2).

Radiocarbon dates of greater than 10,800 rcy BP, the end of the Clovis window, have been reported for WST components in the Great Basin and Columbia Plateau since the 1970s (Beck and Jones, 2013: Table 16-2), but have not been taken seriously. In 2012, Jenkins and collaborators reported the *in situ* discovery of a western-stemmed projectile point encrusted by a thin silt stratum, sandwiched between radiocarbon dates of  $11,070 \pm 25$  and  $11,205 \pm 25$  rcy BP, placing the age of the projectile point at around 13,000 cal BP or near the early end of the Clovis window (Jenkins et al., 2013)<sup>3</sup>.

By 13,000 cal BP, near the beginning of the Younger Dryas climatic episode, North America was occupied by at least two distinct cultural traditions. Clovis big game hunters occupied Central America and from the Great Plains eastward, making forays into what is now the north-western US. WST occupied the west, following a more generalized, but aquatic-oriented way of life.

2 Despite Lyman's (2013) assertions to the contrary, WST faunal assemblages in the Columbia Plateau show an emphasis on large game, distinguishing that region from others occupied by the WST (Chatters et al., 2012).

3 One other site, Cooper's Ferry in northern Idaho has produced radiocarbon dates even earlier (c. 11,400 rcy BP, Davis and Schweger, 2004), but the presence in the same context of much younger dates leaves this finding open to question.



## The Palaeoamericans themselves

In the early 1990s, little was known about the physical characteristics or personal lives of the earliest Americans. Skeletons, when discovered, were described largely in isolation, with little attempt being made to analyse the early skeletons as a group (but see, for example, Steele and Powell, 1992). That has changed, in part because of the high profile controversy over the skeleton known as Kennewick Man (Chatters, 2001).

Remains of more than 50 individuals who died more than 9,000 years ago have been discovered in North America, most of them in the western United States and the Valley of Mexico. Only 30 of these individuals died more than 10,000 years ago and only six predate 12,000 cal BP (Chatters et al., 2014: Tables 1 and S1). Skeletons are often fragmentary; fewer than 30 have skulls and/or nearly complete skeletons and many were cremated. Most sets of remains have been found as individuals or in pairs, so we cannot generalize the characteristics of individual bands or regional populations. If the available skeletons are looked at as a group and taken as representative of the North Americans of their time, however, much can be said about their morphology and the nature of their lives.

### Distinction from modern Native Americans

Palaeoamericans, as this group is called, tend to show a high degree of variability in details of their morphology (Auerbach, 2012; Jantz and Owsley, 2001) and dentition (Powell, 2004), but no regional morphological or dental patterns have yet been described. Morphometric analyses, however, do demonstrate that these earliest people are distinct from those who succeeded them (Steele and Powell, 1999; Jantz and Owsley, 2001), with the change in morphology often being evident within a few centuries after 9000 cal BP (for example, Chatters 2001, 2010a). In comparison with those later peoples and modern Native Americans, they tend to have larger, longer, lower crania with markedly angled occipital bones, shorter, more projecting faces and lower, broader eye and nose apertures. This observation raised the question of whether the earliest Americans represent a different migration from the later people, perhaps even originating in a different region of the world (for example, Lahr, 1997). Ancient DNA from two of the most ancient individuals, however, appears to show that the earliest arrivals came to America via Beringia, as has long been believed. The Anzick skeleton, an infant dated approximately 12,600 cal BP<sup>4</sup>, produced a Native American nuclear genome and a mtDNA subhaplogroup of D4h3a (Rasmussen et al., 2014). A teenage female from Hoyo Negro in the Yucatan Peninsula, radiocarbon dating around 12,800 cal BP and therefore within the Clovis temporal window, exhibits mtDNA haplogroup D1 (Chatters et al., 2014). Both of these haplogroups are considered on the basis of modern genetics to be founding lineages that evolved in Beringia before people migrated southward into the Americas. The change in cranial morphology probably results from genetic drift and natural selection that occurred after the initial colonization south of glacial ice, either in remnant Beringian populations who migrated south in the Holocene, as appears to have occurred in north-western North America (Chatters, 2010a), through genetic drift (Powell, 2004) or through natural selection. Chatters (2014) suggests that the changes may result in part from selection for more docile males after expansion of the plant component of the diet gave females a greater role in the society, selection that resulted incidentally in morphological neoteny.

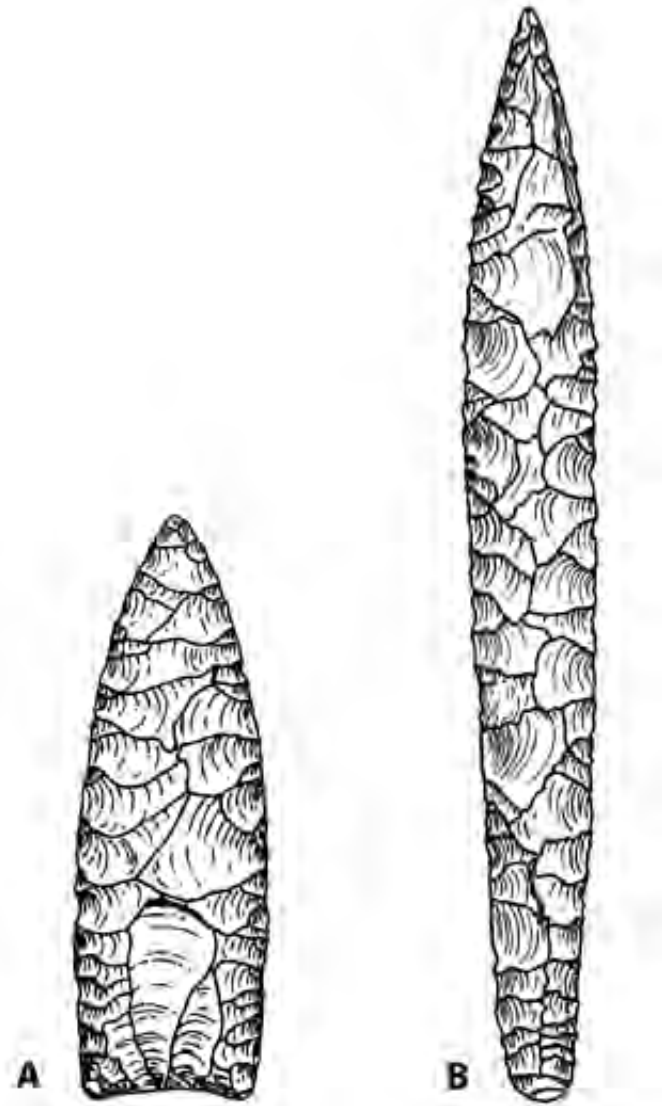


Figure 6. Drawings of Clovis (A) and Haskett (B) (a Western Stemmed Tradition style) projectile points, showing the distinct differences between these contemporary tool technologies. © Claire Chatters.

4 Rasmussen et al. (2014) claim this individual was a member of the Clovis population, but as noted elsewhere in this presentation, the child predates the associated Clovis Cache by about 400 years, so the claim cannot be substantiated.



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### Sexual differences

Skeletons exhibit marked differences between the sexes in stature, morphology and life span. Males tended to be muscular, wide-bodied (Auerbach, 2012) and robust, averaging around 168 cm tall. They would be considered stocky in build, although their limb proportions varied. Female body proportions have not been studied due to the lack of the needed skeletal elements, but they typically appear small and gracile, reaching only an average of 153 cm in height. The sexual dimorphism index this stature difference represents is 1.10 (Chatters, 2014), which is at the upper extreme for modern humans. Sexual dimorphism is strongly illustrated in the craniofacial morphology. Males, even some of the smallest, like the men from Spirit Cave, Nevada (Jantz and Owsley, 1997), and Horn Shelter, Texas (Young et al., 1987), tend to have very large, rugged skulls with prominent supraorbital (brow) ridges, nuchal lines and fronto-malar eminences. They appear hyper-masculine. Females are just the opposite, appearing hyper-feminine. (Figure 6) The difficulty in distinguishing male from female crania, which is often experienced in working with more recent Native American crania, is not a problem with the Palaeoamericans. This pattern is strongly expressed in skeletons from the Valley of Mexico. The >12,000 year-old Chamalhuacan male and other early males from that region are massively muscled; all sexual indicators score at maximum values, whereas the Penon Ill woman scores at or near the minimum (Jimenez Lopez et al., 2006). The same is true of the Hoyo Negro female, from the nearby Yucatan Peninsula (Chatters et al., 2014).

Male and female skeletons also show marked differences in longevity. Among 32 individuals for whom sex and age can be determined, females died at an average age of between 19 and 23 years, males at between 27 and 34 years (Chatters, 2014). To bring the contrast into clearer focus, 11 of 16 males lived beyond 30 years; only 2 of 16 females survived that long. Conditions of high mobility, indicated for both Clovis and WST populations, were particularly hard on females. If females led particularly short lives, they had little opportunity to reproduce and care for their children. Because of this, it is highly unlikely a population arriving through the ice-free corridor shortly after 13,500 cal BP could have fully occupied the hemisphere within less than 500 years (Chatters, 2010b). Humans must have been on this continent for many generations before first becoming archaeologically visible.

### Violent lives

Palaeoamerican men were prone to violence. In a recent analysis of skeletal trauma among the earliest human remains in North America, Chatters (2014) found that 58 percent of males and 18 percent of females had injuries that are consistent with interpersonal violence. Most of that violence was indicative of nonlethal fights between males, probably in competition for dominance or mating rights. Chatters concluded that the Palaeoamericans were representative of a common ancestral phenotype that was strongly selected for risk-taking and novelty-seeking behaviour because they often faced large, dangerous animals during the hunt and were constantly offered new lands to colonize. Biochemical determinants of those behaviours are also associated with aggression, which is exacerbated by high testosterone levels. In competition for scarce females, indicated by the mortality profile of women, the higher testosterone males would win out, supporting a high level of sexual dimorphism and perpetuating the tendency for violence. He suggests this pattern was selected against after human populations increased and became less mobile, making antisocial behaviour undesirable.

### Palaeoamericans

We have not yet seen a Pre-Clovis American, but it is likely that they closely resembled the people from the latest Pleistocene and earliest Holocene whose remains have been found. They had large, low skulls and short, forward-projecting faces with wide noses and wide-set eyes. The males were all stocky in build, markedly masculine in their features and much larger than their equally feminine females. High mobility took a major toll on the females, who tended to die very young. Males were prone to violence, perhaps because of strong natural selection, imposed by a colonizing and hunting way of life. In these respects, they closely resemble the earliest *Homo sapiens* throughout the northern Hemisphere and may be considered a Western Hemisphere manifestation of this ancestral form.

Discoveries in two new settings, the cenotes of the Yucatan Peninsula (Chatters et al., 2014; González et al., 2013) and the Museo Nacional de Antropología in Mexico City (for example, Jimenez Lopez et al., 2006) have the potential to add greatly to our understanding of physical characteristics, behaviour and health of the earliest people in the Americas. Their utility is, thus far, limited by the need for accurate dating, which should be a top priority for research. In both cases, numerous individuals are in question and preservation is excellent.



Figure 7. Examples of female (left) and male (right) Palaeoamerican crania, showing the strong sexual dimorphism. The female is from the Wilson-Leonard Site, the male is Burial 1 from Horn Shelter No. 2, both from Texas. Both are approximately 12,000 years in age.

## New horizons

Work is just getting well under way in two underwater realms that have the potential to add immeasurably to knowledge about how people first reached the Americas and what they were like. Those are the submerged North American continental shelves and the drowned cave systems of the Yucatan and Florida peninsulas.

With the ice-free corridor appearing less likely to have been an initial route of entry to North America, attention is turning to coastal routes. Chance finds of bifaces, like Cinmar, from the Atlantic Shelf (Stanford and Bradley, 2012) and lithic artefacts found by methodical dredging near Haida Qwail, off the west coast of Canada (Mackie et al., 2013) demonstrate the archaeological potential of these submerged landscapes. Researchers in both the Gulf of Mexico and along the Pacific coast have begun to use sonar and geophysical modelling to predict the probable location of ancient campsites (Hemmings and Adovasio, 2013; Mackie et al., 2013). Hemmings and Adovasio (2013) have identified a floodplain deposit along the now-submerged channel of the Aucilla River off western Florida and have begun underwater excavations, finding megafauna bone and a possible habitation site.

Whereas research on the continental shelves is finding possible occupation areas of known age, but so far little human evidence of human activity, cave divers in the Yucatan Peninsula have been finding, for more than a decade, human skeletons that were apparently deposited at times of lowered sea level, but archaeologists struggle to date them. Nine sets of human remains that lack the cranial deformation of the late prehistoric Maya have been reported (Gonzalez et al., 2013; Chatters et al., 2014), but thus far, it has been only possible to determine the age of one of these finds with confidence. The young female skeleton found at a depth of 42 m below modern sea level in Hoyo Negro (Figure 7) dates to nearly 13,000 cal BP, making her one of the earliest, if not the earliest, in the Western Hemisphere (Chatters et al., 2014). One or more of the other reported finds, such as Najaron or el Templo, might be as old or older. The human skeletons are being found in the same submerged tunnel systems as the bones of extinct megafauna. In Hoyo Negro alone, 11 species of large mammal have been found at or near the same depth as the human. These include gomphothere (*Cuvieronius tropicus*) two species of giant ground sloth and the sabertooth (*Smilodon fatalis*). None of these has yet been determined to be coeval with the human, but Gonzalez suggests a blackened camelid bone from a nearby cave demonstrates human predation of megafauna. Human action has yet to be established in that case, however. Nonetheless, it appears to be only a matter of time and careful scientific research before a relationship between megafauna and humans is demonstrated on the Yucatan Peninsula. Similar potentials exist in Florida's karst systems.

## Summary

Over the past 20 years, scientific understanding of the peopling of North America has undergone significant changes. The Clovis-first model, although still retaining its staunch adherents, has been weakened by the discovery of verified archaeological deposits older than 13,500 years. These have been found from the Paisley Caves in Oregon to the Delmarva Peninsula and outer continental shelf of Maryland. It now appears likely that the first people entered North America by 15,000 cal BP. Because no ice-free corridor existed this early on the northern Great Plains between the Cordilleran and Laurentide Ice sheets, it is likely people first entered along the Pacific Coast, not as big-game specialists but as coastal-maritime foragers. The big game specialization, represented by Clovis and its immediate descendants developed after people arrived, perhaps in the southern Great Plains or south-east. Clovis shared the continent with the Western Stemmed Tradition, which continued an aquatic-oriented subsistence strategy. Evidence is building that these early peoples - perhaps primarily the specialists - did indeed play a major role in bringing many of the continent's megafauna to extinction. Much remains to be learned, however. New research on the continental shelves and in submerged cave systems, as well as improved dating methods and efforts to apply those methods to both new and existing collections, will go a long way toward filling the knowledge gaps. The next twenty years promise to be at least as informative and exciting as the last.

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## Underwater Archaeology and Prehistory: the Case of the Cenotes in Mexico

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### Abstract

Much of the early prehistory of the Americas lies underwater along its coastlines and in the submerged caves and cenotes of Florida and Central America. A cenote (from Yucatan Maya *dzoont* 'well') is a deep natural pit, or sinkhole, resulting from the collapse of a doline or limestone bedrock that exposes groundwater underneath. Cenotes are a unique resource in a dry land, especially associated with the Yucatan Peninsula and some nearby Caribbean islands, and were sometimes used by the ancient Maya for sacrificial offerings. In times of lowered sea level and drier climate, as prevailed in the terminal Pleistocene, they were rare sources of freshwater for people and animals. Cenotes and the extensive cave systems to which they are linked have become the focus of palaeontological and palaeoanthropological studies by North American and Mexican Prehistorians, with the Vice-Directorate for Underwater Archaeology, National Institute of Anthropology and History (INAH) commanding several of these efforts. The search for early humans in the Yucatan Peninsula started more than a century ago when Henry Mercer arrived in search of early Americans; however, only in the last fifteen years have systematic efforts been undertaken. Efforts by archaeologists and cave-diving explorers have already resulted in the discovery of numerous assemblages of Pleistocene megafauna and pre-Maya humans. Finds near Tulum, Quintana Roo state, include some of the most complete early Americans skeletons, as well as a largely varied faunal complex including numerous examples of extinct megafauna. Some of the human skeletons are thought to be among the oldest in the hemisphere and they are so well preserved that now they are providing enough organic material for ancient DNA analysis and stable isotope studies. Associated concentrations of bat guano, wood, wood charcoal and calcite formations hold promise for advances in palaeoecology and sea-level history. Despite their great scientific value, these deposits are increasingly at risk from water pollution, salinization, tourism and urban development. As such dangers threaten inundated caves and cenotes all over the world, a major concern for UNESCO and other international and national agencies has been to set minimal standards for protecting this important heritage, which includes detailed recording at the sites and maintaining the materials *in situ* whenever possible.

### Introduction

Geographically, Mexico has an important role in regard to current discussion about the First Americans. It has been considered a large biogeographic corridor (Ríos-Muñoz, 2013) for the first human groups coming from north to south. Few data are available, however, regarding the interactions of these early peoples and large Pleistocene mammals in Mexico (for example, Arroyo-Cabrales et al., 2006; Johnson et al., 2006). Data equally are limited on the relationship, if any, between the extinction of those large mammals and early peoples in southern North America (Sanchez, 2001; González and Huddart, 2008).

The Prehistory of the Americas, the time when the earliest human presence is found on the continent and a hunter-gatherer society begins to develop, has been quite elusive, with several controversial sites all over the continent, from Canada to southern Argentina and Chile, showing possible anthropic evidence either as human skeletons, lithics, hearths or modified bone. In the last fifteen years, there has been a steady increase in studies referring to the early peopling of the Americas, mostly those in North America (for example, Bonnichsen and Turnmire, 1999; Jiménez López et al., 2006; Graf et al., 2013). Particularly in Mexico, interest in early peopling has existed for over a century (for instance, Reyes, 1881; Mercer, 1896); however, scientists have not yet been able to define when and where the earliest people came into Mexico (for example, Mirambell, 2012).

Since 2002, a symposium regarding the early peopling of the Americas has been held biannually, in which colleagues from all over the continent and further afield present their ongoing research on the matter. It was originally started in Mexico by scientists from the National Institute of Anthropology and History, the federal agency that is in charge of the care of archaeological heritage. The symposium has also been held in Argentina (2010) and Colombia (2012) and was held again in Mexico in 2014. Topics that have been dealt with include evolution, genetics, dating methods, migration, palaeoenvironments, megafauna, geology and the like (Jiménez López et al., 2011).

One of the ongoing areas of research for world and Mexican Prehistory is Underwater Archaeology. Currently Underwater Cultural Heritage comprises all the tracks left by human presence with some cultural, archaeological, historical or palaeontological characteristics, and which have been underwater, maritime, fluvial and lacustrine, periodically or continuously for at least the last one hundred years. In fact, there has been interest to protect this important cultural heritage for over one hundred years now, with several Caribbean islands creating special commissions to look after this resource (Leshikar-Denton and Luna Erreguerena, 2008). Much of the early prehistory of the Americas lies underwater along its coastlines and in the submerged caves and cenotes of Florida and Central America.

The geology of the Yucatan Peninsula has been extensively studied. It consists of a Cenozoic sedimentary marine sequence that decreases in age northward and is deposited on a stable basement of older Mesozoic sedimentary and Palaeozoic crystalline and sedimentary rock bodies. Limestone landforms occur only because of the calcareous nature of the platform. In the northern sector, an area of pitted flats is present that has numerous sink holes (cenotes) and no surface drainage (Ferrusquía-Villafranca, 1993).

The HEADS charter specifically mentions the importance of caves as storehouses of evidence for human biological, cultural and artistic evolution. Cave formations are unique in also containing, within small geographic footprints, islands of biological diversity, formations of minerals found in no other geologic contexts and settings of breathtaking natural beauty. The limestone karst systems of the Caribbean rim are no exception to this natural wealth. Long known to speleologists and cave divers for their geologic wonders and increasingly studied by biologists, these systems have recently begun producing a wealth of remarkably well-preserved late Pleistocene palaeontological resources, including some of the earliest human remains yet found in the Americas. Scientific research into these systems has only recently begun to reveal an unexpectedly diverse megafaunal community but also evidence of humans' adaptation to the tropical lowlands within but a few centuries of their first arrival from the Arctic. This presentation concentrates on the cave systems of the Yucatan Peninsula of Mexico and neighbouring Belize, but could equally apply to the limestone platforms of south Florida, Cuba and other Caribbean Islands.

## Geological context

The Yucatan is a nearly level-lying platform of late Cenozoic and Tertiary limestones formed from successions of coral reef systems. Over hundreds of millennia, limestone strata of variable strength have been subjected to sea level changes. During periods of high sea level, the platform is flooded with salt water overlain by a lens of fresh water. The brackish water at the contact between the two water bodies is slightly acidic and has dissolved tunnels into the less resistant strata (Smart et al., 2006). When the sea level drops, these tunnels form a drainage system so effective that the water table tracks sea level to within 2 m as far as 10 km inland. It is, in effect, a natural sponge, soaking up seawater during interglacial times, when sea levels are low and desiccating the land by its effective drainage during glacial times.

Interglacial dissolution has created massive cave networks throughout the peninsula, the closest of these lying within about 10 m to 15 m of the present land surface. Although many systems are dry, especially in higher-elevation portions of the peninsula, such as eastern Yucatan state, more than 90% are currently inundated and serve as conduits carrying fresh water to the sea in an area with no other form of surface drainage system. To date, more than 1,200 km of inundated caves have been mapped along the eastern coast of Quintana Roo state alone.

Cenotes (from Yucatan Maya *dzoonot* 'well') are deep natural pits, or sink holes, resulting from the collapse of a part of the ceiling of dissolution tunnels in doline or limestone bedrock, which expose groundwater underneath (Hubb, 1999). Cenotes are a unique resource in a dry land, particularly associated with the Yucatán Peninsula and some nearby Caribbean islands. They were a source of water to the ancient Maya, who used them for sacrificial offerings. In times of lowered sea level and drier climate, as prevailed in the terminal Pleistocene, they were rare sources of freshwater for people and animals.

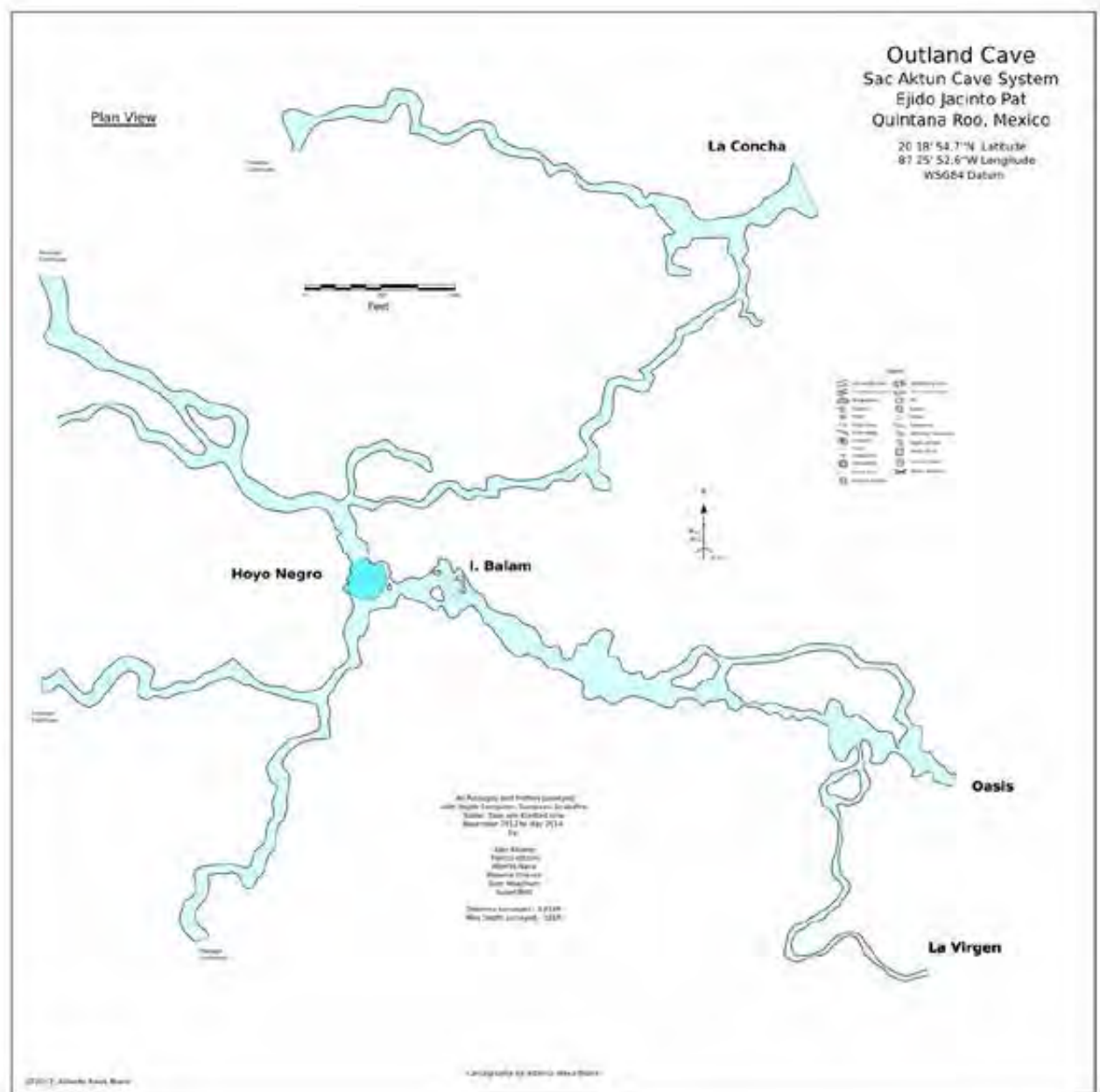


Figure 1. Map of Sac Outland System, Quintana Roo, Mexico, showing the location of Hoyo Negro. Drawn by Alberto Nava Blank.

## Investigations of the cenotes

Research on cenotes started in the late nineteenth century with the expeditions of Henry Mercer and colleagues (Mercer, 1896). They reported several extinct animals but not any human remains related to them. Later, Edward Thompson (1904-1909) recovered the first ancient human skeletons from the Sacred Cenote at Chichén-Itzá, which dated to the classic (800-1100 AD) and postclassic (1100-1550 AD) periods of Maya civilization. Much more recently in 1999, INAH initiated systematic research in several cenotes under the title *Atlas Arqueológico Subacuático para el registro, estudio y protección de los cenotes y cuevas inundadas y semi inundadas en la Península de Yucatán* (Underwater Archaeological Atlas for the recording, study and protection of cenotes and inundated and semi inundated caves in the Yucatan Peninsula).

Over the past two decades, cave divers, many associated with the Quintana Roo Speleological Survey ([www.caves.org/project/grss](http://www.caves.org/project/grss)) have reported finding bones of large animals and humans deep within the tunnel systems of the western Yucatan Peninsula. A team affiliated with the *Museo del Desierto*, Saltillo, has been actively recovering these finds (González and Huddart, 2008; González et al., 2013). Thus far, they have found eight human skeletons from cave systems near the city of Tulum. These skeletons, some of which were almost complete (>80%) and anatomically articulated, have been found at distances of between 12 m and 1,240 m from the nearest entrances and at depths between 8 m and 45 m below sea



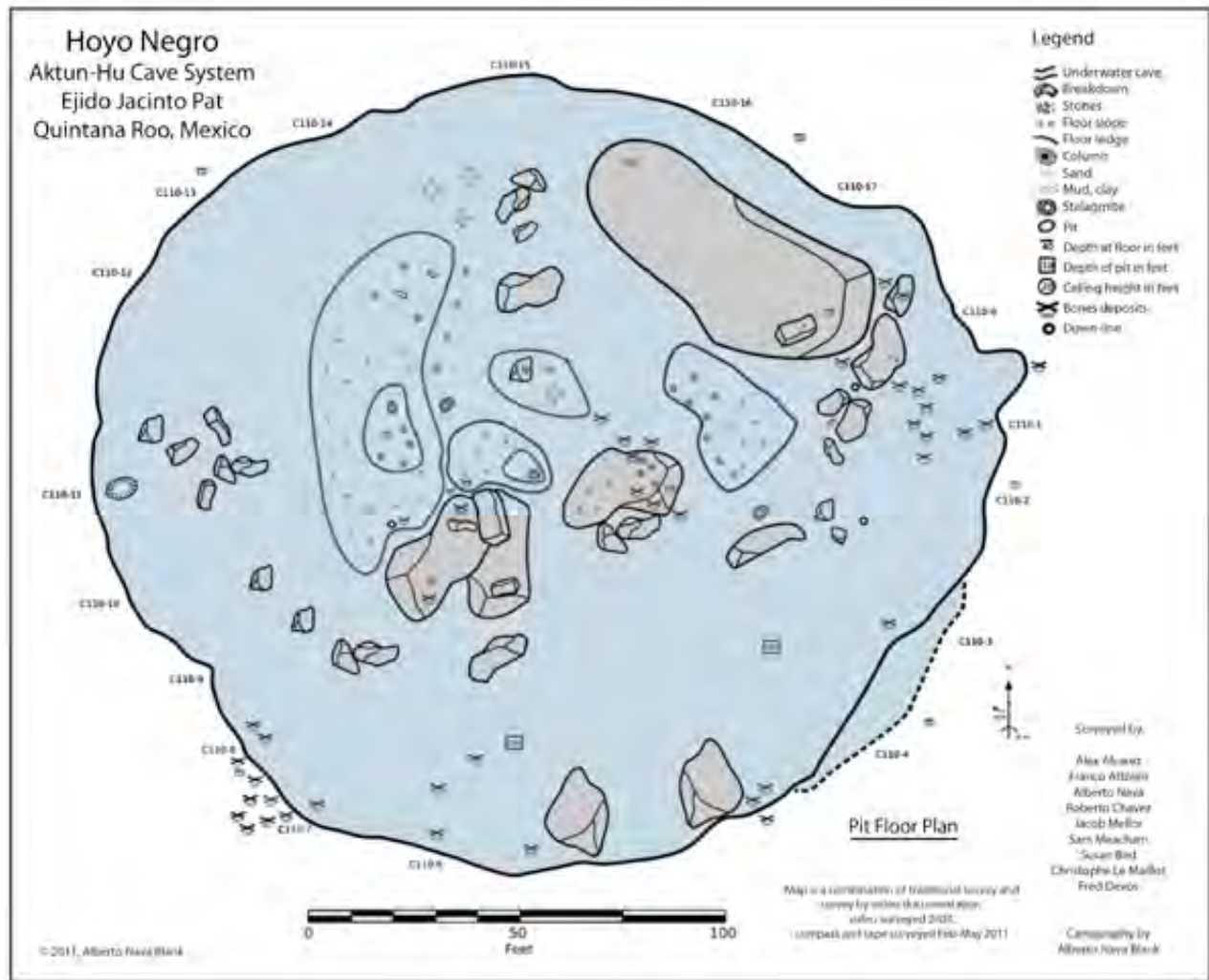


Figure 2. Map of the Hoyo Negro collapse chamber, Quintana Roo, Mexico, showing locations of paleontological finds. Drawn by Alberto Nava Blank.

level. Radiocarbon dating of these finds has been difficult. Radiocarbon dates from several laboratories on bone apatite and residual proteins has produced absolute ages between 8,591 and 13,721 cal BP (modified from González and Huddart, 2008). However, Taylor (2009) who conducted the analysis of the oldest individual from Naharon, indicated that the date was problematic and, at best, a preliminary estimate was awaiting further support, like human skeletal samples from this site with much better protein preservation. In general, the cranial morphology of the cenote individuals is considerably different from pre- and post-Hispanic Maya and more similar to that of Palaeoamericans found elsewhere in the Americas. Archaeological sites associated with this early occupation of the region have not yet been found, but Gonzalez and Huddart (2008) report llama bones (*Hemiauchenia macrocephala*) that had been burned and have possible anthropogenic cut marks, but further studies are needed. A concentration of charcoal found in a covered basin deep within a cave connected with Carwash Cenote, also near Tulum, has been reported as an anthropogenic hearth and dated to over 10,000 cal BP. This too warrants further study.

As for the faunal complex, scattered skeletons representing several extinct and extant species have been found. Extinct animals include the gomphotheres (Proboscidea, Gomphotheriidae, *Cuvieronius*), glyptodonts (Cingulata, Glyptodontidae, *Glyptotherium*), giant ground sloths (Megalonychid forms; Pilosa, Megatheriidae, Megalonychidae), llama (Artiodactyla, Camelidae, *Hemiauchenia*), horse (Perissodactyla, Equidae, *Equus*) and Tremarctine bears (Carnivora, Ursidae, Tremarctinae). Modern species, including animals such as the grey fox (Carnivora, Canidae, *Urocyon*) and tapirs (Perissodactyla, Tapiridae, *Tapirus*), also occur. Based on the faunal complex, there are elements with Neotropical (large 'Xenarthrans' and gomphotheres) and Nearctic (carnivores, lagomorphs) affinities and probably some endemic animals, like the ground sloths, which require further studies. Most of those animals are included within the North American Rancholabrean land mammal age, ranging in age between 120,000 and 10,500 years BP and more specifically, at the late Pleistocene.





Figure A. Hoyo Negro sinkhole. View to the north. © Roberto Chavez Arce / Grupo HN 2013.

## Hoyo Negro

One site stands out among these findings. Working in *La Virgen* Cenote, a part of the Sac Aktun cave system, divers of the Tulum Speleological Project discovered a massive underground collapse chamber more than 600 m from the opening (Figure 1; Attolini, 2010) and (Figure A). The immense, bell-shaped chamber, more than 30 m in depth and 60 m at its bottom, was named *Hoyo Negro* or Black Hole after the astronomic feature that swallows all light. It is worth mentioning that it is not a true cenote because the ceiling has not collapsed in. Bones of tapir and gomphothere occur in the tunnels leading to the *Hoyo Negro*, but skeletons are unusually concentrated on its floor and lower walls. Remains of at least 27 large mammals, including the near-complete skeleton of a human, are found along its deeper, southern half (Figure 2).

The human skeleton is the nearly complete remains of a teenage female, including an intact skull and full complement of teeth. Named as *Naia*, meaning water nymph in Greek mythology, this skeleton has Palaeoamerican craniofacial features and produced mitochondrial DNA of haplogroup D1, a lineage that formed in Beringia. Radiocarbon dating of tooth enamel and uranium-thorium dating of calcite formations developed on the bones after deposition placed Naia's age at between 13,000 and 12,000 calendar years ago. Thus, the differences between Palaeoamericans and Native Americans probably resulted from *in situ* evolution rather than separate ancestry (Chatters et al., 2014).

The animal skeletons found at the site include those of extinct and extant species. Extinct species include the highland gomphothere *Cuvieronius*, the Shasta ground sloth (Pilosa, Megatheriidae, *Nothrotheriops shastensis*) and a new species of Megalonychid ground sloth (Pilosa, Megalonychidae), sabertooth cats (Carnivora, Felidae, *Smilodon fatalis*) and tremarctine bears. Extant species are the puma (*Puma concolor*) (Figure C), bobcat (*Lynx rufus*), coyote (*Canis latrans*), tapir (*Tapirus bairdii*), collared peccary (*Tayassu pecari*) (Figure B), white-nosed coati (*Nasua narica*) and domestic dog (*Canis lupus familiaris*). Numerous skeletons of fish and bats, including the fruit-eating bat (*Artibeus*) are also found. The bobcat and coyote are not found in the region today, indicating significant habitat change between the time of deposition and today. The fauna includes animals with both Nearctic and Neotropical affinities, showing that the Yucatan Peninsula was an important region for the merging of northern (Carnivora) and southern (Pilosa) migrants. Dating has not yet been completed for all nonhuman fauna, but at least one gomphothere (whose pelvis can be seen in Figure 3) died between 19,000 and 40,000 years ago. The elevation of other specimens indicates deposition on the cave floor to more than 10,000 years ago. The close association of so many animals and a human is unique even for the caves of Quintana Roo; concentrations of charcoal and plant seeds, as well as plant microfossils and stable isotope records from cave sediment offer unequalled opportunities for understanding climate and habitat change during the end of the last global glaciation. Detailed research is underway by an INAH-led team and protection is critical for this important site. Efforts focus on using modern technology for documentation in order to leave the majority of the palaeontological finds *in situ*.



Figure 3. Associated human and gomphothere bones on the bottom of Hoyo Negro, Quintana Roo, Mexico. The human skull is a stand-in placed after unauthorized divers disturbed the actual skull. © Roberto Chávez Arce.

### Status of the cenote resources

Despite their great scientific value, the palaeoanthropological and palaeontological records in the Cenotes are increasingly at risk. The eastern Yucatan Peninsula, where most known deposits occur, is scheduled for massive urban development by the government of Mexico, as well as by national and foreign investors. Water pollution, salinization of aquifers and incorporation of the caves into resort developments are among the threats, but tourism poses even greater risks. Inadvertent damage by well-meaning but poorly trained divers and outright theft of priceless specimens has already begun to occur (Nowikowski, 2012). Those dangers threaten inundated caves and cenotes all over the world.

International organizations have begun to promote regulations for protecting the underwater cultural heritage. Two examples of this are the ICOMOS Charter on the Protection and Management of Underwater Cultural Heritage (1996) and the UNESCO Convention on the Protection of the Underwater Cultural Heritage (2001). A major concern for UNESCO and other international and national agencies has been to set minimal standards for protecting this important heritage. These minimal standards include detailed recording at the sites and maintaining the materials *in situ* whenever possible. Furthermore, academic organizations and NGOs have realised the importance of the study and conservation of underwater cultural heritage and are producing the required literature to guide these efforts in a concerted manner (for example, Leshikar-Denton and Luna Erreguerena, 2008).

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## Cuevas Prehistóricas de Yagul y Mitla en los Valles Centrales de Oaxaca, los cazadores-recolectores y el origen de la domesticación de una dieta mesoamericana

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El sitio Cuevas Prehistóricas de Yagul y Mitla en los Valles Centrales de Oaxaca es uno de los tres sitios que cuentan con la categoría de Sitio Patrimonio Cultural de la Humanidad, junto con la zona de monumentos arqueológicos de Monte Albán y del Centro Histórico de la Ciudad de Oaxaca. El hecho de que haya alcanzado esta importante categorización no es fortuito, dado que es un espacio de una gran importancia en el que se localizan los restos de plantas domesticadas más antiguas de América.

Durante la mayor parte de la década pasada, se llevaron a cabo las gestiones para otorgarle esta categoría al sitio, trabajo difícil y lleno de obstáculos, pero que finalmente rindió sus frutos el 1 de agosto del año 2010, con la declaratoria por parte de la UNESCO en su conferencia anual en Brasilia.

El trabajo realizado no pudo quedarse en esta etapa, dado a las características particulares del sitio, esto debido a que el manejo del mismo es tanto o más importante que el haber logrado su declaratoria. Para explicar cómo es que las estrategias orientadas a una gestión adecuada de este sitio se han llevado a cabo, comentaremos sus características particulares, así como las estrategias que se han generado para su adecuado control y protección.

La principal categoría en la que se ha clasificado a este importante espacio es el denominado “paisaje cultural”, comprendido no en un sentido estético, sino como una herramienta metodológica referente a una diversidad de valores que se traslapan en un espacio geográfico (Robles et al., 2009). Es decir, el espacio protegido es la conjunción de una serie de elementos culturales, naturales, tangibles e intangibles que se distribuyen a lo largo de una extensa área y que de manera conjunta otorgan de sentido al sitio.

Las Cuevas Prehistóricas de Yagul y Mitla incluyen un área de 5.300 ha en donde se incluyeron elementos culturales que exaltan los valores científicos, arqueológicos, naturales, estéticos, económicos, sociales e identitarios del área que comparten los municipios de Tlacolula de Matamoros, Villa de Díaz Ordaz y San Pablo Villa de Mitla, junto con la agencia municipal de Unión Zapata.

En el área con declaración patrimonial se conjugan distintos elementos de actividades humanas que son representativas del paso del hombre en el Valle de Tlacolula, siendo este Valle testigo de una actividad humana ininterrumpida por aproximadamente 10 mil años, además de haber sido el lugar donde se dieron importantes hitos en la historia de la humanidad; como la transición del nomadismo al sedentarismo con el desarrollo de las actividades agrícolas.

Este paisaje cultural está compuesto por:



Figura 1. Paraje Guilá Naquitz. Unión Zapata. Mitla. © INAH-Tania Escobar 2009.



Figura 2. Vista al norte desde el Conjunto Monumental de Yagul. Tlacolula. Oaxaca © INAH-Tania Escobar 2009.

**Una serie de cuevas y abrigos rocosos** con rastros de ocupación humana cuyo origen se remonta al periodo prehistórico, y en la que se han documentado evidencias del uso de gran cantidad de plantas útiles para la vida humana, así como proceso de domesticación de aquellas especies que constituyeron y aún constituyen el alimento básico de los pueblos mesoamericanos, tales como la calabaza, el frijol, el chile y el cultivo más importante: el maíz.

**El marco natural de selva baja caducifolia**, conservado de manera por demás afortunada, da origen a un paisaje estéticamente incomparable que guarda dentro de sí una larga lista de especies útiles, incluyendo especies endémicas, que hicieron posible la presencia humana en una interacción que refleja claramente el balance ecológico del área con la población humana como eje del aprovechamiento y la sustentabilidad regional desde épocas remotas.



Figura 3. Caballito Blanco Vista Sur. Tlacolula. Oaxaca. © INAH-Tania Escobar 2009.

**Los vestigios arqueológicos de ciudades monumentales**, siendo Yagul una de las ciudades posclásicas más importantes de México, sitio clave para comprender las dimensiones del desarrollo de las culturas mesoamericanas en las épocas cercanas a la conquista hispana.

Los estudios arqueológicos relacionados con el estudio de las Cuevas Prehistóricas de Yagul y Mitla tienen su antecedente más importante en el estudio de cuevas secas realizado por Richard MacNeish con respecto a la búsqueda de los orígenes de la agricultura realizados en Tamaulipas, Puebla y Chiapas (MacNeish, 1992). Estos trabajos lograron localizar importantes datos referentes a los primeros cultígenos, principalmente encontrados en la cueva de Coxcatlán en Puebla. Los restos arqueológicos de la cueva de Coxcatán comprendieron una larga secuencia de materiales botánicos muy bien preservada, con depósitos que se fecharon desde el 7000 a.C. hasta el momento del contacto europeo (MacNeish, 1964).

Las tierras altas sureñas de México constituyen un sistema complejo único, formado por varios subsistemas comprendidos en el lapso que va desde el 8000 a.C. al 200 a.C. Los estudios realizados por Flannery, Kirkby y Williams (1967), Mac Neish (1961-62-64), Callen (1965) y Smith (1965) sobre restos de huesos de animales y plantas, fueron realizados en el Valle de Oaxaca, el Valle de Tehuacán, Cueva Guilá Naquitz, Cueva Blanca, Abrigo Martínez, Cuevas de Coxcatlán, Purrón, Abejas, El Riego y San Marcos. Todos ellos indican que hubo plantas y animales de mayor importancia, de acuerdo al ecosistema, y que la tecnología y la destreza de los habitantes es lo que les permitió subsistir (Flannery, 1968).

Con base en los nuevos paradigmas de la evolución cultural que se refieren a la capacidad de adaptación humana, Kent Flannery buscó también cuevas secas en el Valle de Oaxaca. Una de estas fue la llamada Guilá Naquitz, ubicada en el Valle de Tlacolula; la secuencia precerámica que encontró fue más corta que en Coxcatlán, pero mucho más antigua, ya que halló elementos fechados en 10750 AP, hasta 8670 AP (Flannery, 1986). Las conclusiones que fueron encontradas a partir de las excavaciones de este sitio consistieron en obtener un patrón de recolección y domesticación temprana de distintas plantas, entre

las que se encuentran la calabaza, el maíz, el guaje y los chiles, aunque también se encontraron otro tipo de plantas no domesticadas como el piñón, la cebolla silvestre, maguey, guaje, frijoles, nanche, nopales y moras; sugiriendo que los habitantes de este lugar estaban involucrados en prácticas protoagrícolas tanto con plantas estacionales como con las que posteriormente serían domesticadas, mostrando un proceso de coevolución que posteriormente fomentaría una interdependencia entre estas especies y el hombre (Pearsall, 1995).



Figura 4. Cueva de la Paloma. Unión Zapata. Mitla. © INAH-Aciel Sánchez 2001.

Para Flannery, los recolectores precerámicos se nos presentan como individuos hábiles para obtener de la naturaleza sus mejores recursos. Los observa como grupos competitivos con un ordenamiento social interno y con gran preocupación por el estatus, acumulación de bienes de lujo, control del agua, etcétera. Uno de los modelos propuestos era el de la cultura adaptada a una zona especial: bosque de roble, pradera de mezquita, chaparral de espinos, bosque tropical, etcétera. El autor sugiere la difícil adaptabilidad de ambientación a todas las zonas ya que, a su juicio, la adaptación básica no se da en microambientes (Flannery, 1986).

Otro modelo indica que el cambio cultural que se da en el paso de la recolección a la agricultura sedentaria se debe pensar como un experimento que estos pobladores comenzaron a hacer con las plantas, pues durante la recolección esos productos no formaban parte de su dieta alimenticia. Así, el cambio de la recolección a la agricultura sedentaria (5000 a.C.-1500 a.C.), se sugiere entonces como un cambio gradual, determinado por la estacionalidad y la programación. Dicho cambio es resultado de la expansión y contracción de los sistemas ya existentes (Flannery, 1968).

Dentro del análisis de las cuevas prehistóricas, se identifica una serie de atributos que permiten observar diversos comportamientos humanos basados en estaciones, suponiendo que cada piso de ocupación en una cueva dada representa los desechos de un solo campamento, usualmente datando una sola estación. Así, las combinaciones de restos de plantas y animales observados en un nivel dado se han interpretado de la siguiente manera, para el contexto arqueológico obtenido (Flannery, 1986):

**Campamentos de estación seca** (de octubre a marzo). Dependiendo de la elevación sobre el nivel del mar, puede haber grandes depósitos de plantas y animales otoñales e invernales silvestres, pero en general falta la variedad vista en los niveles de la estación lluviosa y quizás más significativamente tienen un alto porcentaje de aquellas plantas que –aunque no particularmente gustosas– están disponibles todo el año: tuna, maguey, raíz de Ceiba y otras más. Estas son las llamadas “plantas del hambre”, que se consumen justo en la estación seca, cuando se dispone de pocas cosas más. Estos mismos niveles también tienden a tener altos porcentajes de hueso de ciervo.

**Campamentos de estación lluviosa** (de mayo a septiembre). Hay gran cantidad de plantas disponibles en esa época del año: mezquite, magueyes, amaranto, aguacate salvaje, zapotes y otros más. También son ricos en fauna pequeña como conejo de rabo de algodón, zarigüeya, mapache topo e iguana negra. El ciervo representa sólo un pequeño porcentaje del mínimo de animales en los escombros. Lo que estas generalizaciones sugieren, en su mayoría, es la preferencia a la estacionalidad de las plantas recolectadas, y cuando surgieron situaciones de conflicto, fue cercenada la explotación animal.

En total, fueron registradas en ese momento alrededor de 60 cuevas y abrigos rocosos, caracterizando a su estudio como la descripción cultural de bandas nómadas de cazadores-recolectores, que ocupaban campamentos estacionales y refugios temporales en las cuevas, mismas que constituyen el depósito arqueológico del área.

El análisis de los tres más antiguos fragmentos de la inflorescencia de *Zea mays* de Guilá Naquitz, Oaxaca, México, demuestra que no se desarticulan de manera natural, lo que indica que la selección agrícola de teocintle domesticado estaba en marcha ya 5.400 años 14C antes del presente (alrededor de 4.200 años a.C. dendrocalibrados). La co-ocurrencia de dos ejemplares clasificados con dos filas y cuatro filas de granos y numerosas características morfológicas adicionales de estos ejemplares apoyan la hipótesis basada en el análisis de genética molecular y cuantitativa de que el maíz evolucionó a partir del teocintle. La domesticación del ancestro silvestre del maíz se produjo antes de finalizar el quinto milenio antes de Cristo (Benz, 2001).



La más antigua evidencia macrobotánica de las fases iniciales de la evolución del maíz proviene de dos lugares arqueológicos de Mesoamérica, los valles de Tehuacán y Oaxaca. Estas dos localidades han producido las primeras evidencias del cultivo de maíz por cazadores-recolectores precerámicos. Un amplio debate acerca de estos especímenes gira en torno a su relativa antigüedad y un análisis e interpretación detallada de su morfología. La comparación morfológica de las muestras de Oaxaca y Tehuacán, junto con la fecha exacta de las muestras de Guilá Naquitz, indica que los esfuerzos para domesticar el teocintle tuvieron éxito por lo menos 700 años antes de que las primeras mazorcas de maíz se incorporen a la basura precerámica de la cueva de San Marcos del Valle de Tehuacán (Benz, 2001).

Muestras arqueológicas de las inflorescencias del Zea domesticado (mazorcas) de Guilá Naquitz (C9 y D10) fueron objeto de la espectrometría de acelerador de masas (AMS) de datación por radiocarbono. Dos de los tres ejemplares fueron fechados por AMS en  $5420 \pm 60$  (C9) y  $5410 \pm 40$  (D10) 14C años AP (6235 años calibrados AP). Las pruebas de la contemporaneidad indican que las dos fechas pueden ser promediadas ( $5412 \pm 33$  años AP), ya que sus edades no son significativamente diferentes ( $t = 0,14$ , no significativo). Las fechas de AMS en las mazorcas Guilá Naquitz indican que son alrededor de 730 años más antiguas que los ejemplares más antiguos de maíz reportados en el Valle de Tehuacán (Benz, 2001).

Los dos ejemplares de C9 se produjeron de la misma procedencia y presunta unidad de sedimentación, y se informó que son fragmentos de una inflorescencia. Los intentos de volver a colocar las dos muestras no tuvieron éxito. La comparación estadística con el conjunto de maíz de Tehuacán se ha realizado como si las dos muestras de C9 fueran de diferentes inflorescencias. Las características morfológicas de las mazorcas de Guilá Naquitz apoyan la evidencia de una acumulación genética que demuestra la hipótesis de la relación ancestro-descendiente para el teocinte y el maíz, y además documenta algunas de las diferencias genéticas que distinguen a las inflorescencias de los Zea silvestres y domésticos (Benz, 2001).

Una comparación de las características morfológicas de tres mazorcas de Guilá Naquitz con los tres primeros ejemplares de la Cueva de San Marcos (4.750 años AP2, 14C3) indica que las dos poblaciones no son distinguibles desde el punto de vista estadístico. Por lo tanto, desde 5.400 años AP (14C) y por los siguientes 700 años, la selección humana parece haberse centrado en la estabilización de las dísticas, no desarticulando a un fenotipo de grano desnudo e incrementando el número de espigas de granos de uno a dos por nodo. La similitud morfológica de los ejemplares de Guilá Naquitz y las primeras muestras de Tehuacán sugieren que la intencionalidad humana trató de mantener o aumentar la productividad de este cultivo de cereales. Esta evidencia no rechaza la posibilidad de que el uso humano de teocintle se haya centrado en algo diferente al grano, pero sí sugiere que en el sexto milenio antes de nuestra era, los humanos enfocaron sus actividades de subsistencia en mantener fácilmente cosechables las inflorescencias productoras de granos. Estos fragmentos de algunas inflorescencias también sugieren que la propagación de teocintle domesticado durante este periodo estuvo basado en la subsistencia humana y el sistema de asentamiento, con un grado de permanencia que le permitió desarrollar dependencia de las prácticas del manejo humano de la tierra a lo largo de la temporada de cultivo y de cosecha (Benz, 2001).

La fecha de ca 4.700 años AP (14C) para las más antiguas mazorcas de maíz del Valle de Tehuacán, junto con las fechas de Guilá Naquitz del teocintle domesticado, sugieren que las primeras evidencia de la manipulación humana del teocintle espera su descubrimiento en yacimientos arqueológicos de Mesoamérica (Benz, 2001).

En los estudios llevados a cabo por Dolores Piperno (2001), la determinación de la antigüedad por parte del acelerador de espectrometría de masas de mazorcas de maíz (*Zea mays* L.) de Guilá Naquitz en Oaxaca, México, produjeron fechas de 5.400 años de 14C AP, por lo que esas mazorcas son de las más antiguas de América. Los microfósiles y fitolitos localizados de frutas silvestres y domesticadas están ausentes en estratos más antiguos del lugar, aunque el polen ha sido previamente identificado a partir de esos niveles, así se sugieren que las prácticas culturales que llevaron a la domesticación se produjo probablemente en otras partes de México, concluyendo que Guilá Naquitz ahora ha dado la evidencia más temprana de microfósiles para la domesticación de dos importantes plantas de cultivo de América, la calabaza (*Cucurbita pepo*) y el maíz (Piperno y Flannery, 2001).

Entre los arqueólogos, se han producido dos modelos explicativos para la diversificación del maíz. De acuerdo con uno, ya que el más antiguo fechado de maíz fósil proviene de las tierras altas de México, la temprana diversificación del maíz producido en las tierras altas se extiende a las tierras bajas en una fecha posterior. El segundo modelo interpreta fitolitos de maíz de las tierras bajas como el maíz más antiguo, y por lo tanto pone la temprana diversificación del maíz en las tierras bajas. Los datos científicos sugieren que el maíz se diversificó en las tierras altas antes de extenderse a las tierras bajas (Matzuoaka et. al, 2002).

Además de la domesticación del maíz, las filogenias revelan la diversificación geográfica de las variedades criollas de maíz. Los tipos de maíz basales en ambas filogenias son los de las tierras altas de México. Este resultado coloca a la temprana diversificación del maíz en las tierras altas, entre los estados de Oaxaca y Jalisco. En este sentido, llama la atención que el maíz arqueológico más antiguo conocido es el de Oaxaca, y notablemente el maíz basal donde se presenta una correspondencia entre la evidencia genética y arqueológica (Matzuoaka et. al, 2002).

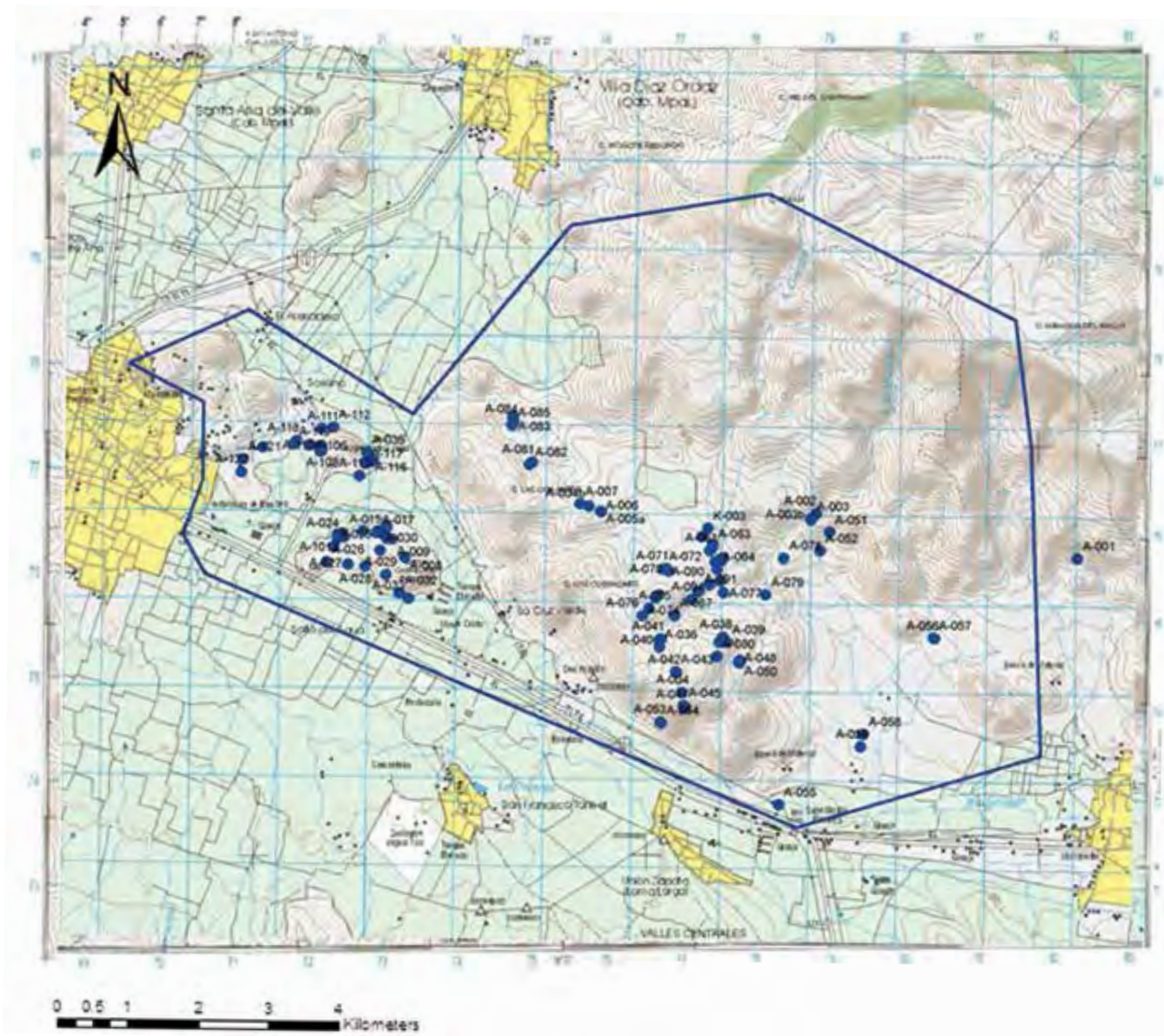


Figura 5. Mapa de registro de abrigos, artefactos, cuevas y fauna. © INAH- Robles, Ríos et al., 2012

Las excavaciones en Guilá Naquitz y la Cueva de Silvia, también arrojaron 122 restos de chiles que datan del periodo entre 600 a.C. y 1521 d.C. Los chiles pueden ser asignados a por lo menos 10 tipos, todos ellos pertenecientes a la especie *Capsicum annum* o *Capsicum frutescens*. Las muestras permiten una evaluación de los criterios utilizados para chiles silvestres y para distinguir entre razas cultivadas. Además, ofrecen la oportunidad de evaluar la fiabilidad de los granos de almidón para documentar la presencia de chiles en sitios arqueológicos, donde hay restos macrobotánicos (Perry, 2007).

Algunos pedúnculos de chile que fueron recuperados han añadido una nueva dimensión a nuestra comprensión de la agricultura, de la subsistencia y de la gastronomía en ambos sitios, y muchas interpretaciones previamente establecidas sobre el uso de la cueva han sido confirmadas. Además, los datos permitieron reexaminar los criterios utilizados en el pasado para documentar la domesticación de los pimientos picantes. La mayoría de los chiles se recuperaron de la capa denominada A, una gruesa capa de cenizas, restos orgánicos, y cerámica Monte Albán IIIb-IV, que produjo fechas 14C no calibradas de 620 ± 130 AD (Perry, 2007).

En los años de 1970 a 1980, la Universidad de Michigan efectuó una investigación basada en recorridos de superficie en los Valles Centrales de Oaxaca. Los resultados obtenidos (Kowalewski, 1989) permitieron obtener un conocimiento amplio de la ecología cultural de la región, dando con esto un giro a la investigación y abriendo un rico campo de acción para equipos multidisciplinarios. Hacia mayo de 1996, el Centro INAH-Oaxaca y la Dirección de Registro Público de Monumentos y Zonas Arqueológicas (DRPMZA), efectuaron trabajos de campo para delimitar la poligonal envolvente que protegerá la superficie de Yagul; estas actividades comprendieron los reconocimientos de superficie en el perímetro alrededor de la zona arqueológica y levantamiento topográfico correspondiente.



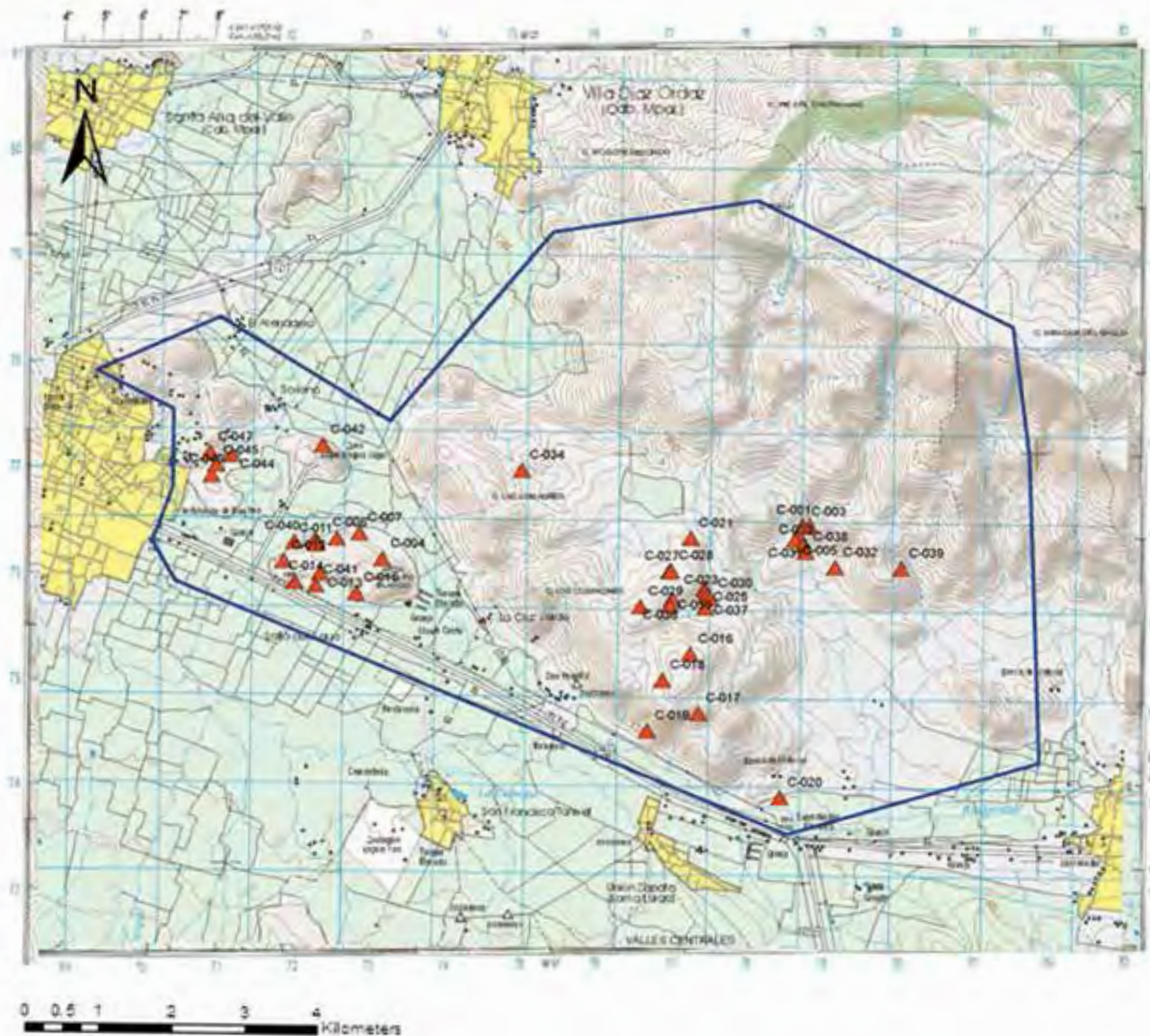


Figura 6. Mapa de registro de abrigos, artefactos, cuevas y fauna. © INAH- Robles, Ríos et al., 2012

Con estos datos, se comenzó la catalogación de las cuevas y abrigos rocosos en el área, trabajo que años más tarde serviría para conformar el Proyecto de Investigación y Conservación de las Cuevas Prehistóricas del Valle de Tlacolula. Específicamente, este proyecto surgió a raíz del Salvamento Arqueológico Carretera Oaxaca-Mitla, diseñado por el Arqu. Samuel Mata y el Dr. Marcus Winter, adscritos al Centro INAH Oaxaca en el año 2000, el cual pretendía trazar el tramo Díaz Ordaz-Mitla de la autopista Oaxaca-Istmo por el área de cuevas prehistóricas investigadas en los años 60, en el Proyecto Prehistoria y Ecología Humana en el Valle de Oaxaca, de Flannery. Esto provocó la reacción de algunos investigadores, quienes consideraron que dicho proyecto carretero no era viable dada la importancia arqueológica del área que sería destruida. De tal forma que en el año 2001, se realizaron recorridos de superficie que documentaron la existencia de sitios arqueológicos no documentados durante el proyecto de Flannery, así como la propuesta de una primera delimitación (Robles et al., 2001).

Dadas estas circunstancias, fue presentado ese mismo año el PICCPVT ante al Consejo de Arqueología del INAH, el cual, durante el año 2006, llevó a cabo su primera temporada de campo a cargo del arqueólogo Rosalío Félix Ruiz, adscrito al CAVO, y con el apoyo de los arqueólogos Miguel Ángel Cruz G. y José Ángel Ruiz Cabañas. Así, ampliando el área de estudio y subdividiéndola en distintos parajes, se documentaron 56 nuevos elementos arqueológicos distribuidos en tres parajes principalmente: Caballito Blanco, Cueva Blanca y Los Compadres. En el año 2005 fue presentado el Proyecto Integral para la Conservación de los Recursos Naturales y Culturales en el Ámbito Regional Yagul-Mitla (PICRCNARYM), el cual se enfocó principalmente en dos frentes: por un lado la restauración de las estructuras arquitectónicas del área monumental de la zona arqueológica de Yagul, a cargo del arqueólogo Jorge L. Ríos Allier, y, por otro, la continuación del registro de cuevas y abrigos comenzada durante el PICCPVT, esta vez a cargo del arqueólogo Antonio Martínez Tuñón y con el apoyo del Arq. Luis García Lalo, quienes continuaron con el registro de sitios y llevaron a cabo la primera excavación en el sitio CAVO-A54, cuyos restos



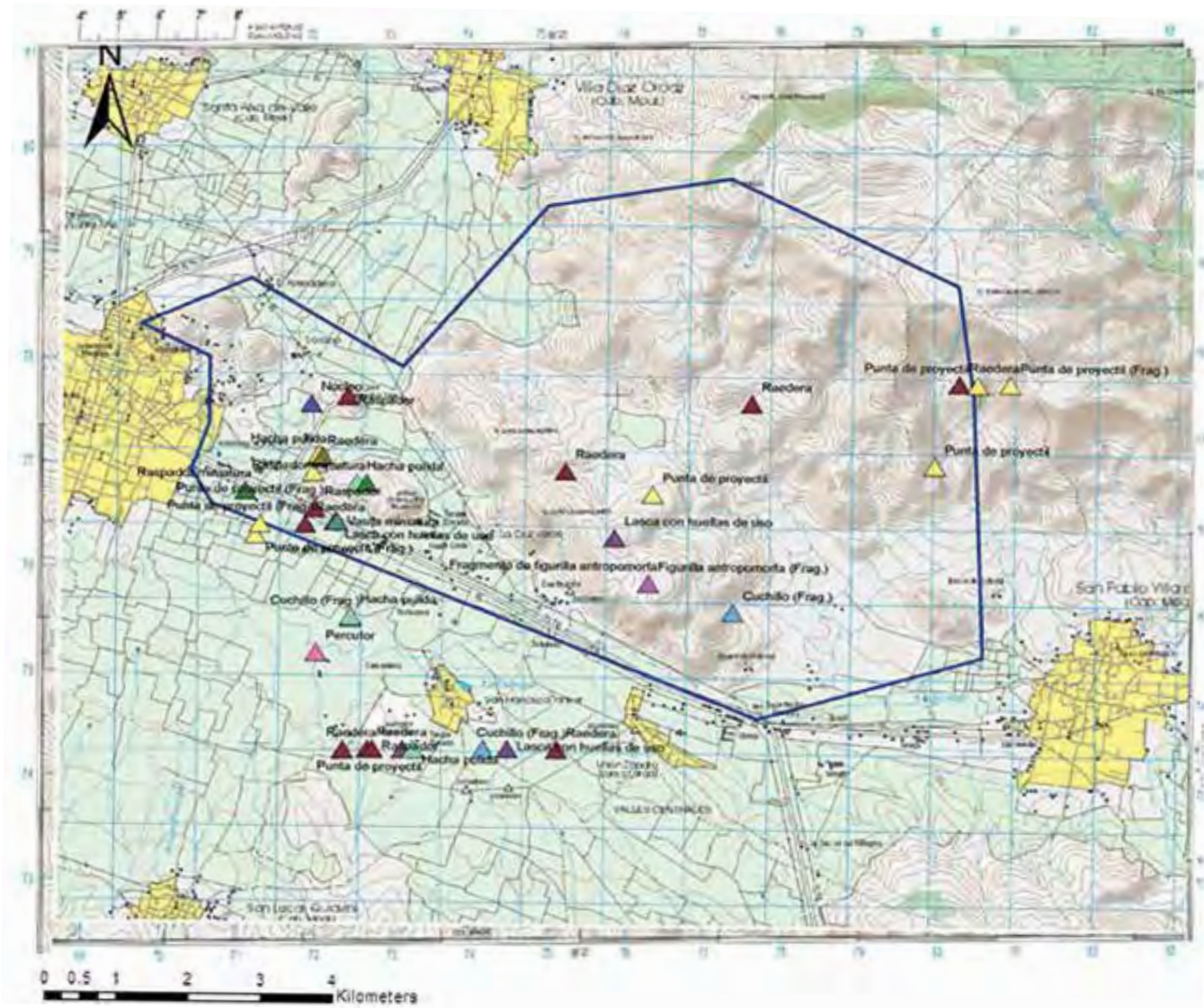


Figura 7. Mapa de registro de abrigos, artefactos, cuevas y fauna. © INAH- Robles, Ríos et al., 2012

orgánicos están siendo analizados por la Dra. Noreen Tuross, adscrita al Laboratorio de Bioquímica de la Universidad de Harvard, E.U.A, siendo éste un aspecto fundamental para la defensa legal de los sitios arqueológicos (Robles et al., 2009).

La Declaratoria como Patrimonio Mundial de las Cuevas Prehistóricas de Yagul y Mitla (2010) es el punto de partida para el reconocimiento del tema de la domesticación temprana de plantas y el inicio de la agricultura incipiente hacia lo que después se convirtió en una dieta mesoamericana integral, reflejando con ello la continuidad de este paisaje cultural en lo particular.

Desde su aprobación, el Plan de Manejo de este bien patrimonial ha proporcionado herramientas metodológicas, enfocándose los esfuerzos en el área de investigación, específicamente en el registro de elementos naturales y culturales con el objetivo de complementar a mediano plazo un inventario regional, así como en la gestión con las comunidades y la interacción de las misma en todos los procesos de conservación.

Los elementos que se tienen ahora registrados dentro de este paisaje cultural nos muestran una capacidad adaptativa humana comparable a otras latitudes del mundo donde se ha llevado a cabo la domesticación de otros cereales y que ha derivado en grandes culturas. Los estudios recientes nos permiten mencionar nuevos contextos y adicionar información a los que continúan integrando conocimiento.

En un primer estudio realizado por Enrique Martínez y Ojeda, en 1996-97, sobre el entorno natural actual del bien, se clasifica en la categoría de selva baja caducifolia o bosque tropical caducifolio, lo que implica que la mayor parte de las especies vegetales pierden las hojas en el periodo de sequía y en la época de lluvias presentan gran exuberancia. Este tipo de vegetación presenta una compleja estratificación arbórea vertical con tres o cuatro estratos identificados: herbáceo de 1 m de altura en la parte baja, intercalado con cactáceas bajas esferoidales como: chilillos o cardos y abrojos de tallo cilíndrico; continúa el arbustivo de 6 m de altura, con una cantidad importante de espinos, dentro de éstas se



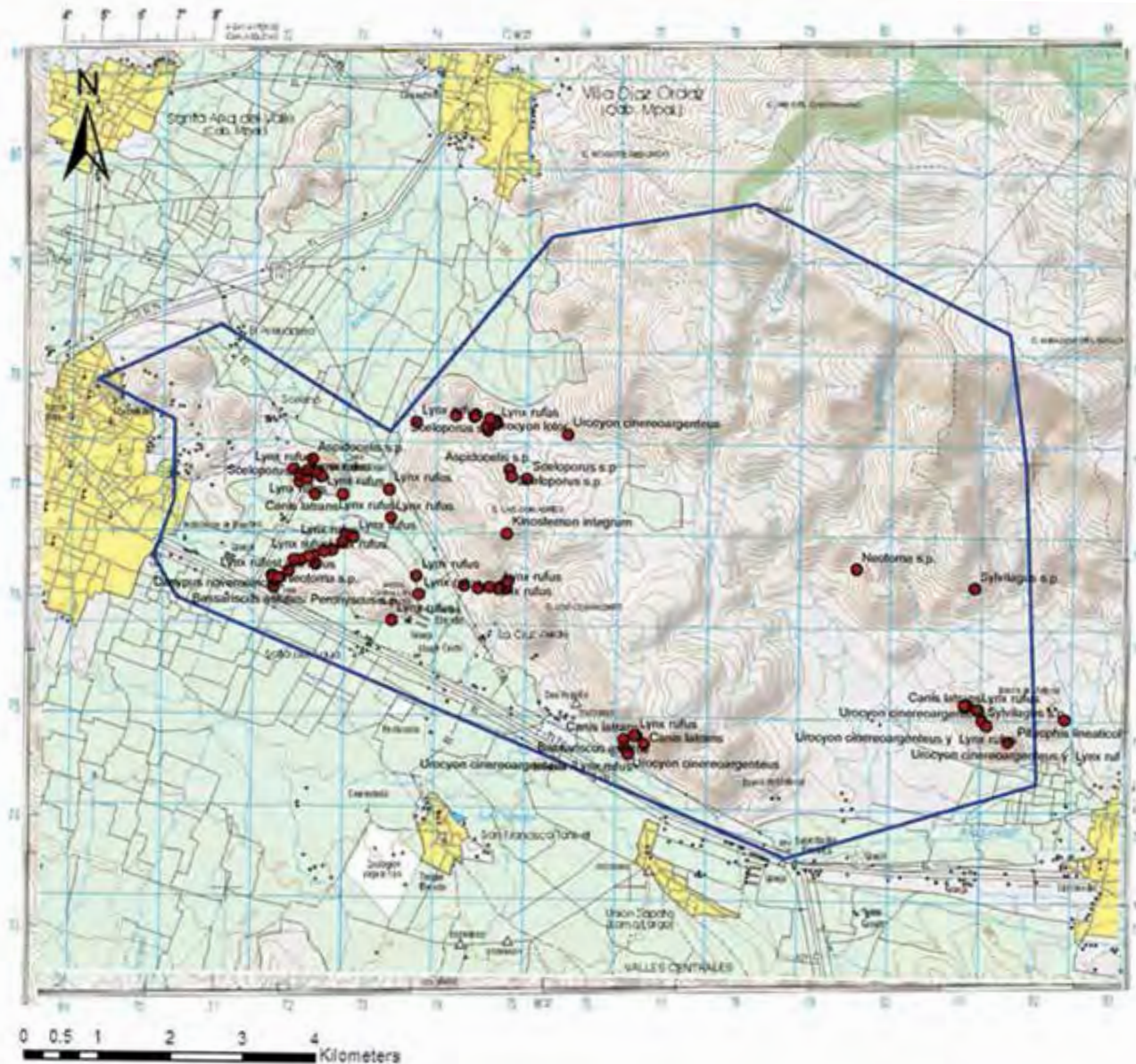


Figura 8. Mapa de registro de abrigos, artefactos, cuevas y fauna. © INAH- Robles, Ríos et al., 2012

encuentran las llamadas epifitas (son aquellas plantas que viven sobre plantas) como bromelias y helechos; trepadoras herbáceas y parásitas (plantas que viven sobre otras plantas extrayendo nutrientes). Actualmente, se siguen llevando estudios para la catalogación de especies de plantas endémicas y el estudio de capacidad de carga física (Ríos et al., 2013).

En cuanto a la fauna como elemento natural, se puede decir que “todos los animales localizados en los Valles Centrales de Oaxaca” se ubican dentro de lo que Udvary (1984) reconoce como provincia Madrean Cordilleran, del Reino Neártico. Actualmente estos animales se encuentran refugiados en los manchones de vegetación que aún quedan en los cerros situados dentro (como en el caso de Yagul) y en los alrededores de los valles. En el caso específico del área de Yagul y Mitla, se han realizado importantes avances en el conocimiento del catálogo faunístico, principalmente en los estudios relacionados con las poblaciones de aves (Grosselet, 2011; Robles, 2011). A la fecha, se siguen realizando estudios para la catalogación de especies de mariposas, mamíferos y de herpetofauna (Ríos et al., 2013).

Un segundo componente es el integrado por los sitios arqueológicos prehistóricos que se encuentran esparcidos a lo largo del sitio, y que están distribuidos entre sitios abiertos, abrigos rocosos y manifestaciones gráfico rupestres. Hasta el momento se ha realizado el registro de 215 sitios con estas características (Ríos et al., 2012), donde las investigaciones van encaminadas en este momento al conocimiento de los materiales usados en las pinturas murales (Tuross y Robles, 2010) o a estudios particulares de reconstrucción de la dieta prehistórica (Warinner, Robles y Tuross, 2013), lo que nos permite en este momento dentro del paisaje cultural conceptualizar una serie de contextos arqueológicos diversos, siendo los más importantes los siguientes:

### a) Guilá Naquitz

Es una pequeña cueva ubicada a una altura de 1.926 msnm. En el extremo sur del macizo rocoso que lleva su nombre. Éste fue el principal sitio investigado por Flannery en la década de 1960, en el cual, debido a las condiciones secas que presenta, fue posible recuperar una importante cantidad de plantas antiguas que documentan el proceso de domesticación de las plantas, en particular del maíz que fue la base de la subsistencia de las comunidades prehispánicas. Al parecer, el elemento fue ocupado en distintas ocasiones durante el periodo arcaico, lo que nos muestra algunas de las actividades más importantes de sus ocupantes. Algunas de las primeras acciones que allí realizaron fue la recolección de grandes cantidades de hojas de encino para ser utilizado como colchones, así como la excavación de un pozo de almacenamiento poco profundo y la preparación de un fogón en el centro de la cueva. Desde allí se dedicaron durante todo el otoño a la recolección de vegetales silvestres y a la caza, en la que obtuvieron al menos un venado y diversos conejos. La riqueza del medio era tal que al momento de abandonar la cueva en invierno, probablemente para trasladarse a las partes altas del cerro donde se conservaba mayor humedad, dejaron en el abrigo grandes cantidades de alimentos, entre ellos más de 3 mil bellotas que quedaron sin ser comidas, lo que indica que las poblaciones de este periodo no sufrían de escasez de alimentos y difícilmente se puede considerar que existiera una gran densidad poblacional en el área.

### b) Cueva Blanca

Este sitio contiene la evidencia humana más antigua en nuestro sitio, correspondiente al periodo Paleoindio. En ella se encontraron restos óseos de fauna pleistocénica con muestras de haber sido quemados y fracturados de manera deliberada. Cueva Blanca arrojó también información significativa del periodo arcaico en cuanto a la tecnología lítica, de la forma en que Guilá Naquitz lo hizo sobre las cuestiones biológicas. De ella se obtuvo una importante muestra de herramientas de material lítico, a partir de las cuales se realizó un estudio por parte de Robert Reynold con el que se pudo identificar herramientas asociadas a las actividades femeninas y masculinas, lo cual enriquece nuestra comprensión de la división de trabajo durante el arcaico. En un nivel superior se encontraron herramientas exclusivamente para la caza de venado, lo que pudiera evidenciar un estado posterior en el desarrollo cultural, cuando las microbandas de forrajeros que recorrían grandes extensiones del territorio en búsqueda de recursos comenzaron a establecer campamentos semipermanentes en los cuales se organizaban partidas de búsqueda de recursos específicos por parte de algunos de los miembros del grupo, mientras que el resto permanecían en el campamento base, lo cual puede considerarse como una nueva estrategia económica del arcaico tardío en vías del sedentarismo y la agricultura.

### c) Gheo Shih

Gheo Shih ("río de los calabazos") es un sitio arcaico al aire libre localizado en el aluvión aledaño al Río Mitla, en la parte baja del sitio que ocupa aproximadamente 1,5 ha. Durante el verano, los mezquites del área y otros vegetales daban abundantes frutos, a la vez que los conejos y venados se concentraban en el bosque aluvial, por lo que la gran cantidad de recursos permitía que las diversas microbandas que se encontraban dispersas durante el resto del año se reunieran y aprovecharan la abundancia de recursos para realizar diversas actividades sociales. Destaca de este sitio el hallazgo de dos líneas paralelas de cantos rodados que se prolongaban por 20 m, separadas por un espacio de 7 m entre ambas, el cual carecía de cualquier clase de objetos mientras que en la parte exterior del espacio delimitado los objetos eran abundantes y diversos, es decir, había sido limpiado. Esto se ha interpretado como que dicho sitio funcionó como un espacio para la realización de danzas, de la forma en que los instalaban algunos indios del oeste estadounidense (Marcus y Flannery 1996, 2001). Otra característica significativa de este sitio es el hallazgo de guijarros perforados en el centro a manera de ornamentos, lo que no se ha localizado en ningún otro de los sitios menores del arcaico.

### d) Cueva de la Paloma

Cueva de grandes dimensiones (35 x 14 m aproximadamente) cuya boca se dirige hacia el norte. El acceso presenta algunas dificultades debido a lo escarpado del terreno y la abundante vegetación, compuesta principalmente por matorral espinoso. Para acceder a la cueva hay que subir por un afloramiento rocoso en talud, frente a la línea de goteo no puede hablarse de terraza ya que se encuentra abundante roca de gran tamaño formando una pared entre la boca de la cueva y el talud del cerro, lo que provee a la cueva de protección adicional. En su suelo se puede observar una gran cantidad de sedimento, producto principalmente de la erosión de las paredes, las cuales son de toba volcánica, si bien también se observan restos de excremento



de ganado bovino y otros animales. Dentro de la cueva se encontró la presencia de cuatro rocas formando un cuadro que podrían corresponder a un fogón. En el suelo es posible observar gran cantidad de materiales arqueológicos como cerámica y lítica, y en sus paredes se distinguen dos pinturas rupestres, una representa dos figuras antropomorfas, una con una lanza y la otra con un penacho, que parecen referir a rituales de caza, mientras que la otra representa una paloma atravesada por una flecha.



Figura 9. Pintura rupestre en Los Machines. Unión Zapata. Mitla. © INAH-Tania Escobar 2009.

### e) Abrigo Banco de Sílex

Éste es un abrigo rocoso localizado al este de Guilá Naquitz que presenta una gran altura y poca profundidad. La mayor parte de sus paredes son de toba volcánica muy suave y presenta una fuerte erosión natural. Sin embargo, a media altura contiene un banco de roca de pedernal de buena calidad con muestras de explotación arqueológica. El acceso no es difícil, aunque la pendiente para llegar a él es considerable. La terraza frente al abrigo tiene entre 2 y 4 m de extensión, tras la cual el talud tiene una pendiente considerable. Hay que resaltar que las principales herramientas utilizadas durante el periodo arcaico fueron fabricadas de materiales líticos, por lo que contar con un banco de material de buena calidad contribuyó al desarrollo tecnológico de los habitantes del área.

### f) Guigósj o piedra tirada

Al sureste del área de estudio, en el paraje conocido como Don Pedrillo, se encuentra un sitio llamado Guigósj o piedra tirada, en el cual puede observarse desde la carretera a 50 m sobre el piso del valle una enorme piedra recortada a la manera de los dinteles de Mitla. Al llegar al lugar se reconoce que en realidad son dos conjuntos de cantera trabajada: el primero es una en la que se observa la cantera con claros cortes hechos para la extracción de material y siete rocas ya cortadas en asociación; el segundo es el observado desde la carretera, formado por seis piedras monumentales, una de las cuales presenta pintura rupestre que muestra cinco líneas verticales paralelas de color rojo (Robles, 1994, p. 17). Este sitio muestra los grandes avances tecnológicos alcanzados por los grupos prehispánicos del área en cuestiones arquitectónicas y en procesos de extracción de materia prima para la solución de las mismas.

### g) Corral de Piedra

Este sitio se encuentra en el extremo noreste del polígono a más 2.200 msnm. Se trata de una serie de muros de contención que rodean la parte más alta de un mogote y se distribuyen por más de 8 ha. Se encuentran distribuidos de tal forma que restringen los pasos más accesibles a la parte superior. En la parte de arriba no ha sido posible identificar estructuras arquitectónicas, lo que hace pensar que el lugar no estuvo habitado más que por un pequeño campamento, y que serviría como punto de vigía de la ciudad prehispánica de Mitla, ya que desde este punto es posible observar casi la totalidad del Valle de Tlacolula, e incluso los márgenes de la ciudad actual de Oaxaca.

### h) Cueva de los Machines

Esta cueva no presenta mucha profundidad pero sí considerable altura. En ella se pueden observar abundantes pinturas rupestres de color rojo. La cueva muestra evidencias de ocupación contemporánea por los restos de una fogata reciente y otros materiales actuales. También se encontró un metate de tres pies fragmentado por la mitad que no parece ser prehispánico, ni presenta huellas de uso. Tiene una cavidad de menor altura en el lado este, en el cual se puede observar la presencia de enjambres de abejas.

El suelo está cubierto por sedimentos además de detritos de ganado vacuno. El acceso, si bien no es difícil, se complica un poco debido a la abundante vegetación compuesta principalmente por matorral espinoso. Frente a la línea de goteo se puede observar un talud de inclinación moderada, que puede formar parte de las áreas de actividad de los ocupantes de esta cueva. Al interior de la cueva, cerca de la entrada, se pueden observar algunas plantas pequeñas, además de un árbol de más de 4 m de altura. El arte rupestre en este sitio es abundante, se puede encontrar un grabado en la piedra que representa un rostro, la pintura es variada y abundante, los principales diseños pintados son un felino, figuras humanas, representaciones celestes, probablemente referentes al planeta Venus, lo que pudiera ser la representación de un maíz, asociado a un elemento acuático; hay también manos al negativo y diseños abstractos.

### i) Pinturas y petroglifos de Caballito Blanco

Otro elemento relevante en cuanto al arte rupestre es el localizado en la parte suroeste de la mesa de Caballito Blanco, el cual cuenta tanto con pinturas como con petroglifos. Las pinturas de Caballito Blanco adquirieron su nombre por un diseño pintado en la roca que tiene cierta similitud con un caballo del mismo color. La primera pintura ubicada en la pared este se conoce como "el candelabro", por la similitud con el objeto, y presenta una combinación de fondo rojo ocre y el diseño en blanco. Debajo de esta pintura y a 3 m del nivel del suelo, se observan dos diseños, en el primero se localiza al sur de la roca y tiene una forma geométrica; el segundo se ubica al sureste de la misma roca y fue realizado con pintura blanca, representando las facciones de un personaje con tocado en la cabeza. El estado de conservación de las pinturas es regular, tomando en cuenta que se encuentran expuestas a la intemperie y a fenómenos naturales como el agua, el viento y el sol, que propician una rápida erosión.



Figura 10. Caballito Blanco. Tlacolula. Oaxaca. © INAH-Tania Escobar 2009.

Debajo de la pintura del candelabro se logró localizar un piso que contenía una impresionante cantidad de grabados en la piedra, así como una representación escultórica que parece corresponder al dios murciélago. Para ingresar a este lugar es necesario atravesar por una serie de grietas en el macizo rocoso hasta llegar a una pequeña terraza bajo la pintura, desde la cual se puede dominar buena parte del Valle, de tal forma que quien acceda a ella puede ser observado desde el piso, lo que nos hace pensar que su uso pudo ser para la celebración de rituales públicos. La gran complejidad que presentan los grabados y su asociación con la zona arqueológica nos indican que pueden proceder de la época de esplendor de Yagul, durante el periodo posclásico. Sin embargo, es necesario un registro y estudio completo de las mismas, lo cual presenta una serie de dificultades dadas las características físicas que caracterizan al elemento. De cualquier forma, se considera de vital importancia para la comprensión del complicado sistema de escritura zapoteca, del cual estos grabados representan un ejemplo sobresaliente.

### j) Caballito Blanco

Este sitio arqueológico fue explorado por John Paddock e Ignacio Bernal (Paddock, 1983). Pertenece al periodo Preclásico terminal o Monte Albán II (200 a.C.-250 d.C.). Está conformado por un conjunto de cuatro edificios congregados alrededor de una plaza. Probablemente, la característica más importante de este pequeño conjunto arqueológico sea la Estructura O, localizada casi en el borde sur de la meseta, que presenta una planta singular en forma de flecha al suroeste que la asemeja al Edificio J de Monte Albán, el cual se ha considerado durante mucho tiempo como un observatorio, si bien la inclinación de ambos edificios no es completamente igual (Schavelzon, 2011).

## k) Yagul

Yagul es uno de los sitios más importantes del Valle de Oaxaca para la comprensión de la transición del periodo Clásico al Posclásico (Bernal y Gamio, 1974). Este sitio complejo está localizado en las laderas y en la parte superior de un macizo rocoso del mismo nombre, el cual ha sido modificado por el hombre, formando una serie de plataformas y terrazas habitacionales en donde se asentó la población. Este sitio tiene presencia de ocupación desde el Preclásico Temprano en su fase Tierras largas (1500 a.C.), empero no es sino hasta el Clásico Tardío (650-850 d.C.) con el apogeo del estado de Monte Albán (época IIIb-IV), que comienza el apogeo del sitio, extendiéndose hasta el Posclásico Tardío, donde fueron construidos la mayor parte de los edificios que actualmente se pueden apreciar.

## Conclusiones

El sitio Cuevas Prehistóricas de Yagul y Mitla en el Valle Central de Oaxaca constituye, así, un paisaje cultural de Valor Universal Excepcional, compuesto por parajes extraordinariamente ricos que guardan evidencias de la domesticación temprana de plantas, en especial del maíz, en un verdadero compendio de plantas útiles para la supervivencia humana y de la conformación posteriormente de una dieta mesoamericana.

El maíz, cuyo posible origen se ha documentado en las Cuevas Prehistóricas de Yagul y Mitla, no sólo fue el sustento material que posibilitó el surgimiento de las civilizaciones mesoamericanas, sino que constituye un elemento central en la ideología de dichas civilizaciones, formando parte fundamental de los mitos y creencias antropogénicas, con base a las cuales estos pueblos se comprendían a sí mismos.

El maíz tiene una significativa relevancia no solo económica sino también ideológica, que se desarrolló en las culturas mesoamericanas a tal grado que éstas pueden ser contempladas como "culturas del maíz", lo cual comprende desde los orígenes de la agricultura mediante la domesticación del maíz, hasta el complejo culto que se formó en torno a éste, así como el cultivo básico que dio origen a la tradición cultural que caracteriza hasta nuestros días a los pueblos mesoamericanos.

De la misma forma que la tradición agrícola que surgió a partir de esta planta se dispersó en un amplísimo espectro geográfico, diversificándose de tal forma como ninguna otra planta lo ha hecho, el maíz se fue conformando como elemento idiosincrático de los pueblos de los que forma parte.

No es raro entonces que, ante la importancia económica e ideológica que presentó esta planta para las culturas prehispánicas de América, se les conozca a éstas como "culturas del maíz", en contraposición a las "culturas del trigo" en el Mediterráneo y a las "culturas del arroz" en Asia, en relación al grano básico en que fundaron sus respectivas civilizaciones. Y no es extraño tampoco que los descendientes contemporáneos de estas culturas sigan manteniendo un fuerte arraigo cultural a esta planta y a los productos gastronómicos que en ella se basan, ya que son parte de lo que los identifica ante el mundo.

Las Cuevas Prehistóricas de Yagul y Mitla albergan los testimonios importantes del inicio de la civilización en América mediante la domesticación de las plantas. Las semillas de calabaza (*Curcubita Pepo*) encontradas en la cueva de Guilá Naquitz, cuya antigüedad es de 10.000 años, son de las más antiguas plantas cultivadas encontradas hasta el día de hoy en Norteamérica y han revolucionado el conocimiento científico de los orígenes de la agricultura en la región.

Sin lugar a dudas, el desarrollo de la agricultura representa el primero y más importante paso del proceso civilizatorio, al conformarse como la base con la que los grupos humanos pudieron agruparse en establecimientos permanentes y solventar especialistas de tiempo completo, sin los cuales ninguna civilización es posible.

Por último, cabe mencionar que parte fundamental del proyecto es la integración de las comunidades circundantes e involucradas en el sitio como parte esencial de su manejo y como los principales beneficiarios de su implementación dentro del Patrimonio Mundial mediante el fomento y asesoría a proyectos productivos compatibles con los valores del sitio. A la vez que diseñar esquemas en que las infraestructuras de visita se encontrarán al interior de dichas comunidades y no dentro del sitio, lo que redundaría en importantes beneficios tanto para la conservación del sitio como para las comunidades involucradas. Así, con base en los diversos estudios que se desarrollan en el área, se podrán plantear y realizar las gestiones necesarias para el fomento a las actividades agrícolas productivas compatibles con los valores del sitio.

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# An Overview of Late Pleistocene Faunal Research and the Early Peopling of Mexico

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## Abstract

One of the most exciting issues of archaeozoological research is the initial peopling of the Americas in the late Pleistocene. At this critical moment, humans were a migrant species who invaded a new territory and then interacted with nature, in particular with the fauna, which is studied mainly by examining skeletal remains for their uses. Some of these uses include basic dietary needs and raw materials for tools, and the assignment of symbolic and ritual values to different animals.

The Americas were also a complex natural scenario during the late Pleistocene, as it comprises the two largest biogeographical regions in the world: the Nearctic and the Neotropical, each with its particular composition of biota, as well as many biological exchanges on different regional and temporal scales, from the late Pliocene to the early Holocene. The peopling of the Americas was probably one of the last colonization events to have had radical environmental consequences.

This paper is an overview of the research carried out on these issues in Mexico, where the first discoveries of Pleistocene megafauna in the New World took place between the sixteenth to eighteenth centuries and were mainly reported by Spanish scientific explorers. Later in the mid-nineteenth century, the first Mexican scientific societies raised interest in human and associated megafaunal remains, which were both assigned to the late Pleistocene and mainly found in emblematic localities such as Tequixquiac and Peñón de la Baños, among others.

From this point, the study of the peopling of the Americas in Mexico has two components: firstly, human remains and their associated cultural artefacts and secondly, faunal remains, predominantly from mammals and birds as these were the commonest discoveries, and provide the basis for palaeoenvironmental interpretations.

Many questions remain surrounding the interaction with the environment produced by these human migratory waves and by the routes they used, such as the degree of influence of human participation in the process of the extinction of the mega- and meso-fauna, the diversity of subsistence strategies by hunter-gatherers in the late Pleistocene and the environmental scenarios associated with the first settlers. Among other issues, it is also worth considering the similarity of migration routes of both animal and human populations, and humanly-induced changes to the geographical distribution of plants and animals.

Knowledge of the peopling of the Americas and interaction with animals not only provides information on a certain moment in time but also helps us to understand the changes and persistence in the subsistence strategies of humans, a diachronic perspective that could be extended to the present. Furthermore, it contributes to the discussion of defining or delimiting cultural, natural or biocultural heritage and its preservation by present societies.

## Introduction

Research on palaeoenvironments in Mexico covers a period that extends from the late Pleistocene to the Holocene, c. 35k years before present (BP), but the main discoveries have been on a time scale ranging from 10k to c. 4k BP, where the presence of human populations was mainly in agricultural societies that maintained a close relationship with the local wildlife, using it for their immediate needs, such as for food or raw materials, or for ritual purposes. The possibility of learning about the ways of life of these early populations arises from the application of various interdisciplinary approaches such as palaeobiology and archaeology, especially related to prehistory and archaeozoology. In order to explore the development of research on prehistory and palaeoenvironments, it is relevant to provide a brief historical



sketch of it. This outline seeks to highlight the importance of further research into this early point in the history of our country, which marks some of the influences in the later development of the Mesoamerican cultures.

### A brief historical outline on the origins and development of prehistoric studies in Mexico

Prehistory in Mexico is mainly the study of non-sedentary human populations that are also known as pre-ceramic, or by the generic name of hunter-gatherer societies. Beyond the applied terminology, the fact is that prehistory places special emphasis on the recovery and analysis of biological materials, such as animal bones, pollen, seeds and so on, with the intention of providing hypotheses on the reconstruction of the environment and subsistence practices of these social groups (Fiedel, 1996). For these reasons, Mexican prehistory is closely related to archaeozoology and the peopling of the Americas.

Since colonial times, different ideas have been put forward to explain human presence in the Americas, such as that of Joseph de Acosta who proposed, in the sixteenth century, the hypothesis of a passage through northern Europe (Pompa, 2006). The Conquest process also included the recognition and inventory of natural resources for exploitation. The relationships that ancient Mexican cultures maintained with faunal and natural resources were recorded, sometimes in detail, in the main chronicles of that time such as those of, among others, Francisco Hernández, Fray Bernardino de Sahagún, Hernán Cortés, Bernal Díaz del Castillo, Jerónimo de Mendieta, Jose Torrubia, Antonio Pineda and Antonio de Herrera (Corona-M., 2002).

The works of the first two authors in particular refer to food, medicinal and ornamental uses of natural resources as well as the domestic environments that these organisms inhabited. The remains of ancient megafauna, which probably belonged to extinct Proboscidean relatives of mammoths, mastodons and gomphotheres, are scarcely mentioned. These remains were believed to belong to giants, who at the time were considered the ancient inhabitants of the earth and were called *Quinametzin* in Nahuatl (Corona-M., 2002; Corona- M., et al., 2008).

The last decade of the eighteenth century was characterized by several events that indicate the development of intense scientific activity and is a key point in understanding the origins of Mexican palaeontology, archaeology and natural sciences, especially with regards to the relationship between humans and fauna. One of these events was the discovery of a pre-Hispanic offering of animal remains in 1790, the first to be studied in some detail by naturalists such as León y Gama and Antonio Pineda (Corona-M., 2002, 2008; Corona- M., et al., 2008; León y Gama, 1990; Maldonado Polo, 1999). Other scientific events of importance were the excavation of mammoth remains led by Antonio Pineda in the vicinity of the present-day Basilica of Guadalupe (in the north of Mexico City), and the inauguration of the first Royal Cabinet of Natural History in 1799, one of the first museum sites of New Spain whose content was based on the most current and up-to-date scientific theories of the time.

The display of flora, fauna and minerals were based on the Linnaean system, which was one of the most up-to-date methodologies of the time, whilst on the other hand, the fossil remains were interpreted as ancient organisms from the past. The excitement generated around these discoveries is also noted in the cultural publications of the time, in the *Gazeta de Mexico* for instance, where several articles were written about reported scientific activities (Corona-M., 2008).

These activities were accompanied by the first attempts to create local scientific institutions, such as the aforementioned Cabinet of Natural History. However, the effects of the struggle for independence, including the economic crisis and the emigration of some scholars associated with it, limited the development of these institutions and prevented their consolidation. By 1821, with the end of the struggle for independence and the opening of borders, several foreign geographers and naturalists visited the country, giving new life to research and building relationships with the local scientific community. In this context, the most popular was the voyage of Alexander Humboldt (Maldonado Koerdell, 1952).

All this led to the creation of various local scientific institutions in the nineteenth century. The National Museum was founded in 1825, but existed only on paper, whilst the remaining local scientific institutions carried out few activities and many of them stopped operating. As a consequence, much of the scientific research carried out was the result of individual efforts (Gortari, 1980; Trabulse, 1983). The National Museum of Mexico was founded in the 1860s and was one of the leading institutions of natural history. Within this framework, it generated innovative research in order to understand the relationship between humans and nature. Members of the institutions included Mariano Bárcena, Alfonso Herrera and brothers Eugenio and Alfredo Dugès, who contributed to the data obtained from colonial historical sources, particularly in regard to the use of resources by the ancient cultures and indigenous communities of Mexico (Corona-M. et al., 2008).

The nineteenth century is also a very significant time for prehistoric research due to two discoveries in the Basin of Mexico that are still very emblematic to the discipline. The first was the finding of a locality in Tequiquiac, in the state of Mexico, with a well-preserved and diverse Pleistocene fauna, principally composed of proboscideans, camels and horses. The second, also discovered in the same location, was a camel sacrum with many marks considered of cultural origin, including two holes that look like a representation of an animal head. Bárcena described the piece in 1882 and it became irrefutable evidence of the use of fauna by the first settlers of the Basin of Mexico. These findings could be considered as the modern origin of archaeozoological studies and prehistory in Mexico. Subsequent studies have discussed if the cultural marks, in particular the drilling holes, were made using prehistoric methods and were contemporary with the animal's death. However, no studies have proved conclusive in this regard. The locality of El Peñón de los Baños, in the east of Mexico City, which was located very near the current airport but has now disappeared due to urban growth, was another important discovery of human remains considered as late Pleistocene and therefore provided direct evidence of the early peopling of the Americas. This finding led to a heated debate about its correct dating and increased researchers' interest in the subject (Bárcena, 1885; Bárcena and Castillo, 1886; Newberry, 1886). Later in the early twentieth century, Enrique Lozano Díaz was one of the first to explore the interaction between the first inhabitants and extinct fauna. He also conducted pioneering research on the historic locality of Tepexpan, where evidence of human occupation in the late Pleistocene was also found (Corona-M., 2008).

### The current situation of research on fauna in prehistoric localities

In 1958, the foundation of a department dedicated to prehistoric research at the Instituto Nacional de Antropología e Historia (INAH, the National Institute of Anthropology and History) was an impetus for research. It was promoted by Professor José Luis Lorenzo, a well-known archaeologist. The department was made up of laboratories for disciplines such as palaeozoology, palaeobotany, soil chemistry, geology and radiocarbon dating, interacting with archaeologists to provide palaeoenvironmental hypotheses, constituting a novel contribution to archaeological and palaeobiological research (Lorenzo, 1991; Corona-M., et al., 2010).

The Palaeozoology Laboratory, now renamed the Archaeozoology Laboratory, began activities in 1963 by studying a large number of skeletal remains from prehistoric contexts in Mexico (Alvarez, 1965, 1967), where it was assumed there was interaction between early human populations and extinct fauna. At a later stage, the faunal remains of Pre-Hispanic localities were included in the analysis.

These research projects provided a relative chronological framework, comprising two main stages: the first is located in the transition from the late Pleistocene to the mid-Holocene, prior to 4,000 BP and is called the Archaeolithic or the Lithic stage. Extinct faunae and small populations of hunter-gatherers, mainly in the Mexican Plateau and the Basin of Mexico, are predominant in this stage (García Bárcena, 2007). The second stage comprises the first sedentary societies that had an economy based on agriculture and the later complex hierarchical societies with intensive control of their territories. Most of these cultural forms were developed before the Spanish Conquest in the mid-sixteenth century. These contexts are the most prevalent in archaeozoological studies in Mexico.

Whilst the former Department of Prehistory still exists, in the 1980s it was transformed into the Archaeology Laboratories Section, which promoted research in at least 20 locations, 10 of them located in the Basin of Mexico. These investigations uncovered stone tools (for example, arrowheads and axes) and some bones modified by cultural use, mainly with butchering marks and some others characterized as bone tools artefacts (Figure 1).

### Summary of localities and faunal groups studied

Over 700 locations with mammalian records were studied and the most diverse of these were 20 locations that included mammals, birds and herpetofauna, known from the Quaternary Period in Mexico (Corona-M., 2014; Arroyo-Cabrales et al., 2002). The terminal phase of the late Pleistocene, named in mammalian ages as the Rancholabrean, in accordance with the North American Land Mammal Ages (NALMA) system, spans the last 120,000 BP. At some point during this phase, human groups started to colonize the Americas. Due to the quantity and diversity of faunal remains identified, it is necessary to carry out a broad characterization of the known localities in the five regions (Figure 1).

One region is the Mexican Plateau that has over 250 locations. Of these, the San Josecito Cave, in Nuevo Leon, has the greatest faunal diversity of all known Mexican localities. In addition to faunal diversity, El Cedral, in San Luis Potosi, has the oldest

claimed evidence of human inhabitants (c. 33,000 BP), but the debate with regard to its chronology and human presence at this time remains unresolved. Valsequillo, in Puebla, is another largely controversial site in the Americas regarding the chronology of early humans. Several archaeological excavations from the late 1950s to the mid-2000s have provided contradictory evidence about the presence of the earliest peoples in the area. An occupation as early as from the Sangamonian interglacial (between 132 and 119 BP; Van Landingham, 2004) was postulated, but then questioned and rejected (Feinberg et al., 2009; Mark et al., 2010). The most reliable dating on fauna is more conservative, at 20,780 BP (Arroyo-Cabrales et al., 2010).



Figure 1. Map of México showing the regionalization discussed in the text.

The Basin of Mexico, which mainly covers the current Federal District (Mexico City) and the state of Mexico, is the most explored area in the country and has nearly 215 localities. Furthermore, it is the region with the highest density of localities as well as more emblematic and well-known localities, such as Tequixquiac, Tlapacoya and El Peñón de los Baños, to name a few. The enormous amount of construction that continues to occur in the region has resulted in the discovery of numerous palaeontological localities and archaeological sites. One of the earliest findings of a woman's bones at El Peñón de los Baños dates to  $10,755 \pm 75$  RC BP (González et al., 2003; González and Huddart, 2008). This early age indicates that these human remains were among the oldest human skeletal remains in the Americas (Meltzer, 2009). In Tlapacoya, hearths, extinct fauna and human remains were found, not in direct association with each other, but it is assumed that they are contemporary.

Some authors propose fifteen sites that could be linked to the modified bone in this area, which is mainly mammoth (*Mammuthus columbi*). These sites are: Tequixquiac, Chimalhuacán, Los Reyes La Paz, Atenco, San Bartolo Atepehuacan, Santa Isabel Iztapan I y II, Los Reyes Acozac, Tlapacoya, Santa Lucía, Santa Marta Acatitla, Tepexpan, Tepexpan Hospital, Gertrudis Sánchez, Tocuila and Villa de Guadalupe (Aveleyra, 1950; Corona-M., 2014). Other authors were more conservative in their proposals and consider only three sites linked to the mammoth bones, Santa Isabel Iztapan, Villa de Guadalupe and Tocuila (Arroyo-Cabrales et al., 2006).

In fact, this debate should be further investigated and refined as it is a critical issue in prehistoric studies, in meeting the criteria to evaluate the sites and to review the localities and the specimens of bone artefacts on both a regional level and a country level. The late Pleistocene Basin of Mexico was an extremely rich environment that supported a large Columbian mammoth (*Mammuthus columbi*) population. Over 100 mammoth localities are known in the area, yet very few show evidence of human interaction with the carcass (Arroyo-Cabrales et al., 2006).

Other regions with fewer locations, but no less important, are the states covering the western coast, including the states of Jalisco and principally the localities near Chapala Lake and Sonora. In the latter, in recent years more than a dozen Clovis sites have been found, but few have stratigraphically-controlled excavations such as the one named *El Fin del Mundo* (Gaines and Sanchez, 2009; Sanchez-Miranda et al., 2009). At this site, possible interaction between people and gomphotheres indicates either hunting or scavenging activities (Sanchez-Miranda et al., 2009). It is important to keep in mind that Clovis points are conventionally considered as a marker for the presence of early technology among the first people arriving to the Americas. In Mexico, however, there is no evidence for the presence of Clovis people. A few Clovis points have been recovered from Baja California to Costa Rica, including some in the state of Hidalgo in the Mexican Plateau (Sanchez-Miranda, 2001).

The southern region includes two sub-regions, the states Oaxaca and Chiapas, and the states of Morelos and Guerrero. The first sub-region has been actively explored over the last few years and Guila Naquitz, a small shelter in central Oaxaca, is an example of a site that has been investigated. Flannery's (1986) excavation yielded both seeds and peduncles of squash (*Cucurbita pepo*) with indications of domestication as early as  $9.0 \text{ }^{14}\text{C k BP}$  (Smith, 1997). This date coincides with views about the earliest Naquitz phase being attributed to the early Archaic period (Flannery, 1986). Nearby in Mitla and Tehuantepec,

two sites have been discovered with a postulated association of gomphotheres and Clovis-like points elaborated in silex (Winters, 2014).

The research seems to indicate the presence of two early cultural traditions in the Americas: North American Clovis from Oaxaca and Chiapas, and fish-tail fluted points from Central and South America (Santamaría and García-Bárcena, 1989). Recent studies from rockshelters near Ocozocuatla in Chiapas have provided strong evidence of human presence in the state around 11.0 to 10.0  $^{14}\text{C}$  kyr BP. These sites have yielded lithics, reflecting an expedient technology and also milling stones and botanical samples that may indicate incipient horticulture starting at the end of the Pleistocene to the early Holocene. Small and medium-sized animals (such as deer, peccary and rabbit) were the most hunted prey, while megafaunal remains were not found (Acosta Ochoa, 2010).

The subregion Morelos-Guerrero has been studied in recent years and the reports include one of the most complete specimens of mammoth, seven reliable localities, one with herpetofauna, birds and mammals (Cueva Encantada) and others with only extinct fauna, mainly mammoth such as La Nopalera (Corona-M., 2006, 2013). The findings show some presumably distributional modifications, for instance, southern records of clearly known Nearctic mammals, suggesting changes in vegetation (Figure 2). The region of the east coast (Tamaulipas, Veracruz, Tabasco), with the exception of some localities, seems to have neither a great faunal diversity nor clues about the early population of Mexico.



Figure 2. Palaeontological explorations at Tlayacapan, Morelos.

There has been important progress in the Baja Californian Peninsula, with at least five sites with  $^{14}\text{C}$  dates from 11,000 to 9,000 BP: Isla de Cedros, Abrigo Paredón-Laguna Chapala, Abrigo de los Escorpiones, Sierra de San Francisco and Isla Espíritu Santo. Some hypothetical routes are in debate; one, the most accepted, is the peopling from the north, either by terrestrial or maritime routes. Two kinds of subsistence strategies are clearly shown: one is the hunter-gatherer exploiting land resources and the other is the more specialized maritime hunter-gatherer who fished, gathered edible molluscs, crustaceans and urchins, and also hunted sea lion, seals and marine turtles; they also occasionally hunted terrestrial mammals (Fujita and Porcayo-Michelini, 2014).

Finally, there have also been some important discoveries in the Yucatan Peninsula. A few decades ago, there were only a few Pleistocene records known from caves and these were mainly of horses and ground-sloths (*Paramylodon*). The most diverse cave was Loltun Cave that had reptiles, birds and mammals, including gomphotheres, carnivores, meso- and micro-fauna (Alvarez, 1983; González González et al., 2006; Corona-M., 2010). This assemblage suggests an arid steppe environment, very different from today's dry tropical forest. Current explorations in this region have increased the records, with glyptodonts and camels; one of these specimens was in a hearth with fire marks and is presently being recorded.

In addition, two new early human specimens were found in Naharon Cave (11,670±60 RCBP) and Las Palmas (8,050±130 RCBP) and in evidence of hearths (8,941±39RCBP) (González González et al., 2006). Most recently, saber-tooth cat and spectacled bear-like (*Tremarctos*) remains have been found in several *cenotes* (submerged caves) in the Yucatan Peninsula, as a result of thorough research into early human presence.

**Notes on palaeodiets and biogeographical issues.** Stable isotope analysis provides particular data on the palaeodiets of herbivores in twenty-four Mexican localities. As example, it was generally maintained that mammoths and horses were grazers, specialists of C4 plants, but analyses show that they were also occasional browsers including a mix of C3/C4 plants, for instance, leaves and shrubs. Particularities were also observed in gomphotheres; these animals were traditionally considered specialist browsers, but only the *Stegomastodon* specimen showed a diet of mixed C3/C4 plants, while the *Cuvieronius* specimens were grazers (Pérez -Crespo et al., 2012). These analyses also support the palaeoenvironmental

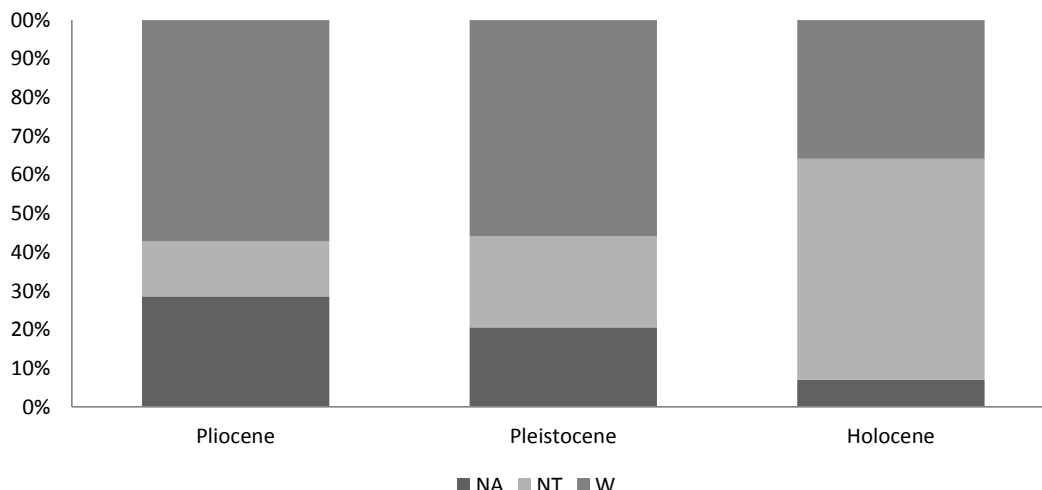


Figure 3. Changes in bird groups based on biogeographic origin, see the growth of neotropical group from Pleistocene to Holocene. NA=Nearctic; NT=Neotropical; W=Wide distribution. Based on data from Corona-M. 2010.

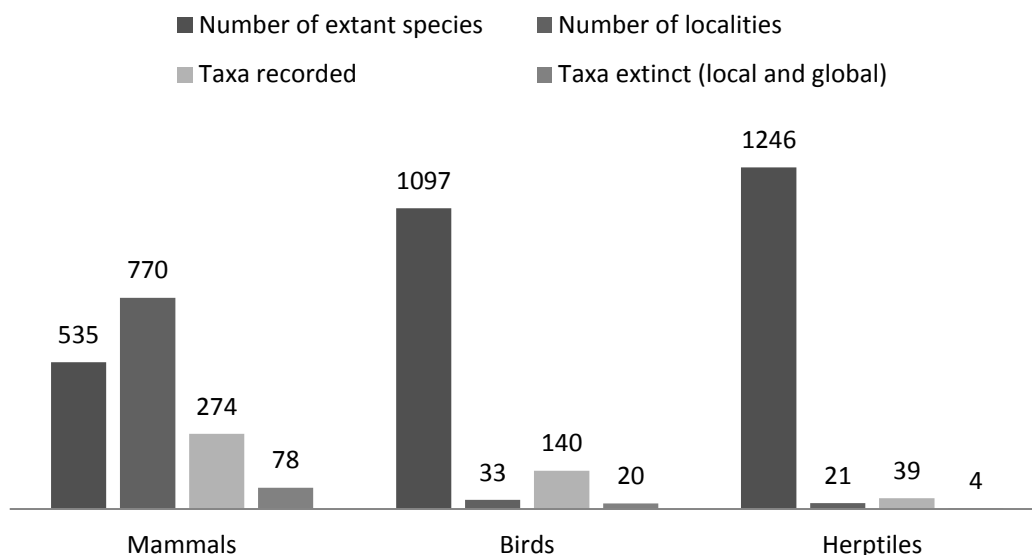


Figure 4. Comparative between classes of terrestrial vertebrates based on data from late Pleistocene Mexican localities and Holocene records, based on data from Arroyo-Cabrales et al. 2008.

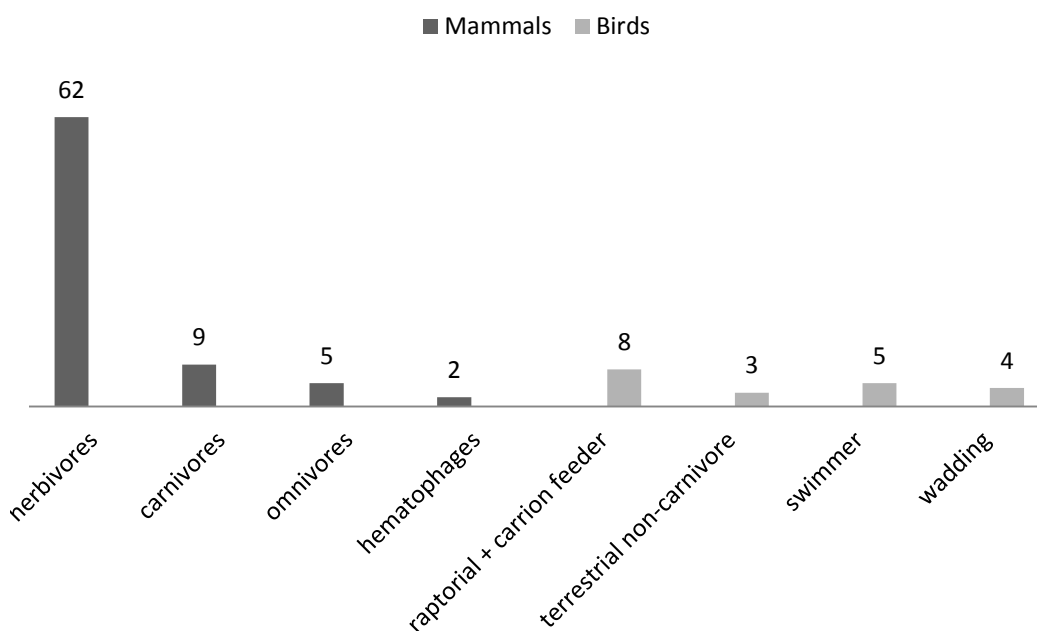


Figure 5. Comparative of late Pleistocene extinct species based on "taxon-free" groups. based on data from Arroyo-Cabrales et al., 2008 and Corona-M., 2010.



reconstruction of sites such as El Cedral and Laguna de las Cruces, San Luis Potosi and Valsequillo, Puebla, where it is suggested that these were sites with a mixed composition of grassland and open forest.

The coming together in Mexico of two major biogeographic regions, the Nearctic and Neotropical, led to a series of north-south exchanges in the transition of Pliocene - Pleistocene; in particular, after forming the Panamian Bridge (c. 3.7 Mya), which facilitated the transit of terrestrial species and substantially changed the composition of the fauna and environments, especially in the regions of the Mexican Plateau and the Basin of Mexico. An example of this radical change occurs in the bird fauna composition, where an increase of Neotropical birds is observed to the detriment of Nearctic birds (Corona-M., 2010: Figure 3).

This biogeographic influence has also delimited the ancient distribution of mastodons (Polaco et al., 2001), gomphotheres (Alberdi and Corona, 2005; Corona and Alberdi, 2006), mammoth and another mammals (Arroyo-Cabrales et al., 2010). Later, other changes in the distributional ranges of individual species of birds, mammals and herpetofauna were recorded, suggesting changes in palaeoenvironments during the late Pleistocene, but further research on this issue will be necessary.

**Extinctions.** The processes of extinction during the late Pleistocene can be evaluated by comparisons with extant taxa. Here, the extinction of mammals is highest, with losses of almost 50% of recorded mammals, whilst the extinction of birds and herpetofauna represents a loss of less than 2% of each group (Figure 4). These differences could be caused by a sample size effect, as mammals are the most recognized and recorded Pleistocene group, but overall the data indicates the sheer size of extinction in Mexican localities. In order to make a better comparison, taxon-free categories related to habitats and diet were used (Figure 5), showing that herbivorous mammals and their predators, and scavenger birds were the most affected groups in the extinctions that took place.

Currently the four major species of extant mammals (reaching approximately 100 kg) are the pronghorn (*Antilocapra americana*), the mule deer (*Odocoileus hemionus*), the white-tailed deer (*O. virginianus*) and the bighorn sheep (*Ovis canadensis*), but in the late Pleistocene almost 61 species were recorded, most of which were herbivores that were up to 10 times larger than the existing mammals (weighing almost a ton), such as mammoths (*Mammuthus* sp.), the American mastodon (*Mammut americanum*), gomphotheres (*Cuvieronius* and *Stegomastodon*) and ground sloths (*Glossotherium*, *Eremotherium*). In this scenario, some unique taxa were completely lost, like the Notoungulata order (*Toxodon*) and six families, Camelidae, Herpestidae, Equidae, Elephantidae, Hydrochoeridae and Megalonychidae. In other taxa, only some representatives survive, such as antilocaprids and bovids, whilst some others are extant in other areas of the world, such as the red dog (*Cuon*), which survives today in Asia; the spectacled bear (*Tremarctos*) and the giant anteater (*Myrmecophaga tridactyla*), both inhabitants of South America, while the yellow-bellied marmot (*Marmota flaviventris*) and meadow vole (*Synaptomys cooperi*) occur in North America (Arroyo-Cabrales et al., 2008).

In the case of birds, taxa affected by extinction processes include various water birds such as divers (*Polyolimbus baryosteus*, *Podiceps parvus*), ducks (*Oxyura zapatima*), cormorants (*Phalacrocorax goletensis* and *P. chapalensis*) and two storks (*Mycteria wetmorei* and *Ciconia* cf. *maltha*). Terrestrial birds were a kind of turkey (*Meleagris crassipes*) and a small parakeet (*Rhynchopsitta phillipsi*), along with several types of scavenger or predator birds (*Teratornis merriami*, *Breagyps clarki*, *Wetmoregyps daggetti*, *Neogyps errans*, *Neophrontops americanus*, *Buteogallus fragilis*, *Spizaetus grinnelli*, *Strix brea*) (Corona-M., 2010).

The overall data are consistent and similar with the processes that have occurred in North America. Nonetheless, the debate on the main causes for this mass extinction still continues. However, the strong dichotomy between environmental changes and the role of humans as extreme events to explain the extinctions has been slowly abandoned. Instead, it has come to be understood as a multi-effect process where environmental changes, the life histories of the species involved, and the human waves peopling the Americas all contributed to the mass extinction of the late Pleistocene in which the net effect is the loss of herbivores, carnivores and scavengers, the simplification of food webs and a loss of ecosystem stability (Barnosky et al., 2004).

## Future challenges of prehistoric studies in Mexico

This overview shows the progress in studies of late Pleistocene fauna that include new localities, the identification of mammals, enhancing the data on birds and herpetofauna; the particularities of palaeodiets of herbivores in Mexican localities, the ancient range of distribution of some vertebrates and their changes in biogeographic distribution (Nearctic / Neotropical); most of these are the product of climatic and vegetational changes.



I should also highlight the presence of human specimens over 10 or 11 ky (Peñon de los Baños, Basin of Mexico and Naharon, Yucatán) or early evidence of lithic points in Sonora and Chiapas, with different techniques suggesting that the peopling of Mexico is earlier than 10ky, and also this peopling covers practically all the current territory and that different terrestrial routes were used. Maritime routes should not be ruled out, but at this time no clear evidence exists on this topic. This evidence is congruent with the genetic and archaeological findings of early populations in North America, with the arrival through the Beringia Land Bridge between 30-22 ky and migration from Beringia to the Americas by 16.5 ky (Goebel et al., 2008). Surely, new discoveries on this issue will contribute to solving the puzzle of the prehistoric colonization of the Americas, and promote new ideas on its configuration.

In Mexico, however, some issues should be resolved or improved, such as a fine radiometric chronology, incorporating palaeobotanical data, a complete biogeographical distributional analysis of vertebrates, refining the categories of modified bone, the delimitation of the correlation between the migratory routes of animals with humans, and, last but not least, the search for the direct association and traces of the use of animal remains with human skeletons.

Another important topic is local and regional analysis to avoid discoveries by chance or as a result of urban growth in the cities, since most of this produces disturbed localities. In any case, this inevitable situation could be improved by means of outreach work with local authorities, residents and students of basic levels in order to produce cooperation and incorporation of the towns and cities in the protection of palaeontological and archaeological evidence. In this way, research could be transformed into heritage that could be natural, cultural or biocultural, and could produce legal procedures or in some cases, the incorporation of that heritage into local economies, by means of local museums, and the supervision and consultation by researchers.

The alliance between researchers, institutions and local populations who are all involved in the production of knowledge and in the care of localities and their content, always offer the best results with a view of building a social heritage, and in this case, a social heritage relating to prehistoric sites. Nowadays, it is possible to expand this effort by the use of mass media and social networks. The opportunity to construct a collective narrative is near, at hand and surrounding us, and involves the coming together of scientific resources, local knowledge and traditional practices, all of which are incorporated into legal frameworks that facilitate the cooperation and the care of this heritage. All that we need to do is take the opportunity to construct it.

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## Los primeros grupos humanos en el Centro de México

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### Introducción

El ser humano, dentro del mundo animal, es la única especie que ha dedicado parte de su vida a formular una serie de preguntas relacionadas con su origen, evolución, migración, antigüedad, así como con los procesos sociales que ha desarrollado. Para responder a estas interrogantes se han planteado una serie de investigaciones que han permitido adentrarse en el conocimiento de los diferentes momentos históricos de la humanidad.

Para hacerlo, ha desarrollado diferentes modelos, por medio de los cuales se explica el origen del *Homo sapiens*. Uno de ellos es el llamado *multiregional*, que plantea los procesos de transformación filogenética de nuestra especie a partir de las poblaciones ancestrales del *Homo sapiens*, que evolucionó gradualmente hasta llegar al *Homo sapiens* arcaico y, posteriormente, al hombre moderno. Este hecho se inició con la salida de pequeños grupos humanos del continente africano, que se dispersaron por diferentes lugares de la tierra.

Durante el transcurso del tiempo se dieron una serie de cambios evolutivos, mismos que provocaron nuevas modificaciones anatómicas importantes en los individuos, con lo que el ser humano adquirió una capacidad cognoscitiva que le permitió explorar nuevos nichos ecológicos, elementos que fueron necesarios para sobrevivir y desarrollarse fuera de África. Uno de estos nichos fue el continente americano, donde tuvo que enfrentarse a una serie de problemas; por ejemplo, conocer los cambios medioambientales (que eran muy severos), problemática que finalmente resolvió con éxito tras la exploración del terreno y la ubicación de las mejores condiciones para trazar las rutas que facilitarían su ingreso en el nuevo continente. Otro de los factores importantes que permitieron llevar a cabo la conquista de América fue la obtención de una buena alimentación, elaboración de instrumentos, utilización del fuego, domesticación de plantas y animales, diseño de un vestuario apropiado para las condiciones del lugar, conocimiento de cómo curar y controlar algunas enfermedades, etcétera. Todos estos son factores importantes que contribuyeron para que los grupos humanos sobrevivieran e ingresaran con éxito al continente americano, al punto de habitarlo por completo en tan sólo unos miles de años.

Partiendo de la premisa de que América fue el último de los continentes en ser colonizado por los humanos, este suceso se da a conocer después de los primeros contactos entre Europa y América, momento en que surgió la incógnita respecto al origen de los nativos americanos (en aquella época no se tenía noticia de la existencia del continente, mucho menos se sabía que estuviera habitado por humanos). Es a partir de la llegada de los europeos cuando se formula una serie de hipótesis y teorías en relación al origen, migración y antigüedad del poblamiento del continente.

Así, en el transcurso del tiempo se fueron generando nuevas investigaciones tanto antropofísicas como arqueológicas, lingüísticas, genéticas y geológicas, por mencionar algunas, cuyo objetivo era obtener mayor información sobre los primeros grupos humanos que llegaron al continente. La interpretación de los resultados ha generado posiciones enfrentadas entre los especialistas debido a que no existe consenso en relación con algunas aseveraciones, tales como las rutas de migración.

Éstas son las principales vías que se discuten sobre el ingreso de los primeros grupos de seres humanos que conquistaron América. La que tiene mayores adeptos es la ruta Siberia-Alaska, debido a que en este lugar se formó un puente natural que tenía las condiciones necesarias para que los grupos humanos pasaran al continente. Sin embargo, para tener más elementos de análisis, se deben desarrollar investigaciones antropológicas en esta zona que permitan localizar más evidencias que soporten esta teoría. De la misma manera, se debe rastrear todo tipo de testimonio humano en la región de Siberia para verificar que éste haya sido uno de los puntos de partida de los humanos que después dieron origen a los nativos americanos.

Otra de las discusiones sobre la llegada de los primeros humanos al continente gira en torno a la fecha en que esto ocurrió. Actualmente se debate una gran cantidad de fechamientos, que van de los 12.000, los 16.000 y los 18.000, hasta los 20.000 años. Dichos cálculos se han obtenido tras el análisis de diferentes sitios en el continente, lo cual provoca una enorme heterogeneidad y da pie a una serie de cuestionamientos: cómo fueron obtenidos, cuáles fueron las evidencias datadas, con qué métodos, etcétera. Aclarando todas estas interrogantes se podrá llegar a una fecha aproximada.

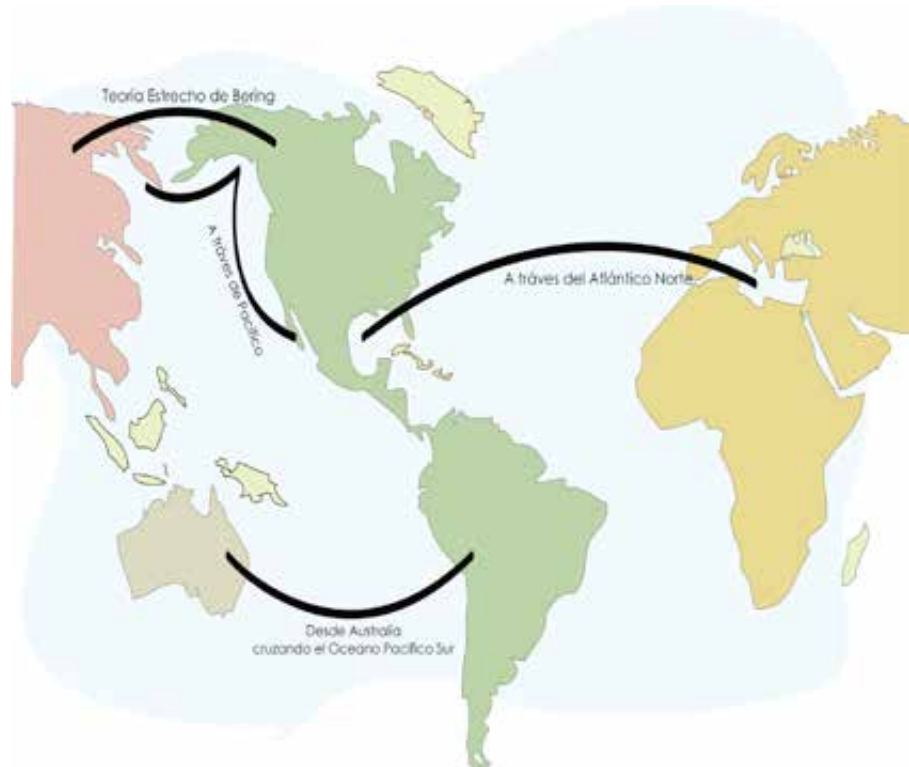


Figura 1.

1. Migración desde Oceanía, a través de la Polinesia, a América del Sur. Modelo sustentado con base en evidencias arqueológicas muy antiguas, con fechas que van de 14.440, 12.560 y 11.500 años, por mencionar algunos. Otro indicador es que los especímenes humanos antiguos de estos lugares comparten ciertas afinidades biológicas con la población de la Polinesia. Tales son algunos de los argumentos que sustentan que éste fue uno de los corredores por donde ingresaron los primeros grupos humanos que colonizaron la parte sur del continente.

2. Migración desde Europa, siguiendo la ruta del Atlántico, para llegar al noroeste de América. Esta hipótesis se sustenta en la similitud morfológica de las puntas Clovis (datadas en 11.500-10.900 años) con las puntas solutrenses europeas (18.000-16.000). Esta ruta fue por donde se desplazaron los cazadores y pescadores solutrenses, tomando como referencia las masas de hielo del Atlántico norte en dirección a América.

3. Ruta más aceptada por donde se cree que ingresaron los primeros grupos humanos a América fue por el puente terrestre, formado en el estrecho de Bering. Debido a la cercanía geográfica entre la parte oriental de Siberia y Alaska, hay una mayor posibilidad de que los humanos ingresaran por esta vía, partiendo del noreste de Asia para llegar al noroeste de América entre los 25.000-10.000 años.



Otro de los temas que se han puesto sobre la mesa es si los nativos americanos están conformados por una población homogénea, producto de un solo grupo fundador, como afirmaba Hrdlička (1916), o si, más bien, la variabilidad encontrada es atribuible no sólo a las migraciones sino también a factores evolutivos como la deriva génica, la selección natural y el flujo de genes *in situ*, como lo tipifica Greenberg et al. (1986) y Turner (1985). En relación con esto, Stewart y Newman (1951) mencionaban que la heterogeneidad podría atribuirse a los distintos grupos humanos que ingresaron al continente.

En décadas pasadas se ha aceptado que el origen del hombre americano responde al modelo propuesto por Greenberg, Turner y Zegura (1986), el cual propone que existe cierta variabilidad en las poblaciones nativas americanas producto de tres migraciones que salieron del noreste asiático con un patrón mongoloide. Según este modelo, los grupos que ingresaron al continente son principalmente tres: los primeros en llegar fueron el grupo de los paleoamericanos, alrededor de los 14.000 años (si esto es cierto, éste es el grupo que dio origen a la población amerindia); el segundo grupo en entrar fue el de los Na-Dené, el cual migró tiempo después, alrededor de los 10.000 años, asentándose en la costa noreste de Canadá; los últimos en ingresar fueron los esquimales, los cuales tienen una temporalidad que oscila en los 4.500 años y que habitan en el Círculo Polar Ártico Americano.

En años recientes se sabe que la población amerindia es más variable y diversa de lo que se esperaba. Al respecto, se han propuesto otros modelos migratorios como alternativa al modelo tripartita de Greenberg et al. (1986). Uno de ellos es el propuesto por Neves y Pucciarelli (1991), en el que añaden una migración más a la tripartita, basada principalmente en una morfología no mongoloide que caracteriza a los amerindios. Estos autores sugieren que los primeros humanos que colonizaron el continente americano derivaron de un grupo de *Homo sapiens* moderno que migró del norte y sur de Asia, dejando descendencia en Australia y América.

Así, basándose en el patrón de diferenciación, los paleoamericanos representan un grupo de inmigrantes no mongoloides del Pleistoceno Tardío provenientes del este de Asia, quienes ingresaron a América durante el Holoceno. Posteriormente llegó el grupo Na-Dené y, finalmente, los esquimales aleutianos.

Siguiendo el modelo propuesto por Neves y Pucciarelli, en los últimos años se han realizado estudios alternos para evaluar la variabilidad fenotípica de los primeros habitantes americanos, a partir de la morfología craneal (Jantz y Douglas, 2001; Powell y Neves, 1999; González et al., 2008; González et al. 2005; Sardi et al, 2005). Los resultados de estos estudios han permitido conocer que existe una ruptura en la morfología, sin mostrar rasgos fenotípicos de continuidad en el tiempo, además de cuestionar la homogeneidad que se dice existir entre las primeras poblaciones americanas.

Estos autores han utilizado dos términos para referirse a las poblaciones americanas, los llamados amerindios y los paleoamericanos, estos últimos fueron los primeros en llegar al continente.

La morfología que caracteriza a los paleoamericanos ha sobrevivido en grupos más recientes, sobre todo en lugares como México. Estudios reportan similitudes biológicas entre los cráneos de los pobladores más antiguos del continente, con los de grupos cronológicamente más recientes, tales como los pericúes de Baja California Sur y los laguneros de las cuevas de La Candelaria y La Paila, en el estado de Coahuila. Éstos presentan formas dolicoide, que son características morfológicas de las primeras oleadas que migraron al continente americano (Imbelloni, 1938; Martínez del Río, 1947; Rivet, 1943; Romano, 1955, 2007).

Uno de los problemas que se tienen en el continente es que son muy escasos los esqueletos humanos de los primeros nativos americanos, lo que dificulta tener información integral que permita discernir con mayor claridad los marcadores morfogenéticos de la antigüedad, así como su desarrollo cultural, lo cual es una de las bases primarias para entender los fenómenos poblacionales.

En México, la Dirección de Antropología Física del INAH ha reunido 45 esqueletos humanos de ambos sexos y de edades diferentes del periodo prehistórico.

Así, por ejemplo, en 1884 se dio a conocer el primer hallazgo en la cuenca de México de un esqueleto humano perteneciente a la época prehistórica, el cual fue bautizado como el "hombre del Peñón I". Es a partir de esta fecha que nace el interés por iniciar una búsqueda de las primeras evidencias humanas en territorio mexicano. La mayoría de estos esqueletos se ha localizado en la Cuenca de México.

El objetivo de este trabajo es presentar la información morfológica de cinco cráneos humanos, uno del sexo femenino y cuatro masculinos, con una antigüedad que oscila entre los 12.700 y 10.500 años.

La hipótesis que se tiene de estos esqueletos humanos es que pertenecieron a dos grupos que ingresaron por el estrecho de Bering, pertenecientes a la primera oleada, tomando como referencia la morfología y su antigüedad.



Figura 2. Cuenca de México, señalando los lugares donde se localizaron los cráneos precerámicos.



Figura 3. Oleadas de ingreso al continente Americano.



Figura 4. Profesor Maldonado dentro del pozo donde se localizó la "Mujer del Peñón III". Fotografía tomada, González Rul (1959).

Esta hipótesis se apoya en las evidencias arqueológicas localizadas en Alaska, Canadá, Estados Unidos y México, donde se pueden trazar rutas posibles por donde estos grupos se fueron desplazando hasta llegar a la frontera con México. Tomando como referencia estas evidencias podemos decir que una de las vías con mayor posibilidad es que entraran por los estados de Nuevo León, Tamaulipas, San Luis Potosí, Querétaro y Estado de México, hasta llegar a la Cuenca de México.

## Material y método

Se presenta una muestra de cinco cráneos humanos de ambos sexos y de edades diferentes, todos ellos ubicados cronológicamente en el Pleistoceno Tardío y procedentes de la Cuenca de México y del Estado de Puebla.

La determinación de la edad y sexo se basa en el método propuesto por Lovejoy (1984), Lovejoy, Meindl, Pryzbeck, Mensforth (1985), y Loth y Henneberg (1996).

## Datación

**Directa:** se tomó una muestra de hueso del esqueleto y fue analizado por el método del Carbono 14 ( $^{14}\text{C}$ ).

**Indirecta:** se tomó una muestra de tierra de la parte endocraneal, la cual fue analizada por el método de geoquímica.

El análisis de las muestras se realizó en el Research Laboratory for Archaeology and History, de la Universidad de Oxford, Inglaterra, en el año 2000.

La información presentada en este trabajo es en relación con los cráneos localizados en el periodo que va de 1959 a 1980. El primero de ellos es el cráneo que pertenece al esqueleto de la "Mujer del Peñón".



## Mujer del Peñón III

En 1959 fue descubierto accidentalmente el esqueleto marcado como la “mujer del Peñón III” cuando el señor Tereso Hernández cavaba un pozo en el patio de su casa, ubicada entre las calles de Emiliano Zapata y Bolívar, Manzana 78, Lote 2, en la colonia Peñón de los Baños, muy cerca del Aeropuerto Internacional Benito Juárez, en la Ciudad de México.

El esqueleto fue entregado al Departamento de Prehistoria del INAH y, por la importancia del mismo, se comisionó al arqueólogo Francisco Gonzales Rul para que realizara una serie de pozos de sondeo con la finalidad de verificar la estratigrafía del área. El arqueólogo encontró que el esqueleto se ubicaba en la parte inferior de un sedimento con características de toba volcánica, intensamente húmeda, de posición subacuática y sellada por una capa de roca travertínica de un espesor de 2 m. El depósito en que se hallaba el espécimen humano era totalmente acerámico (Aveleyra, 1950). El esqueleto pertenece a un individuo del sexo femenino, con una edad entre los 24 y los 26 años a la muerte.

### Perfil morfológico

**Norma frontal.** El frontal es de forma abombada, las eminencias frontales son prominentes, presenta una quilla a lo largo de la sutura metópica, crestas laterales prominentes, marcadas las líneas curvas en la región del parietal. El torus orbitario es poco prominente al igual que la glabella. Los bordes supra-orbitarios son fuertes y cortantes. Las apófisis ascendentes son amplias, los agujeros infraorbitarios son grandes, las órbitas son redondeadas.

**Norma lateral derecha.** El malar es amplio y fuerte, el ángulo inferior es prominente y robusto, la sutura temporoparietal está abierta, la cresta supramastoidea es prominente, el conducto auditivo externo es amplio.

**Norma lateral izquierda.** La sutura fronto-cigomática está abierta, la apófisis marginal del hueso malar es prominente, el orificio anterior es doble, el ángulo inferior es robusto, el arco cigomático es fuerte, las líneas temporales marcadas. La cresta supramastoidea es prominente, la apófisis mastoides es grande y robusta. El conducto auditivo externo es amplio de forma ovalada.

**Norma basal.** La bóveda palatina es profunda, el conducto palatino posterior del lado derecho presenta dos pequeños agujeros accesorios. La apófisis piramidal del hueso palatino es pequeña. Conserva once piezas dentarias y una raíces, las faltantes fueron perdidas post mórtem. Todas las piezas presentan un desgaste muy marcado.

**Mandíbula.** Es grácil, la sínfisis es pequeña y poco prominente. El borde anterior de la rama es cortante, ambos cóndilos se proyectan ligeramente hacia adentro, la apófisis corónides son poco elevadas, los gonios son pequeños. Conserva todas las piezas dentarias, presentan un desgaste muy marcado, en algunas piezas queda al descubierto la pulpa, pero sin provocar ninguna infección. El mayor desgaste lo presentan los incisivos. Tiene tres incisivos, el del lado izquierdo no brotó, así como los terceros molares, posiblemente por falta de espacio o por un problema congénito.

**Métrica.** El cráneo se pudo medir en su totalidad, lo que permitió calcular los índices que permitieron tener una configuración del cráneo: es alargado (70,59), de altura media (96,97), frente de anchura media (67,42), anchura de la cara es media (50,76), orbitas altas (95,94), paladar ancho (91,30). Su estatura es de 1,51 m.

**Datación.** Fue por medio del método del 14C, obteniendo una antigüedad de 12.700 años AP calibrado con un valor de isótopos estables de carbono de  $\delta^{13}C = -11,6$ ,  $\delta^{15}N = 13,6$ , C.N=3,5, Collagen mg/g=50,3.



Figura 5. Mujer del Peñón III

## Hombre de la Cueva de Texcal

En el año de 1964 y 1965 se llevaron a cabo una serie de excavaciones en la Cueva de Texcal por el Departamento de Prehistoria del INAH. La cueva se localiza en el municipio de Texcal y pertenece a la región sur del Valle de Puebla-Texcal. Se ubica en el margen del antiguo río Atoyac, que hoy en día está cubierto por las aguas de la presa Manuel Ávila Camacho, muy cerca de las faldas del volcán Toluquilla (García, 1977).

La excavación del abrigo se realizó en cuatro temporadas, la primera fue a partir de 1964, cuando se recuperaron seis enterramientos humanos secundarios, y 1965, cuando se halló uno más de tipo primario en posición de decúbito lateral flexionado, con una orientación de norte-sur (García, 1977). El cráneo pertenece a un individuo de sexo masculino, adulto, de 31 a 35 años a la muerte.



Figura 6. Por sus características geológicas, la Cueva de Texcal es un abrigo rocoso natural, formado por una oquedad poco profunda con un talud plataforma de ocupación y un techo tipo visera.

### Perfil morfológico

**Norma frontal.** El torus orbitario es prominente al igual que la glabella. Las órbitas son cuadradas, la sutura fronto-nasal se encuentra abierta, el hueso nasal es grande y prominente.

**Norma lateral derecha.** Los malares son robustos, arcos cigomáticos fuertes, presenta el orificio anterior del conducto malar y un accesorio. La línea temporal superior es marcada y rugosa, los arcos cigomáticos son grandes, el conducto auditivo externo de ambos lados es amplio y de forma ovalada, las apófisis mastoides son grandes y robustas.

**Norma posterior.** Se observa cierta asimetría en las eminencias parietales. La sutura lambdoidea está abierta, presenta pequeños huesos wormianos, y un hueso interparietal cuyas dimensiones es 44 x 46 mm. La porción escamosa presenta huellas de fuertes inserciones musculares. Las apófisis mastoides son muy asimétricas, el occipital es ligeramente pronunciado.

**Norma basal.** Los bordes inferiores del hueso malar son amplios, robustos. La bóveda palatina es poco profunda, presenta cuatro rebordes óseos, dos de cada lado. Las láminas horizontales del palatino son prominentes y curvas. Conserva el primer premolar del lado izquierdo, el cual presenta un desgaste que llegó hasta el cuello de la pieza, dejando expuesta la dentina, las piezas faltantes fueron perdidas post mórtem.

**Mandíbula.** Incompleta, la sínfisis es pronunciada, a nivel del canino tiene un absceso que llega casi a la mitad del cuerpo mandibular, la línea oblicua externa es pronunciada. Los ángulos se proyectan hacia fuera, al igual que las apófisis coronoides, se observa un proceso de reabsorción alveolar. Conserva cuatro piezas dentarias, con un desgaste muy marcado dejando expuesta la dentina. De las piezas faltantes, seis fueron perdidas post mórtem y las demás ante mórtem, se observa un proceso infeccioso y reabsorción alveolar.

**Métrica.** El cráneo fue restaurado debido a que estaba muy fragmentado, lo que permitió tomar algunas medidas para valorar su forma. Es de longitud corta (80,66), de altura media (64,64), de frente angosta (65,75), nariz angosta (46,15), orbitas de altura media (82,93).

**Datación.** Fue por el método del 14C, tiene una antigüedad de 7.480 + 55 AP, &13C= -14,4, &15N= 11,0, C: N= 3,5, Collagen mg/g =12,3.



Figura 7. Hombre de la Cueva de Texcal



## Hombre de Tlapacoya I

Desde finales de 1965 hasta 1973, se realizan una serie de excavaciones en el cerro de Tlapacoya. Este cerro es un promontorio volcánico que se localiza al sur de la Sierra del Pino, en la región sureste de la Cuenca de México. Estos trabajos arqueológicos fueron motivados por la construcción de la autopista México-Puebla, que pasa bordeando el cerro de Tlapacoya. Durante la excavación aparecieron huesos de diversos animales, artefactos líticos y cantos de piedra que indicaban ser restos de un hogar, que sin duda fue producto de una actividad humana.

En el año de 1968 se recibió la noticia de que habían localizado un cráneo humano, accidentalmente fuera de contexto. El cráneo está incompleto, pertenece a un individuo masculino adulto, con una edad aproximada de 30 a 35 años a la muerte.

### Perfil morfológico

**Norma frontal.** Cerca de la zona bregmática presenta un ligero hundimiento, de forma irregular, con una dimensión de 31 x 18 mm. Es probable que fuera provocado por un traumatismo ocasionado a una edad muy temprana. En la parte media del frontal se aprecia un ligero aquillamiento. Los arcos supraorbitarios están muy desarrollados.

**Norma lateral derecha.** La apófisis mastoideas es grande. En el borde posterior, así como en la cara lateral, presenta huellas provocadas por un roedor. Se marca muy bien el triángulo mastoideo. El conducto auditivo es grande y de forma ovalada.

**Norma posterior.** El occipital es prominente, las líneas curvas superior e inferior están muy marcadas, al igual que la cresta externa del occipital. La sutura lambdoidea presenta una gran cantidad de huesos wormianos.

**Norma basal.** Las órbitas son cóncavas, en la derecha se aprecian dos pequeños agujeros debajo de la escotadura supraorbitaria.

**Métrica.** El cráneo es alargado y angosto (67,17), es de altura media (73,23), frontal ancho (72,93).

**Datación.** Fue por el método del 14C, teniendo un resultado 10.200 + 65 años AP, &13C=-10.6, CN: 3.5 colágeno/mg/g 10.9.



Figura 8. Hombre de Tlapacoya I

## Hombre Metro Balderas

En 1968, en la calle de Balderas, entre las avenidas Independencia y Juárez, al realizar excavaciones profundas para construir el túnel para el Sistema de Transporte Colectivo Metro, en la Ciudad de México, se localizó accidentalmente un cráneo con su mandíbula a una profundidad de 3,10 m.

Pertenece a un individuo masculino, con una edad de 35 a 40 años a la muerte.

### Perfil morfológico

**Norma frontal.** El frontal es grande y huidizo; los arcos superciliares son marcados, la glabella es ligeramente pronunciada, las crestas laterales son muy marcadas, las órbitas son de forma cuadrada con bordes redondeados. La sutura que une la apófisis orbitaria externa del frontal con la apófisis orbitaria del malar se encuentra abierta. Las fosas orbitarias son cónicas y profundas, los techos son convexos. El hueso nasal está incompleto, las fosas caninas son muy marcadas.

**Norma lateral derecha.** El parietal es pronunciado, la línea curva temporal superior se aprecia claramente. La cresta supramastoidea es robusta, como la apófisis mastoides. La apófisis marginal del hueso malar es pronunciada, el conducto auditivo es pequeño.

**Norma lateral izquierda.** La línea curva temporal superior es muy marcada, la apófisis mastoides es prominente, el agujero auditivo es pequeño de forma oval.

**Norma superior.** La sutura coronal y sagital están abiertas, presenta huesos wormianos.

**Norma posterior.** La sutura sagital y lambdoidea presentan huesos wormianos, el occipital es abombado, la línea curva superior es ligeramente marcada, a diferencia de la inferior que es muy pronunciada.

**Norma basal.** El paladar es largo, ancho, profundo, la arcada alveolar es casi cuadrada. Ambas tuberosidades del maxilar son robustas, el conducto palatino anterior es grande. Conserva nueve piezas dentarias, faltándole siete, tres de ellas las perdió ante mórtem y las demás post mórtem. Todas las piezas presentan un desgaste muy marcado, en algunas en forma de bisel. Queda expuesta la dentina.

**Mandíbula.** Es grande, robusta, en forma de herradura, marcadas inserciones musculares; conserva todas las piezas dentarias, presentan un desgaste muy evidente.

**Métrica.** Se calcularon los índices que permitirán valorar la forma del cráneo, es alargado y angosto (73,97), de frente ancha (80,83) orbitas altas (86,04) y paladar ancho (75,47).

**Datación.** La antigüedad obtenida fue de 10.500 AP, se obtuvo de manera indirecta. Debido a que el proceso de mineralización que presenta el cráneo es muy avanzado, no fue posible obtener colágeno. Se tomó una muestra de sedimento que se encuentra en la parte endocraneal, ésta fue analizada por el método de la geoquímica.



Figura 9. Hombre Metro Balderas

## Hombre de Chimalhuacán

El esqueleto fue localizado accidentalmente en el año de 1980, cuando cavaban una fosa séptica, en la colonia el Embarcadero, Municipio de Chimalhuacán, Estado de México. Pertenece a un individuo de sexo masculino, de una edad de 33-35 años a la muerte.

### Perfil morfológico

**Norma frontal.** Presenta una quilla en la parte superior del frontal, el torus orbitario es pronunciado en forma de pequeños arcos, la glabella prominente, los arcos supraorbitarios son robustos, los bordes son redondeados, en ambas órbitas presenta el agujero supraorbitario, órbitas cuadradas.

**Norma lateral izquierda.** La apófisis marginal del hueso malar es prominente, arco cigomático robusto, son marcadas las dos líneas curvas frontotemporales, la apófisis mastoides es grande, la cresta supramastoidea es prominente, el conducto auditivo externo es amplio, de forma ovalada, proyectado hacia arriba y ligeramente hacia delante, el borde externo del hueso timpánico es pequeño.

**Norma lateral derecha.** El ángulo superior del hueso malar es muy prominente, el arco cigomático robusto, la apófisis mastoides grande, la cresta supramastoidea es pronunciada, el conducto auditivo externo es grande, de forma ovalada.

**Norma posterior.** La sutura sagital, lambdoidea se encuentra abierta, presenta pequeños huesos wormianos, el occipital es de forma prominente.

**Norma basal.** La bóveda palatina es profunda, presenta ocho piezas dentarias con un marcado desgaste dentario, deja al descubierto la dentina. Las piezas faltantes fueron perdidas post mórtem.

**Mandíbula.** La sínfisis es alta, pronunciada, los tubérculos laterales son marcados y robustos, las apófisis coronoides se dirigen ligeramente hacia fuera, mientras que el cóndilo se proyecta hacia dentro, el tubérculo es robusto, se observa el agujero mentoniano de tamaño medio de forma ovalada, la línea oblicua externa es pronunciada, el borde inferior es robusto con marcadas huellas de inserciones musculares. Conserva ocho piezas dentarias completas dos incompletas, presentan un desgaste muy marcado, quedando al descubierto la dentina.

**Métrica.** Se pudo valorar la forma del cráneo, que es largo (70,70), es de cara media (51), nariz angosta (41), orbitas altas. Estatura de 1,70 m.

**Datación.** La antigüedad es de 10.500 años, fue obtenida indirectamente debido a que no se encontró colágeno en los huesos por el proceso de mineralización tan avanzado. El fechamiento fue a través de sedimento que pertenece a cenizas volcánicas que se correlacionan con la Pómez Toluca. Superior (tripartita), este material se encuentra en la parte endocraneal, fue analizado por el método de la geoquímica.



Figura 10. Hombre de Chimalhuacán I

## Resultados de los Análisis

Los resultados del análisis morfológico de los cráneos indican que cuatro de ellos pertenecen a un grupo, debido a que comparten características morfológicas semejantes. El cráneo es dolicocefalo con un índice craneal de 67.67, esto apoya la hipótesis de que uno de los primeros grupos que ingresaron al continente, tenía estas particularidades anatómicas. Además estos cráneos están dentro del rango cronológico que se marca cuándo ingresan los primeros grupos, que va de 12.700-10.500 años AP. Estos cráneos fueron localizados en diferentes sitios dentro de la Cuenca de México. El cráneo que no comparte los rasgos morfológicos fue localizado durante las excavaciones realizadas en la Cueva de Texcal Puebla. Se caracteriza por ser corto, ancho, bajo, y tiene una antigüedad de 7.480 años AP. Con esta información de estos especímenes podemos inferir que entre 12.700- 7.480 años, llegaron entre dos o más grupos humanos al Territorio Nacional.

Uno de los esqueletos con mayor relevancia para la investigación prehistórica en México es la "Mujer del Peñón III", cronológicamente es el más antiguo. Además presenta particularidades anatómicas en la mandíbula, no le brotó el incisivo del lado izquierdo, así como los terceros molares. Una de las causas puede ser que la mandíbula sufrió un decrecimiento y no hubo espacio para que brotaran las piezas. Otra posibilidad es que ello sucediera por causas biomecánicas, tipo de alimentación, etcétera, o a un proceso micro-evolutivo o congénito. Este fenómeno se observa hoy en día en algunos grupos mexicanos, donde existe un porcentaje elevado de personas que no tienen espacio suficiente en el maxilar, en la mandíbula para que les broten los terceros molares. Se puede inferir que en estos dos segmentos anatómicos del esqueleto es donde se refleja un proceso micro-evolutivo en los grupos mexicanos, que posiblemente ha tenido una continuidad ininterrumpida desde la llegada de los primeros grupos al continente hasta la actualidad.

Un aspecto más que llama la atención es en relación con la estatura de la "mujer del Peñón III", que es 1,51 m. La estatura promedio de la mujer mexicana, de la época prehispánica, virreinal y actual, es de 1,51-1,52 m. Esto se debe a causas relacionadas con la genética, problemas alimentarios, estrés, factores biológicos característicos de la mujer (embarazo, parto, menstruación, número de hijos, amamantamiento, estrés, el medio ambiente, etcétera).

En el caso de los hombres de la Cuenca de México con una antigüedad de 10.500 años, tienen una estatura promedio de 1,72 m. Para la población masculina de la época prehispánica, virreinal y actual, que habitaron el territorio de México, el promedio es de 1,68-1,69 m. En este caso se observa un decrecimiento durante 10.500 años a la fecha. Una de las aseveraciones que se pueden plantear es que los grupos posteriores y actuales no descienden de este grupo. Otro de los indicadores es que fue por causas mestizaje entre los grupos que ingresaron y uno de ellos fue el que predominó genéticamente. La alimentación fue menos balanceada, pudo haber sido por escasez, debido a un crecimiento demográfico, etcétera.

En términos generales podemos decir que estos individuos no presentan ningún problema de enfermedad debido a que no se observa huella alguna en el esqueletos, posiblemente las enfermedades que padecían eran virales, que no dejan su marca en el esqueleto. Lo que se aprecia son traumatismos, infecciones en el maxilar y la mandíbula, debido al desgaste que sufrieron los dientes provocados por la alimentación y posiblemente por falta de una limpieza constante y adecuada.

Es importante mencionar que las piezas dentarias de estos individuos jugaban un papel muy importante en la elaboración de posibles instrumentos e implementos personales o de uso social, como algunas correas que sirvieran para elaboración de sus vestuario, debido a que los dientes tienen un desgaste que sólo puede ser provocado por una constante actividad como la elaboración de un materia, como pieles, raíces y el tipo de alimentación, etcétera.

Otro de los aspectos que llama la atención es el promedio vida, que es entre los 25 y 30 años, con esto podemos señalar que su edad reproductiva era a muy temprana edad. Además su crecimiento demográfico era muy regulado, por éste y otros factores, como puede ser el fallecimiento de infantes, etcétera. Posiblemente habían desarrollado una inteligencia que les permitió vencer todo tipo de problemas que se opusiera la sobrevivencia del grupo, lo que permitió radiar todo el continente americano.

La datación de estos esqueletos los convierte en las mujeres y hombres más antiguas de México, que soportaron todas las inclemencias naturales como las bajas temperaturas, las lluvias torrenciales, el enfrentamiento con animales y las enfermedades que pudieron padecer, etcétera. A pesar de todo esto y algunas eventualidades más, lograron llegar a la cuenca de México entre los años 12.700 AP. Con los resultados obtenidos de la antigüedad de los cuatro cráneos más 36 evidencias de esqueletos humanos y la mega-fauna que se han localizado, la Cuenca de México se perfila entre los sitios prehistóricos más importantes del territorio nacional.

Este lugar, durante el Pleistoceno final y principios del Holoceno, tenía las condiciones propicias para el desarrollo de los grupos humanos. Debido a que en la cuenca existían lagos de agua dulce y salada, en donde había pescados, acociles, ranas, aves de todo tipo, patos, garzas, amaranto, quintonil, verdolaga, quelite, nopal, tunas, animales, conejos, ardillas, liebres, mamut, etcétera. La suma de la variedad de productos comestibles formó una dieta adecuada que permitió que estos grupos humanos

tuvieran un desarrollo físico y mental armonioso. Además, en la cuenca había una gran cantidad de manantiales de agua dulce para su consumo. Éstos fueron algunos factores que permitieron el desarrollo de los grupos. La Cuenca de México debió ser uno de los puntos de partida de algunos grupos que poblaron parte del Territorio Mexicano actual.

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# La producción de arte rupestre en el contexto del primer poblamiento de México: algunas evidencias tempranas

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## Resumen

Durante gran parte del siglo XX, el arte rupestre prehistórico ocupó un lugar secundario y de poco valor para el estudio de las sociedades que lo crearon. Dicha situación es comprensible si consideramos las pocas expectativas que su investigación generaba para la arqueología de aquel entonces, por lo que durante décadas su estudio quedó rezagado de las principales corrientes de esta disciplina. Algunos factores que contribuyeron a este rezago se relacionan con la dificultad que implicaba el tratar de situarlo cronológicamente e integrarlo en un marco interpretativo general.

En México, fue hasta la década de 1980 cuando empezó a registrarse un interés creciente por abordarlo de manera consistente y sistemática. En aquellos años, se fundó un número importante de centros de investigación del Instituto Nacional de Antropología e Historia (INAH) en el norte y noroeste de México, región que se destaca por la abundancia y buena conservación de numerosos sitios con imaginería rupestre. Poco a poco, el desarrollo de la arqueología nortea acrecentó el inventario de sitios con arte rupestre (Murray y Valencia, 1996; Murray et al., 2003; Viramontes et al., 2008). Paralelamente, el panorama a nivel mundial dio un vuelco cuando su estudio empezó a abordarse a través de novedosas perspectivas teórico-metodológicas. Esto, sumado al desarrollo de sofisticadas herramientas tecnológicas y científicas, nos coloca hoy en día ante la posibilidad de avanzar con presteza en su estudio y, así, reducir la desventaja que todos estos años de indiferencia trajeron consigo. No obstante, pocos son los casos que han abordado la investigación arqueológica de esta manifestación cultural desde una perspectiva contextual y regional, incluyendo la posibilidad de investigar y definir su antigüedad (Gutiérrez, 2013).

A continuación se revisará el estado que guardan las investigaciones en México, que ya sea directa o indirectamente tratan de colocar en el tiempo las abundantes manifestaciones rupestres del país, aspecto crucial para el estudio integral de la imaginería plasmada en piedra. Por la limitación que impone el espacio disponible, se expondrán ejemplos de algunos sitios que destacan por su antigüedad y su posible correlación con las primeras ocupaciones humanas en el país. Posteriormente se abordará el caso de la región central de la península de Baja California, en la cual ha tenido lugar una investigación arqueológica integral de largo plazo, lográndose el establecimiento de un corpus cronológico consistente, que sitúa la ocupación humana en la región en cerca de 11 mil años AP (Gutiérrez y Hyland, 2002) y el inicio de la tradición pictórica de los Grandes Murales, al menos, en 7.500 años AP (Gutiérrez, 2013; Watchmann et al., 2002).

Finalmente, como evidencia adicional para sustentar la antigüedad del arte rupestre de la región y su posible relación con los primeros pobladores de México, se expondrá el caso de los Volcanes Tres Virgenes, extraordinario *Lugar Natural* (Bradley, 2000) que reúne bajo sus dominios algunos rasgos de naturaleza excepcional que fueron "...culturizados y codificados con significado" (Strang, 2006, p. 68), como por ejemplo: grandes yacimientos de pigmentos minerales y de obsidiana, este último con un aprovechamiento calculado en al menos 10 mil años AP, manantiales de aguas termales y un abrigo rocoso insólito con un arte rupestre enigmático, pero que incluye, al menos, dos motivos muy característicos del subestilo pictórico Gran Mural denominado San Borjitas, hasta el momento uno de los que evidencia mayor antigüedad en la región (Gutiérrez, 2013).

## Introducción

**Desde finales del siglo XIX, los rumbos que tomó la arqueología mexicana fueron decididos, sin lugar a dudas, por la presencia consistente y trascendental de las culturas que se desarrollaron en Mesoamérica, región cultural que ocupa gran parte del territorio nacional. Ésta se extiende aproximadamente desde el paralelo 28° hasta los actuales territorios de Guatemala, El Salvador y Honduras. Ante esta inagotable fuente de estudio, arqueólogos mexicanos y extranjeros encauzaron su interés casi exclusivamente en lo mesoamericano, realizando importantes investigaciones en torno a tan maravilloso e innegable legado. En consecuencia, el avance logrado en el conocimiento de Mesoamérica fue sustancial, sobre todo durante la segunda mitad del siglo XX (Gutiérrez, 2006, pp. 13-20).**

Mientras esto ocurría, más allá de los límites septentrionales de este reservorio pluricultural, el norte del país, región denominada coloquialmente la “Gran Chichimeca” por los antiguos cronistas, guardaba sus secretos al amparo de su vasto, agreste y remoto territorio. Ya desde épocas prehispánicas, esta distante y desconocida región era considerada un espacio geográfico muy temido, asociado con la muerte y con una serie de carencias de todo tipo. “Ellos llamaban aquella región la Chichimecatlalli —o tierra de los Chichimecas— y también la Teotlapan Tlacochealco Mictampla —o ‘campos espaciosos que están hacia el norte-lugar de la muerte’—” (Braniff, et al., 2001, p. 7).

Si bien aquellas distantes y misteriosas regiones no presentaban las ventajas geográficas y ecológicas que prevalecían en Mesoamérica, y que fueron importantes para el desarrollo de notables “civilizaciones”, esto no significa que esplendor y complejidad cultural no hayan sido alcanzadas en tan remota región, como se verá más adelante.

De este modo, es más que evidente que la arqueología en México ha sido bastante desequilibrada, dada la diversidad de culturas que se desarrollaron en su vasto territorio. Ejemplo de esta inequidad del proceso investigativo es la notable escasez de estudios dirigidos a la prehistoria temprana, etapa en la que arribaron al país sus primeros pobladores (Arcaico Temprano, Etapa lítica, Pueblos Clovis, son algunas de las maneras de referirse a dicha etapa), así como el estudio de otro tipo de sitios arqueológicos y regiones culturales que representan contextos arqueológicos esenciales y cruciales para entender los ajustes y adaptaciones desarrollados por los pueblos que protagonizaron el largo proceso de poblamiento del continente Americano, el cual aún se encuentra rodeado de grandes enigmas y mitos, presentando el conocimiento científico importantes vacíos que no permiten vislumbrar con claridad las características de los primeros grupos humanos que llegaron a estas tierras milenios atrás, así como las rutas que siguieron, la cultura material que produjeron y el pensamiento y la cosmovisión que regían sus actuares cotidianos y excepcionales.

Como mencioné en un inicio, otro elemento cultural reiteradamente marginalizado por la arqueología mexicana es el arte rupestre. La imaginería plasmada en piedra, ya sea pintada o grabada, es uno de los recursos simbólicos más utilizados por los grupos humanos en todo el mundo, a través del cual los pueblos materializaron su pensamiento, ordenaron su mundo y crearon y negociaron sus identidades, perpetuando así su memoria, la cual permanece en el paisaje desde tiempos ancestrales. Una circunstancia que llama mucho la atención respecto a este recurso de comunicación visual es que muchos signos y símbolos del repertorio rupestre registrados a nivel mundial se repiten en todos y cada uno de los continentes, adquiriendo una connotación universal. Entonces, el arte rupestre puede ser considerado un metalenguaje que expresa pensamientos, conductas y realidades codificadas, probando que, en ocasiones, durante el proceso cognitivo, la mente humana interpreta la realidad y asocia ciertos signos a las mismas entidades o fenómenos, simbolizándolos. La omnipresencia de algunos elementos iconográficos rupestres en el orbe entero permite reflexionar acerca de la posibilidad de que, desde un pasado muy remoto, el hombre ha respondido de manera similar a los estímulos, fenómenos y circunstancias de su entorno, además de que eran portadores de un acervo de signos y significados heredados genética y culturalmente a lo largo de incontables generaciones. En este orden de ideas, los pueblos originarios percibieron su realidad, hicieron sentido de ella y asignaron un significado a sus diversos componentes; esto otorgó un orden y precisó la representación de este mundo mediante la creación de códigos metonímicos y metafóricos, en este caso, a través de la pintura o el grabado sobre las rocas, realizados mediante una diversidad de técnicas y en una pluralidad de contextos.

## México y su enigmático e incomprendido arte rupestre

Al ser considerado un elemento ordinario y arqueológicamente improductivo, el arte rupestre fue olvidado por la arqueología mexicana hasta muy avanzado el siglo XX, lo que generó un enorme atraso en la sistematización de su registro y la innovación de postulados teóricos y metodológicos que permitieran una visión profunda y objetiva de su sentido y significado. Esto resulta paradójico dada su abundancia en todo el país, especialmente en su territorio septentrional, espacio geográfico que posibilitó el desarrollo de interesantes pueblos que hicieron uso de este recurso visual a lo largo de amplios territorios y enormes lapsos. En México, la imaginería rupestre fue producida tanto por pueblos de tradición sedentaria y agrícola, como por móviles sociedades cazadoras recolectoras, quienes en un prodigio de adaptación ecológica a un medio ambiente recio y riguroso, lograron desarrollar interesantes complejos culturales.

En la actualidad, la mayoría de sitios rupestres registrados e investigados en el país se localizan en su septentrión, aunque esto no significa que en el resto de su territorio no haya igual o mayor cantidad de sitios; lo que sucede es que tal vez aún no se han encontrado. La riqueza de contextos rupestres en esta enorme región creó la falsa impresión de que su producción estaba relacionada, exclusivamente, a sociedades cazadoras-recolectoras, pensamiento que prevaleció durante un largo periodo:

durante décadas, el Norte ha sido considerado un lugar habitado por cazadores-recolectores, que fueron más propensos a producir arte rupestre que sus vecinos agricultores sedentarios del sur. Sin embargo, esta imagen es



falsa, de hecho, el arte rupestre es común a ambas sociedades, sedentarias y nómadas. Además, el fuerte sesgo de la arqueología mexicana para el estudio de las sociedades agrícolas sedentarias de Mesoamérica fue una influencia que margina los estudios del arte rupestre en los estados del sur de México, porque se pensó, erróneamente, que el arte rupestre fue exclusivo de las sociedades nómadas (Viramontes et al., 2008).

En torno a este paradigma, es necesario mencionar algunos otros factores que han contribuido a afianzar esta subjetiva apreciación: el México septentrional se caracteriza por su amplio y en ocasiones abrupto territorio, su clima semidesértico y su inherente aridez o semiaridez son elementos que han contribuido, de manera notable, a la buena conservación de miles de sitios grabados y/o pintados. Esta variable ambiental, sumada a la geología de ciertas regiones, ha sido definitiva para la preservación de la imaginería del norte y noroeste del país, si tomamos en cuenta las condiciones climáticas totalmente opuestas que se manifiestan en el centro, sur y sureste de México, donde la erosión pluvial y eólica y el efecto del desarrollo de la abundante y exuberante cobertura vegetal, entre otros factores, inciden directamente en la pintura, en ocasiones “desescamando” el soporte pétreo y colapsando fragmentos del panel pintado, y en otras cubriéndolo con sustancias que la ocultan, como por ejemplo los oxalatos y carbonatos de calcio. En el caso de los petrograbados, el desarrollo de una capa vegetal densa, e incluso el crecimiento de musgos y líquenes al interior de los surcos que conforman las figuras o motivos, pueden impedir su visibilidad. De este modo, mejores condiciones para la conservación inciden en las cifras de los inventarios y es así que, hasta el momento, el norte es la región que presenta un mayor porcentaje de sitios rupestres registrados y en ciertas áreas constituye uno de los elementos que otorgan identidad y representatividad a las diversas prehistorias regionales.

## Cronología y arte rupestre

Dejando a un lado las políticas de investigación nacional que imperaron en las siete primeras décadas del siglo XX y que dejaron en hibernación los estudios del arte rupestre, también se requiere enfocar la atención en otras razones de carácter científico que coadyuvaron a la marginación de esta manifestación cultural y la marcada indiferencia hacia su estudio; esta variable se relaciona con la complejidad que seguramente representó el abordar un material cultural tan ambiguo e “improductivo” para la arqueología de aquellos tiempos. Whitley y Loendorf (1994) señalan dos importantes factores que favorecieron esta tendencia, no sólo en México sino en todo el continente americano.

El primero se refiere a la posibilidad de fechamiento por radiocarbono que se dio en los años cincuenta y que no fue aplicable al arte rupestre. El segundo tiene que ver con el desarrollo de la Nueva Arqueología, corriente que, salvo excepciones, “falló en cumplir la promesa de integrar plenamente todos los aspectos del registro arqueológico en interpretaciones y explicaciones incluyentes” (Whitley & Loendorf, 1994, p. xii). Al prevalecer estas dificultades, era casi imposible integrar al arte rupestre en un panorama interpretativo general, lo que desalentó a los colegas de aquellos tiempos (Gutiérrez, 2007). Esto es aún más comprensible si consideramos que un elemento que va aparejado a hallazgos notables es cuán antiguos puedan ser; esto es algo que durante años fue el anhelo común de los arqueólogos, descubrir lo “más antiguo”. La antigüedad probada de un vestigio arqueológico incrementa el prestigio del investigador, y aún hoy en día, atrapa la atención de la comunidad científica y del público en general. Esta búsqueda de lo arcaico, y lo que trae consigo, tiende a sesgar y fraccionar los objetivos de una investigación arqueológica integral, al priorizar ciertos indicadores y desechar otros. Ahora bien, esto no significa que se subestime la importancia de contar con indicadores cronológicos precisos de antigüedad considerable, pero sí es necesario no enfocar la atención sólo en esta propiedad de lo arqueológico.

Partiendo de esta disyuntiva, ubicar los eventos del pasado en una línea de tiempo que permitiese las comparaciones entre eventos prehistóricos e históricos, se convirtió en un requisito para la investigación, y ésta es, quizás, la única variable donde el arte rupestre no aportaba valores confiables. Hasta hace relativamente poco, a lo más que se podía aspirar para asignar temporalidades a este material cultural, era a la reconstrucción de secuencias relativas, lo cual comúnmente sólo puede realizarse en caso de existir sobreposición de figuras y motivos, así como cambios en las tendencias de representación gráfica. Un apoyo esencial para determinar dichas secuencias con mayor precisión es la observación y registro detallados de la erosión diferencial de las diversas capas pictóricas para su posterior comparación, procedimiento muy útil y productivo en ciertos contextos. En el caso de que figuras y motivos estén aislados, la situación se complica. Una figura que se percibe sumamente deteriorada parecería ser muy antigua, sin embargo, esto es muy impreciso, pues el deterioro de la pintura rupestre no sólo la determina su desgaste por el paso de los procesos erosivos durante largos periodos; existen otros factores que las dañan y esto no se relaciona en nada con su temporalidad real (tipo de soporte pétreo, exposición al sol, erosiones eólica y pluvial y la calidad de la fórmula de la pintura).

Pero, asumiendo que estas secuencias relativas fuesen coherentes, lograr su temporalidad absoluta requiere *vincularlas* a artefactos utilizados durante el *evento de pintar*, o asociados a éstos, que fuesen fechables por  $^{14}\text{C}$ ; podría pensarse que estos artefactos se encuentran con relativa frecuencia en los depósitos arqueológicos de los recintos pictóricos, no obstante,

esto, por lo común, no pasa. Es sumamente raro el hallazgo de estos vestigios, tal vez por su naturaleza frágil y deleznable, aunque debo decir que en contextos desérticos o semidesérticos sucede lo contrario: las cuevas “secas” conservan muy bien los materiales arqueobotánicos y zooarqueológicos. Tal vez la ausencia de artefactos utilizados para pintar obedece a que poseían un valor simbólico profundo y por tanto, una cualidad sagrada, lo que hacía que fuesen objetos muy venerados, protegidos, resguardados e incluso heredados por los especialistas rituales, de generación en generación. Bajo los conceptos de Latour (2008), podríamos pensar que se trataba de “cuasi-objetos u objetos actantes”<sup>1</sup> vinculados estrechamente a la parafernalia del especialista ritual pintor y sobre todo a él, como el responsable de realizar esta trascendental actividad y, como en el caso de otros *cuasi-objetos* utilizados por diferentes especialistas rituales, su gran valor simbólico y poder intrínseco los hizo elementos sagrados, escasos, codiciados y por tanto difíciles de encontrar en el contexto arqueológico.

A finales de la década de 1980, las limitadas posibilidades de fechamiento aplicables al arte rupestre dieron un vuelco: se puso al alcance de la investigación arqueológica la posibilidad de obtener fechas radiocarbono de muestras de pintura rupestre a través del Espectrómetro de Masas (AMS por sus siglas en inglés):

The major advancement that laid the groundwork for the later dating revolution was the development of accelerator mass spectrometry (AMS). That innovation led to a drastic reduction in the amount of carbon necessary for a radiocarbon date - from a few grams to less than 1 mg of carbon. This reduction in sample size opened the way for even the small amounts of organic matter in rock paintings to be dated starting a decade later in 1987. Assigning painted images to a particular time period and, thus, a prehistoric culture, allows archaeologists to gain information on the artistic, cultural, technical and religious aspects of a people. (Rowe, 2015)

No obstante, aun cuando este método en sus inicios pareció ser la solución a los problemas para calcular la antigüedad del arte rupestre, también adolece de ciertas deficiencias y esto tiene que ver, básicamente, con el origen del carbón que se fecha. Por ejemplo, la datación es más confiable en el caso de que las pinturas hayan sido elaboradas con sustancias orgánicas que al mismo tiempo aportaron el color, por ejemplo, el carbón de madera para elaborar pintura negra y quizás la sangre para elaborar pintura roja; el asunto se complica cuando las fórmulas de las pinturas están realizadas a partir de pigmentos minerales, los cuales carecen de carbón; en algunos casos sólo se mezclaban con agua, lo cual hace imposible el fechamiento; en otros casos, al pigmento molido se le añadía un aglutinante, a la par del agua u otros líquidos que, en condiciones afortunadas, es el que provee el carbón que puede ser fechado. Luego entonces, primero es necesario saber si la pintura que queremos fechar contiene material orgánico datable.

En la actualidad, la datación AMS en muestras de pintura rupestre es objeto de una severa controversia, especialmente cuando es puesta en duda la pureza de las muestras y el origen del carbón a partir del cual se obtuvieron las fechas. En los albores del siglo XXI, ignorábamos que al paso de los años, esta revolucionaria técnica de fechamiento sería cuestionada, sin embargo fue aplicada a una amplia cantidad de muestras provenientes de sitios Gran Mural de las cordilleras centrales de la península de Baja California, lo cual arrojó interesantes resultados, como se verá en la segunda parte de este escrito.

## La investigación del arte rupestre

Las diversas maneras que existen de abordar el estudio de la imaginería rupestre son muy heterogéneas y prácticamente obedecen a los intereses de cada investigador y al grado de profundidad interpretativa que se quiera alcanzar. Como he reiterado, en ciertas circunstancias es necesario que su estudio sea regional, pues cada lugar pintado y/o grabado constituye tan sólo una parte de un universo simbólico que comunica discursos, por lo tanto aislar la imaginería de su contexto general sólo permitirá una aproximación parcial a su posible lectura e interpretación.

Por lo común, uno de los primeros asuntos que interesa investigar es la identificación de las diversas maneras de “representación” que desarrollaron los artífices del arte rupestre, su clasificación, la definición de estilos y sus secuencias; esto puede hacerse a partir de varios niveles de aproximación que pueden ir desde el estudio de un solo panel, hasta el de toda una región. En ocasiones, la espectacularidad que presentan ciertos sitios, por su tamaño, superficie pintada, excelente grado de conservación, temáticas y el lugar que ocupan en el paisaje, entre otros factores, puede atrapar al investigador

1 “Para este autor [Bruno Latour], incluso en el mundo actual no debería hablarse de la separación absoluta entre el sujeto y el objeto, sino más bien de cuasi sujetos y cuasi-objetos ‘actantes’ en las redes de su ‘teoría de la red de actores’. Según Latour los seres humanos siempre han estado conectados con las redes ‘actantes’ de los objetos. Todos los objetos que participan en la mediación entre los seres humanos ‘actúan’ en cierta manera. Los rasgos del paisaje también. Además de formar una red actante los rasgos del paisaje participan en los procesos de vincular el pasado con el presente, pues constituyen las huellas y los recuerdos del pensamiento cognitivo y simbólico de las generaciones pasadas”. [Iwaniszewski, 2012]

haciendo que su interés se enfoque exclusivamente en algunos de estos sitios excepcionales; esto indudablemente representa un sesgo profundo en la investigación y repercute en la interpretación final, pues se pasan por alto otros sitios que conforman este sistema de códigos metonímicos y metafóricos. Por lo tanto, es importante elevar el nivel de la investigación al ámbito regional, pues esto permite dos elementos esenciales para la comprensión de este metalenguaje: la familiarización con sus atributos cualitativos y cuantitativos, así como con sus entornos inmediatos, mediatos y remotos.

Desafortunadamente, en México son pocas las investigaciones que se han desarrollado en los términos descritos y, menos aún, aquellos que han contemplado la posibilidad de establecer un control cronológico relativo o absoluto de la imaginería rupestre, aunque es necesario reconocer que no siempre es por falta de interés; me refiero, por un lado, a la ya mencionada dificultad para la obtención de artefactos fechados relacionados directamente con el evento de pintar y grabar y, por el otro, a los costos que conlleva el fechamiento por AMS y las dificultades logísticas y financieras de todo el proceso, desde la obtención de las muestras, hasta su preparación y procesamiento en el espectrómetro de masas. A esto hay que añadir que el fechamiento directo de pintura rupestre es relativamente nuevo, como se señaló con anterioridad, lo que ha colocado a esta metodología en el fondo un debate profundo.

## Evidencia temprana de arte rupestre en México

En el ámbito internacional, existen importantes ejemplos de sitios que cuentan con evidencia contundente para ubicar con cierto rango de precisión, el tiempo en el que se inició la práctica de plasmar en la roca el pensamiento humano, a través de signos y símbolos que en ocasiones tienen una connotación universal; tal es el caso de lugares como las grutas de Altamira, El Castillo y Tito Bustillo, en España, las Grutas de Laxcaux y de Cosquer en Francia y abundantes sitios en Australia, por mencionar algunos ejemplos. En México, son pocas las regiones del país donde se han desarrollado esfuerzos para lograr la obtención de cronologías precisas del arte rupestre a través de las nuevas metodologías y tecnologías de las últimas décadas.

En el norte del país, esta práctica discursiva conforma grandes redes de comunicación, metalenguajes consistentes y persistentes aunque, la gran mayoría de las veces, enigmáticos e incomprensibles debido a la ausencia de estudios sistemáticos, regionales y de larga duración. Sin embargo, existe otra razón que nos impide *descubrir* lo que está *encubierto* (Heidegger, 1953): nuestra incapacidad de percibir la imaginería rupestre a partir de la recreación de una realidad paralela a la que prevaleció en el mundo indígena, y dejar de lado, en la medida de lo posible, el pensamiento occidental que domina nuestro inevitable “pre-entendimiento” del mundo, aprehendido de las múltiples generaciones que nos precedieron, así como la preconcepción de nuestra propia realidad, aprendida de nuestras propias vivencias (David, 2002; Gadamer, 1993; Gutiérrez, 2013).

A continuación se revisarán brevemente los pocos ejemplos que han intentado ubicar cronológicamente la imaginería rupestre en nuestro país. La mayor parte de la información ha sido tomada de la obra quinquenal *Rock Art, News of The World I* (Murray y Valencia, 1996), *II* (Murray et al., 2003), *III* (Viramontes et al., 2008) y *IV* (Viramontes et al., 2012), a menos que se indique lo contrario (figura 1).

## Noreste y Norte de México

En esta región del país, no se han realizado dataciones directas de pinturas rupestres, sin embargo, se cuenta con valiosa información que permite un cálculo aproximado de la temporalidad que podrían presentar algunos destacados sitios rupestres; si bien estas fechas no se vinculan directamente al evento de la producción de la imaginería, confirman la muy temprana ocupación de estas localidades, algunas de ellas asociadas a restos de paleofauna.

### Nuevo León

Este es uno de los estados de México que destacan por el desarrollo de investigaciones de larga duración, en las cuales el arte rupestre es considerado un elemento arqueológico fundamental para profundizar en su prehistoria. Algunos de los sitios que han reportado una gran antigüedad son el abrigo rocoso ubicado en las inmediaciones de La Morita Villaldama, (12.000 AP), La Calzada (10.600 AP) y Loma El Muerto (5.000 AP), localidad próxima a General Terán (Rivera, com. per.). Si bien estas fechas no pueden ser directamente relacionadas con la producción de la imaginería rupestre, sí demuestran que grupos de personas ya transitaban y moraban estas tierras, al menos hacia los finales de la glaciación Wisconsin y, ¿por qué no?, la producción de ciertos tipos de imaginería rupestre, especialmente la grabada, podría ser contemporánea al establecimiento de estos antiguos asentamientos humanos. Estas fechas arcaicas corroboran la antigüedad que ha sido definida en otros sitios rupestres de Nuevo León, como Cueva Ahumada y Boca de Potrerillos.



Figura 1. Sitios mencionados en el texto

### Boca de Potrerillos

Se trata de un sitio destacado del inventario de sitios rupestres de este estado; el enorme yacimiento concentra miles de figuras y motivos<sup>2</sup> grabados. Excavaciones realizadas por Valadez (2005) han descubierto la presencia de entierros humanos; el hallazgo de prácticas mortuorias en este espacio revela uno de los ejes esenciales de la cosmovisión indígena: la veneración de los muertos y los ancestros. La evidencia de este tipo de ritualidades en el contexto general del sitio incrementa, aun más, su enorme carga simbólica. En Boca de Potrerillos se han realizado algunos fechamientos radiocarbónicos de muestras provenientes de las excavaciones, colocando las primeras ocupaciones humanas en alrededor de 8.000 años AP (Turpin et al., 1993, 1994, 1995, 1996; Valadez et al., 1998; Valadez y Carpynteiro, 2011), y no existe razón para negar la posibilidad de que algunos de los petrograbados asociados al área de excavación de este importante complejo petroglífico, pudieron haber sido realizados en esas remotas épocas.

Paralelamente, en Cueva Ahumada, N.L. (Corona, 2001), las excavaciones han llevado al establecimiento de una cronología que va del Arcaico Medio Temprano (ca. 7.000 AP) a una ocupación de entre 5.000 y 3.500 años AP; de trascendental importancia es que estas últimas fechas fueron obtenidas de muestras provenientes de estratos adyacentes a un sector del panel pintado, mismos que contenían algunos nódulos de pigmento.

### La cronología entrelazada entre Cueva Ahumada y Boca de Potrerillos, Nuevo León, y El Pelillal, Coahuila

Un evento afortunado ha permitido ubicar en el tiempo, con cierto rango de certeza, la producción de un tipo de imaginería en algunos sectores del área cultural que nos ocupa; me refiero al hallazgo de arte rupestre mobiliario, es decir, placas pétreas portátiles con incisiones, en tres localidades arqueológicas de la región. Turpin es la primera que reporta este tipo de artefacto “ritual” para el sitio Boca de Potrerillos (Turpin et al., 1996); posteriormente, otras placas similares fueron encontradas en las excavaciones de Cueva Ahumada, Nuevo León y el Pelillal, Coahuila (Turpin & Eling, 2003), estas últimas yaciendo en

2 “el elemento básico de toda descripción de un panel de arte rupestre es un icono equiparable a la representación mental de un referente real o construido [...]. Como primer paso, y aunque complica ligeramente la terminología, abogáramos por hacer una diferencia entre la figura y el motivo. Una figura sería el icono individual, que pasaría a ser un motivo una vez identificado” (Berrocal, 2002, p. 94, citado en Gutiérrez, 2013).

contexto estratigráfico datable, lo cual permitió situar la antigüedad de este arte rupestre mobiliario en el Arcaico, quizás en aproximadamente 5000 años antes del presente (Heling, 2002).

Otro suceso afortunado que consolidó esta temporalidad relativa es que las excavaciones en Cueva Ahumada produjeron también una secuencia de puntas de proyectil en contexto estratigráfico datable. Tipos de puntas semejantes a los de esta secuencia han sido reconocidas en los grabados de Boca de Potrerillos y otros sitios de la región, proporcionando una temporalidad relativa a esta importante área rupestre (Valadez y Carpynteiro, 2011).

### Chihuahua

En el vasto espacio del norte de México, el Estado de Chihuahua destaca por la considerable cantidad de sitios rupestres que concentra a lo largo y ancho de su enorme territorio. El registro sistemático de su imaginería y su investigación arqueológica integral comenzó a practicarse en la década de 1990; en consecuencia, el inventario de sitios rupestres se ha incrementado de manera notable y algunos de ellos han sido investigados detalladamente, lo que ha aportado una gran cantidad de información que ha puesto de relieve el potencial que el estudio de esta manifestación cultural tiene para la investigación arqueológica en el país. Sin embargo es preciso enfatizar que, dada su enorme extensión, los contrastantes paisajes que conforman su geografía y la complejidad de su arqueología, aún falta mucho por hacer. Es pertinente señalar que territorios que se caracterizan por la diversidad de su paisaje como Chihuahua, con sus abruptas cordilleras que incluyen innumerables mesetas, cañones y valles intermontanos, así como las vertientes exteriores y las planicies desérticas que rodean las montañas, representan todo un reto para la investigación arqueológica integral.

Si bien no ha habido proyectos específicos enfocados a la obtención de fechas radiocarbono de la imaginería, existe un ejemplo en el cual se ha logrado establecer una cronología a través de métodos indirectos. Se trata del caso del sitio rupestre que lleva por nombre Boquilla Flores-Códice de Piedra (conocido también como Boquilla de Conchos, de Flores o The Rock Codex). En este sitio se han contabilizado alrededor de 116 grabados individuales, entre los cuales destaca un conjunto de puntas de proyectil que recuerdan a los tipos Shumla<sup>3</sup> y que están asociados a antropomorfos de cuerpo triangular. A partir del análisis de estos tipos de puntas de proyectil grabadas, Michael Bilbo y Kay Sutherland (1986: 11-30) han remontado la antigüedad de la producción de estos grabados hacia el Arcaico Medio, es decir, unos 4.500 años AP.

## Península de Baja California

### Baja California

En años recientes, los proyectos de investigación arqueológica en Baja California (norte) se han incrementado de manera notable y, si bien la investigación del arte rupestre no es el objetivo central de los mismos, sí han producido interesante información arqueológica con respecto a grandes áreas previamente desconocidas (Porcayo, 2009; Porcayo et. al., 2010). De esta manera, la posibilidad de obtener una visión regional del arte rupestre que concentra el estado está aumentando gradualmente.

Pocos han sido los intentos para datar directamente pinturas rupestres de algunos de los sitios emblemáticos de Baja California: El único caso conocido es el realizado en el panel rupestre del sitio El Vallecito. En principio, este proyecto se llevó a cabo para determinar la composición de las pinturas rupestres (Valdez, 2004). Los resultados preliminares demostraron que la fórmula de la pintura no incorporó ningún aglutinante, sólo se agregó agua; el análisis demostró que los pigmentos blanco, rojo y naranja son de origen mineral, mientras que el negro resultó ser carbón vegetal. Esta última circunstancia facilitará su datación, aunque actualmente no se sabe si las muestras de carbón ya fueron sometidas al proceso para definir la antigüedad de las pinturas (Oviedo, 2003, 2005). Estos resultados marcan dos importantes diferencias con relación a la composición de la fórmula con que fue elaborada la pintura rupestre en la península Central, ya que en esta región, los pigmentos utilizados para elaborar la pintura son: óxido de manganeso para el color negro, mientras que para los colores rojo y amarillo se utilizó óxido de hierro, y el blanco se realizó a partir de yeso. Todos estos pigmentos minerales son muy abundantes en la región (Gutiérrez y Hyland, 2002).

### Baja California Sur

La investigación arqueológica realizada en torno al arte rupestre de Baja California Sur ha tenido lugar, especialmente, en el norte del estado, específicamente en las Sierras de San Francisco y Guadalupe, donde se ha desarrollado un proyecto regional

3 Las puntas de proyectil tipo Shumla se sitúan entre el 2000 a.C. y el 200 d.C., de acuerdo con el esquema cronológico propuesto por Shum y Jelks (1962), (Viramontes et al., 2012, p. 274).



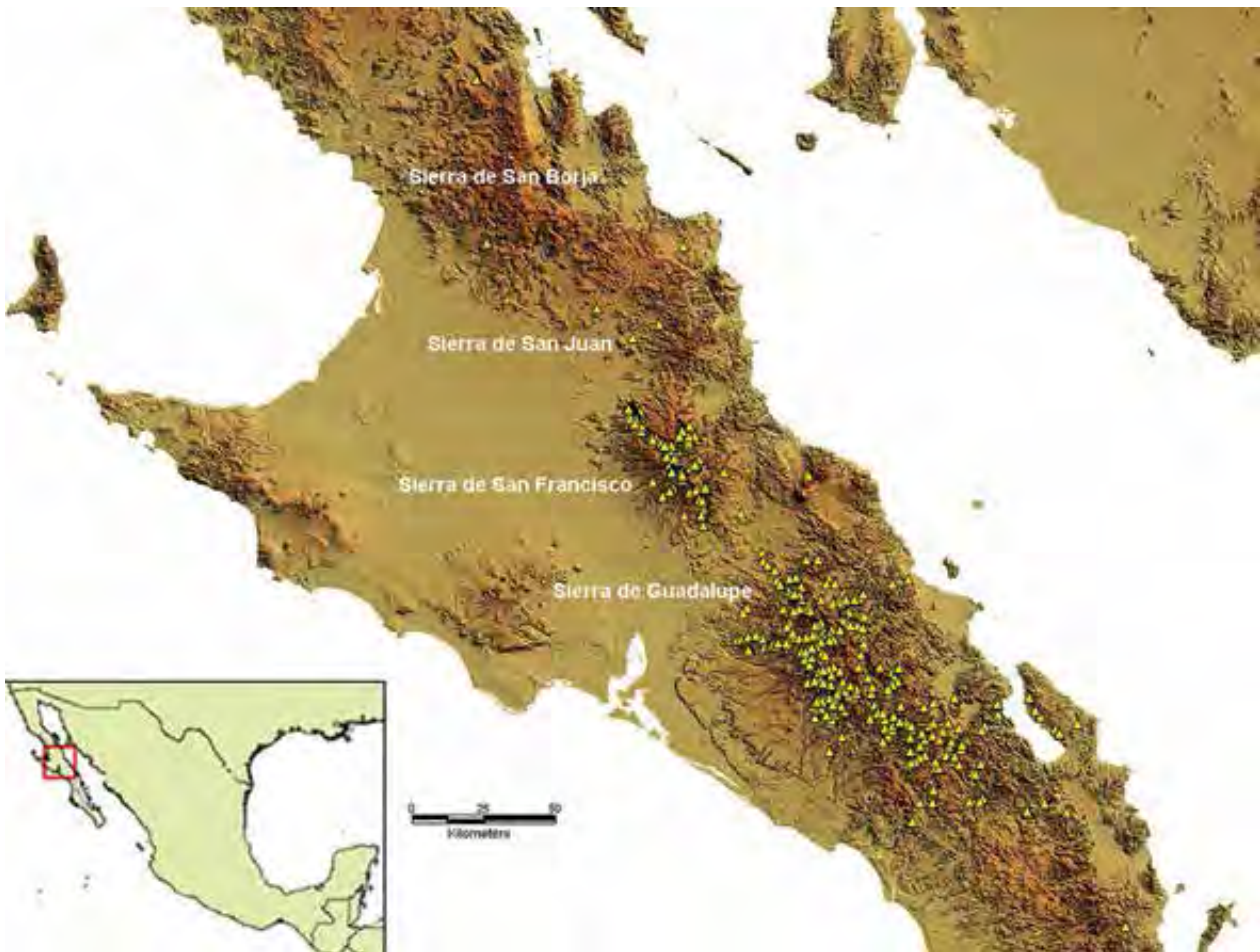


Figura 2. Sitios rupestres en las sierras de San Francisco y Guadalupe, Baja California Sur.

de largo plazo que ha incluido todos los elementos de un estudio arqueológico integral e interdisciplinario; este proyecto inició hace tres décadas y aún queda mucho material por analizar y muchas vertientes de estudio que escudriñar (figura 2).

Uno de los principales objetivos del proyecto consistió en establecer una cronología confiable para la imaginería de la tradición pictórica Gran Mural, porque hasta hace relativamente poco se contaba sólo con unas cuantas fechas directas para un fenómeno que se extiende por miles de kilómetros cuadrados (Fullola et al., 1994; Gutiérrez y Hyland, 2002). Por lo tanto, el proyecto general incluyó un subproyecto específico para alcanzar este objetivo. Esto no sólo consideró la posibilidad de obtener fechas directas, sino también la caracterización de los componentes de la pintura, poniendo un especial énfasis en la identificación de los aglutinantes que se utilizaron en la fórmula (Gutiérrez, 2003; Watchman et al., 2002).

Se obtuvieron cerca de 300 muestras de arte rupestre de algunos de los sitios Gran Mural más representativos de las cuatro cordilleras donde se distribuye: las Sierras de San Borja, San Juan, San Francisco y Guadalupe. Hasta este momento, se ha obtenido una gran cantidad de fechas, entre las que destaca la de Cueva San Borjitas, con una antigüedad de 7.500 años AP, ubicando el panel pintado de este sitio como uno de los más antiguos de la zona de los Grandes Murales (figura 3). Estos resultados han superado las expectativas, en virtud de la considerable antigüedad que representan. No obstante, es necesario puntualizar que la obtención e interpretación de todas las fechas aún está en proceso, razón por la cual no contamos con conclusiones consistentes. Lo que por el momento es posible afirmar es que existe una persistente continuidad en la práctica de pintar imaginería rupestre de esta tradición, misma que se extendió por un largo periodo. Tal vez esto explica la gran cantidad de sobreposición que se manifiesta en muchos de los paneles rupestres de estos sitios. Además, la notable antigüedad de algunos de los fechamientos obtenidos de muestras de pintura rupestre es consistente con ciertas fechas radiocarbónicas obtenidas en otro tipo de evidencia arqueológica, como se verá más adelante.

El análisis practicado en la parte orgánica de la pintura, es decir, el aglutinante añadido a la fórmula, parece indicar que su origen es vegetal, probablemente derivado de la savia de una o varias cactáceas y/o mezcal (*agave sp*), plantas muy abundantes en los alrededores de los sitios pintados y disponibles durante todo el año. Este componente de la fórmula es lo que ha permitido la obtención de las fechas a las que me he referido en párrafos anteriores (Gutiérrez, 2013; Gutiérrez y Hyland, 2002;



Figuras 3. Panel del sitio rupestre Cueva San Borjitas.

Watchman et al., 2002). A continuación se analizarán otros aspectos esenciales para ubicar la temporalidad de la imaginería rupestre y se ampliará la información sutilmente perfilada en párrafos anteriores, con el objetivo de consolidar la propuesta cronológica regional y establecer los tiempos en los que fue construido este paisaje ancestral, escenario del fenómeno Gran Mural.

#### **Los Volcanes Tres Vírgenes: Agentes Sociales en el proceso de Culturización y Fechamiento del Paisaje en Baja California Central**

En la primera parte de este texto, se señaló que la península de Baja California representa un parteaguas en cuanto a la investigación del arte rupestre, desde el momento en que su estudio se abordó a partir de una perspectiva regional y una visión de continuidad de largo plazo. Sus peculiaridades geográficas, climáticas, arqueológicas e históricas han hecho de este territorio un terreno muy fértil para desarrollar distintas aproximaciones a su excepcional y muy recurrente imaginería, no obstante, muchos años tuvieron que pasar para lograr este propósito.



Localizada en el noroeste de México, esta alargada franja de tierra permaneció casi inexplorada hasta muy avanzado el siglo xx. Este desinterés es, hasta cierto punto, paradójico, porque durante años se presentó en proporción inversa a la importancia y riqueza de su arqueología y su destacado arte rupestre. A excepción de su extremo septentrional, fue habitada por grupos cazadores-recolectores-pescadores que subsistieron en una amplia gama de circunstancias ecológicas y configuraciones sociales. Como se ha señalado, se sabe que dichos grupos se desplazaban sobre estas tierras por lo menos desde los finales del Pleistoceno (Gutiérrez y Hyland, 2002). La condición casi insular de Baja California mantuvo a estos pueblos relativamente aislados de las influencias continentales, permitiendo el desarrollo de excepcionales complejos culturales. Y, precisamente, uno de los rasgos más sobresalientes de la prehistoria peninsular es que estos pueblos promovieron, en algunas regiones, la producción masiva de arte rupestre desde tiempos muy remotos. Tal es el caso de las cordilleras centrales de la península, espacio en donde se manifiesta una gran cantidad de pinturas rupestres y petrograbados pertenecientes a diferentes estilos y temporalidades; sin embargo, lo que más llama la atención en estas montañas es que fueron un escenario ideal para el desarrollo de una singular tradición pictórica: los Grandes Murales (Crosby, 1997; Gutiérrez, 2013; Gutiérrez y Hyland, 2002).

A lo largo de todos estos años de investigación, las preguntas más recurrentes que suelen hacerse los investigadores y el público en general en torno a estas pinturas de gran escala son ¿quién las hizo? y, sobre todo, ¿cuándo las hicieron? Por supuesto, la primera pregunta es de más fácil resolución pues la investigación arqueológica y la abundante información que emana de las fuentes etnohistóricas y etnográficas permiten “rastrear”, en ocasiones, la posible filiación cultural de quienes ahí moraron. Sin embargo, responder a la segunda pregunta es mucho más complicado; ya se ha hecho amplia referencia a las dificultades que conlleva la ubicación cronológica directa de la producción del arte rupestre; es por esto que en muchos casos, sólo nos queda la posibilidad de estimar su antigüedad a partir del fechamiento de materiales culturales asociados a los escenarios en los que tuvo lugar el evento de pintar y/o grabar.

## La cronología del paisaje

Antes de 1992 se carecía de indicios cronológicos confiables que permitiesen la ubicación temporal de los desarrollos culturales que tuvieron lugar en la parte central peninsular. Esta situación es una más de las desafortunadas consecuencias que trajo consigo la escasez y parcialidad de los trabajos arqueológicos que aquí tuvieron lugar hasta dicho año. Si bien el hallazgo de la Punta Clovis de San Joaquín, reportada para el área en la década de 1950 (Ashmann, 1951), permitió inferir que grupos humanos transitaban por esta tierra por lo menos desde el Holoceno,<sup>4</sup> era evidente el enorme vacío cronológico que imperaba en la región. La escasez de fechas radiocarbono, la relativa homogeneidad del conjunto de artefactos regionales y, en especial, la falta de una tipología de las puntas de proyectil nos enfrentaban a contextos arqueológicos sin indicios cronológicos diagnósticos para definir su antigüedad y las etapas de desarrollo de los grupos humanos que aquí moraron. Ante esta situación, la investigación arqueológica desarrollada en la región priorizó la obtención de una muestra representativa de fechas que permitiese establecer una cronología regional confiable. Los objetivos de este programa no solo se encaminaron a la obtención de indicadores cronológicos aislados, sino que también se hicieron cargo del reconocimiento previo de los contextos y los procesos culturales relacionados. Dadas las dificultades para encontrar óptimos contextos estratificados y, en consecuencia, materiales fechables procedentes de niveles primarios, se trató de abarcar la mayoría de técnicas posibles. En estos términos, los indicadores cronológicos obtenidos a través de métodos y materiales diversos nos colocarían ante la posibilidad de definir un cuadro cronológico amplio y sobre todo de parámetros confiables (Gutiérrez y Hyland, 2002).

Los indicadores para definir la temporalidad de la ocupación humana en la región fueron los siguientes: 1) la obtención de cerca de 100 fechas radiocarbono de carbón, madera, cordel y hueso, incluyendo restos óseos humanos provenientes de contextos excavados y de superficie de sitios de diversa naturaleza;<sup>5</sup> 2) el análisis de diversos tipos de artefactos líticos diagnósticos, especialmente de una amplia muestra de puntas de proyectil que cuentan con referentes cronológicos; y 3) el desarrollo de un programa dirigido especialmente al fechamiento radiocarbono AMS de la producción Gran Mural.

## Fechas Radiocarbono de materiales arqueológicos diversos

En la secuencia de fechas radiocarbono obtenidas de materiales arqueológicos de la Sierra de San Francisco, destaca la presencia de dos fechas muy tempranas: 10860 ± 90 AP y 6990 ± 60 AP. La fecha de 10860 ± 90 AP (fecha calibrada 11040-

4 Cabe destacar que a un kilómetro al suroeste de San Joaquín (rancho El Mezquital) fueron reportados restos fósiles de mamut (*Mammuthus archidiskodon imperator*) (Alvárez y González, 1986). La asociación geográfica relativamente cercana entre la Clovis de San Joaquín y los restos de fauna pleistocénica podría estar representando más que un evento fortuito (Gutiérrez y Hyland, 1994; Hyland y Gutiérrez, 1995).

5 Abrigos rocosos o cuevas con y sin arte rupestre, cuevas funerarias y campamentos al aire libre.





Figura 4. Sitios funerarios excavados en la región central peninsular.

10620 a.C.), proviene de un fragmento de carbón recuperado en la Unidad 1 de Cueva Pintada, sitio rupestre emblemático localizado en el Arroyo de San Pablo. Podría discutirse la posibilidad de que este carbón tenga un origen natural (Nelson, 1994), sin embargo, dada su presencia en un depósito arqueológico y la identificación del periodo Clovis o Paleoindio en la región (Gutiérrez y Hyland, 1994; Hyland y Gutiérrez, 1996), es muy probable que se derive de un evento cultural. La fecha  $6990 \pm 60$  AP (fecha calibrada 5960-5700 a.C.) se obtuvo de un cordel torcido de agave, recuperado en la excavación de la Unidad 1 en Cueva de la Soledad o Pájaro Negro,<sup>6</sup> situada en un tributario del arroyo de San Pablo.

En términos de una periodización histórico-cultural regional, la distribución de las fechas cubre la secuencia completa desde el Paleoindio y el Arcaico hasta el prehistórico tardío Comondú y los periodos posteriores al contacto Misional. La cúspide de la distribución desciende hacia los siglos xv y xvi AC durante el periodo prehistórico tardío Comondú (Gutiérrez y Hyland, 2002), el cual integró el conjunto de cultura material de los hablantes de Cochimí del periodo histórico en la región (Massey, 1966a).

## Fechas radiocarbono de Restos Óseos Humanos

Uno de los aspectos menos conocidos de la arqueología de la parte central de la península es el que se refiere a los rituales mortuorios practicados por los grupos humanos que la habitaron. Actualmente, en el área de estudio sólo se han investigado seis cuevas funerarias, muy pocas si consideramos la gran extensión de dicha región; éstas son El Pílon de Guadalupe y La Cueva del Cartucho en la Sierra de San Francisco y Las Cuevas de La Cañada, El Guano, La Gallineta y Los Muertos en la Sierra

<sup>6</sup> Este abrigo rocoso se sitúa en el Arroyo de La Soledad, tributario muy importante del Arroyo de San Pablo, en el sector noroeste de la Sierra de San Francisco.

de Guadalupe (figura 4). No obstante, la información recabada ha permitido conocer algunos elementos esenciales acerca del pensamiento que estos grupos desarrollaron en torno a la muerte (Gutiérrez, 2013).

Algunas muestras de hueso provenientes de cuatro de estos sitios han sido datadas. En el caso del Pilón de Guadalupe las fechas obtenidas exhiben un rango de 3.090 a 3.380 años AP, lo que indica que la inhumación de los individuos tuvo lugar durante un breve lapso. Para La Cueva de La Gallineta, las fechas presentan un rango de 2.552 a 2.689 años AP, sin embargo aún no es posible concluir nada puesto que esta cueva no ha sido excavada en su totalidad. El caso de la Cueva de los Muertos es muy interesante, ya que presenta un rango de 2.024 a 2.786 años AP, cerca de 760 años de intervalo; lo que llama la atención es que las fechas más antiguas provienen de un cráneo, una pelvis y una clavícula que se

encontraron en profundas grietas del piso del pequeño abrigo rocoso, acompañadas de una lasca de basalto y cubiertas con capas de zacate y tierra, lo que parece indicar que estos elementos fueron intencionalmente colocados ahí, tal vez consagrando el lugar como recinto mortuario (Gutiérrez, 2013, pp. 110-112).



Figura 5. Desierto Central. Puntas acanaladas: a la izquierda Clovis del Batequi, realizada en obsidiana del Yacimiento Valle del Azufre; a la derecha Clovis de San Francisco de la Sierra.

## Cronología del equipo tecnológico

El análisis tipológico del total de artefactos recuperados en el área que nos ocupa ha incrementado el conocimiento acerca de su distribución regional en el área geográfica comprendida entre la Bahía Concepción hacia el sur (Ritter, 1979) y el área de Bahía de Los Ángeles hacia el norte (Davis, 1968; Ritter 1944, 1995) donde ya se había realizado trabajo previo. El análisis corroboró la existencia de una fuerte continuidad tipológica entre la extensa área desplegada entre estas dos bahías, particularmente presente en los materiales diagnósticos del conjunto prehistórico tardío Comondú, representados especialmente por las puntas de proyectil *Comondú Triangular* y *Comondú Serrated*.

De la colección analizada en la década de 1990, destacan dos puntas acanaladas tipo Clovis. Una de ellas es a la que me referí en páginas anteriores y se trata de un fragmento basal de obsidiana proveniente de las inmediaciones del Rancho El Batequi, localizado al suroeste de San Ignacio (Gutiérrez y Hyland, 1994; 2002; Hyland y Gutiérrez, 1995). De especial importancia es que la obsidiana que fue usada para producir esta punta proviene del yacimiento Valle del Azufre, en el campo Volcánico Tres Vírgenes. La segunda punta está completa y fue encontrada en superficie cerca de San Francisco de la Sierra, poblado localizado en una de las partes más altas de la Sierra de San Francisco; este segundo espécimen está realizado a partir de un silicio de grano fino, de origen aparentemente no local. Ambas fueron catalogadas como Puntas Clovis Típicas (García-Bárcena, com. per.) (figura 5), las cuales al parecer son las más tempranas de entre los cinco grupos de puntas acanaladas. Su edad mínima se ha calculado en 12.000 años AP. en Texas y áreas vecinas y en 10.700 años AP, en Guatemala (García-Bárcena, 1979, p. 15).

Posterior al hallazgo de estas puntas acanaladas, en la década del 2000 se reportaron dos puntas más para la región central, ambas encontradas en la Isla de Cedros en superficie; estos dos especímenes representan las únicas puntas acanaladas encontradas en contexto *isleño* para la costa de California y la península de Baja California (Des Lauries, 2006, 2008, 2010). Una de ellas es un fragmento basal realizado de material microcristalino de color café oscuro y con un elevado grado de patinación (Sitio Arce-Meza; PAIC-70) (Des Lauries, 2008, p. 271); el otro espécimen fue encontrado durante la prospección arqueológica en el sitio PAIC-44 en enero de 2009 (Des Lauries, 2010, p. 60). También se trata de un fragmento basal pero en esta ocasión, realizado a partir de sílex rojo tabular derivado de fuentes locales. Des Lauries (2008) señala que ambas puntas fueron recuperadas de sitios de grandes dimensiones y contextos muy erosionados, y es contundente al señalar que es difícil determinar su antigüedad con precisión.



La historia temprana en la región central peninsular es un interesante asunto que ha sido poco abordado por la arqueología mexicana; los hallazgos de artefactos de antigüedad considerable son esporádicos, aunque en algunas áreas muestran cierta "recurrencia"; en estos términos, es indispensable que se desarrollen proyectos arqueológicos interdisciplinarios en dichas áreas para profundizar en las condiciones y escenarios en los cuales los pueblos originarios de la península central arribaron a esta asombrosa región.

## La temporalidad de la imaginería

La impresión que la imaginería Gran Mural causó en los pocos jesuitas que en algún momento la conocieron fue que las pinturas eran *antiguas*. Esta impresión se basó en la valoración de las características físicas de la imaginería y en las respuestas que obtuvieron de sus informantes cuando se les preguntó acerca del origen de los Grandes Murales. Los Cochimís locales negaron conocer el origen de la imaginería, señalando que había sido realizada por una antigua y ya desaparecida raza de gigantes que habían poblado las sierras arribando desde el norte. Dada la política jesuita de erradicar la religión nativa, la veracidad de tales respuestas está abierta a un cuestionamiento serio<sup>7</sup> (Gutiérrez, 2013; Gutiérrez y Hyland, 2002).

Poniendo a un lado las subjetivas estimaciones jesuitas acerca de la condición de las pinturas y el resultado de sus interrogatorios, algunos investigadores han sugerido que los Grandes Murales deben ser considerados relativamente recientes (Crosby, 1984, pp. 180-183; Grant, 1974, p. 115; Meighan, 1966, p. 379, 1978, p. 11; Ritter et al., 1982, p. 53). Esta premisa se fundamenta en el conjunto de artefactos del periodo Prehistórico tardío relacionados a la cultura Comondú, que por lo común se encuentran en los depósitos de los sitios Gran Mural, y en una fecha de radiocarbono confirmada, la primera para uno de estos sitios:  $530 \pm 80$ .AP, proveniente de un fragmento de madera encontrado en la superficie de Cueva Pintada (Meighan, 1966, 1969). Los materiales Comondú (Massey, 1966a y b) de los contextos prehistóricos e históricos, están asociados con los Cochimís del periodo del contacto y con sus ancestros prehistóricos inmediatos.

Con respecto a fechamientos por radiocarbono de pintura rupestre, como se mencionó con anterioridad, antes del 2000 sólo se contaba con seis fechas absolutas AMS de tres paneles Gran Mural de la Sierra de San Francisco: Cueva del Ratón, San Gregorio II y La Palma de San Gregorio, un número muy reducido para un fenómeno que se extiende por miles de kilómetros cuadrados (Fullola et al., 1994; Gutiérrez y Hyland, 2002, p. 337). Por ello, en la primera década del siglo XXI, uno de los objetivos principales de la investigación arqueológica desarrollada en la región fue expandir la cronología conocida para los Grandes Murales, específicamente con la intención de rastrear en el tiempo y el espacio, el surgimiento de las diversas tendencias de representación visual de dicha tradición pictórica y proponer una secuencia cronológica relativa de las mismas (Gutiérrez, 2000, 2013).

Como se señaló anteriormente, la investigación no sólo contempló la posibilidad de obtener fechas directas AMS, sino también la caracterización de los componentes de la pintura, poniendo un especial énfasis en la identificación de los aglutinantes que fueron utilizados en la fórmula. De 300 muestras de pintura provenientes de algunos de los lugares más emblemáticos y representativos de las diversas tendencias de representación visual Gran Mural, se han obtenido 60 fechas, las cuales presentan un amplio rango de temporalidad llegando a colocarse en momentos tan distantes como 7.500 años AP en Cueva San Borjitas (Watchman et al., 2002) (figura 3) y tan recientes como la época del contacto, a finales del siglo XVII. Estos resultados son sorprendentes porque superan todas las expectativas al colocar la producción de esta tradición rupestre en una época tan remota.

Sin embargo, actualmente, la datación AMS en muestras de pintura rupestre es objeto de una severa controversia, especialmente cuando es puesta en duda la pureza de las muestras y el origen del carbón a partir del cual se obtuvieron las fechas. A principios del siglo, ignorábamos que al paso de los años sería cuestionada esta revolucionaria técnica de fechamiento en su aplicación a la imaginería rupestre, por lo que concluimos el proyecto obteniendo interesantes, aunque controvertidos resultados. No obstante, estas dataciones no sólo han modificado las interpretaciones y discrepancias que se produjeron en torno a las primeras fechas (Fullola et al., 1994; Gutiérrez et al., 2002; Magar et al., 2004; Murray et al., 2003), sino que también aportaron valiosa información relativa al proceso de producción de las imágenes pintadas, el uso que se les dio a éstas y a los recintos que las contienen, y el sentido que su elaboración tuvo para las antiguas sociedades que las generaron (Gutiérrez, 2013; Watchman et al., en preparación).

A la luz de todas estas consideraciones, lo único que queda muy claro es que tenemos más interrogantes que respuestas en torno a la cronología del Gran Mural. En los años por venir será necesario conseguir financiamiento adicional para obtener más

<sup>7</sup> Los reportes de los jesuitas Joseph Mariano Rothea y Francisco Escalante en torno a las narraciones indígenas acerca de estos gigantes se encuentran en Barco (1988, pp. 221-212).

fechas del resto de muestras de pintura, además de hacer un énfasis particular hacia la posibilidad de entender la química del carbono, esto debido a que, como he mencionado, en términos prácticos, este método aún está lejos de poder ser considerado rutinario y confiable en la totalidad de los casos, debido a los complejos problemas asociados con el control del origen del carbono en las muestras (esto es, que el carbono medido esté realmente asociado con el evento pictórico); se espera que la tecnología en torno a la datación por radiocarbono AMS avance cada día más para obtener resultados precisos y confiables.

## El campo volcánico Tres Vírgenes y sus lugares naturales codificados

Un asunto de gran interés para hipotetizar acerca de la antigüedad de las pinturas rupestres de la región es aquel que se relaciona con los importantes yacimientos de materias primas a las que me he referido con anterioridad. Estudios especializados han determinado que la punta Clovis de El Batequí (Gutiérrez y Hyland, 1994; Hyland y Gutiérrez, 1995; Shakley et al., 1996) fue realizada con obsidiana proveniente de dicho yacimiento, lo que implica que su descubrimiento puede remontarse a unos cuantos milenios atrás, muy probablemente a principios del Holoceno (11.000 AP). Pero, ¿cómo la antigüedad establecida para el inicio de la explotación del yacimiento puede ser considerada un indicador cronológico para inferir indirectamente la antigüedad de las pinturas rupestres de la región?

Indudablemente, el territorio central peninsular reúne una serie de elementos que lo hicieron sumamente atractivo para los nativos, sin importar su temporalidad: oasis de planicie e intermontanos que les aseguraron la disponibilidad del vital líquido, una diversidad de recursos alimenticios, terrestres y marinos disponibles a lo largo de un ciclo anual, abundantes materias primas para la elaboración de artefactos de diversa naturaleza, de origen orgánico y lítico (entre estos últimos destacan los grandes yacimientos de basaltos y, por supuesto, la obsidiana). Pero a todo este cúmulo de recursos se suma otro elemento especialmente singular: el enorme yacimiento de pigmentos minerales que lleva por nombre el Cañón del Azufre y que se encuentran a sólo 3,5 kilómetros del yacimiento de obsidiana Valle del Azufre. A continuación se describirá brevemente el espacio simbólico que ocupan Los Volcanes, en el cual coexisten excepcionales rasgos naturales del paisaje que, de acuerdo con la evidencia arqueológica encontrada en estos dominios, muy probablemente fueron conocidos desde épocas muy tempranas, cuando los primeros hombres llegaron a estas tierras privilegiadas en su titánica aventura migratoria.

## El sistema volcánico Tres Vírgenes

Este Sistema Volcánico se localiza en el *ombli*go de la península de Baja California, hacia su flanco oriental. Está conformado por tres volcanes: El Viejo, El Azufre y La Virgen, éste último es el más elevado, alcanzando una altitud de 1.940 msnm (figura 6).

El volcán más joven, La Virgen, es un estratovolcán andesítico con numerosos domos y flujos de lava en sus flancos. Una gran erupción explosiva en su ladera suroeste ha sido datada por radiocarbono en alrededor de 6.500 años AP, pero la exposición de helio y de uranio dan una serie de fechas que colocan este evento a finales del Pleistoceno. Un sacerdote jesuita español reportó una columna de cenizas que emanaba de este volcán, mientras navegaba por el Golfo de California en 1746, sin embargo no se han encontrado depósitos de una erupción tan reciente; no obstante, en la cumbre de La Virgen, flujos de lava andesítica que no han sido fechados podrían estar relacionados con este suceso. Actualmente, en el extremo norte del complejo cerca del borde de la caldera Pleistocénica de El Aguajito, opera una planta geotérmica de la Comisión Federal de Electricidad.<sup>8</sup>

En las planicies desérticas aledañas a estos volcanes se han localizado numerosos sitios arqueológicos, especialmente hacia el sureste, en el Valle de la Virgen, donde son comunes los campamentos habitacionales y yacimientos de piedra pómez y canteras-taller de basaltos, algunos de considerables dimensiones. Antiguas puntas de proyectil han sido localizadas sobre este valle (Gutiérrez, 2000).



Figura 6. El Sistema Volcánico Tres Vírgenes.

8 Tomado de Global Volcanism Program 2012: <http://www.volcano.si.edu/world/volcano.cfm?vnum=1401-01>

En abril de 2009, realicé el ascenso a la cumbre de La Virgen. Mi principal objetivo fue detectar la presencia de actividad humana prehistórica en la cima de la montaña y a lo largo del sendero que me condujo hasta allí. La cumbre más alta y el cono principal carecieron de vestigios arqueológicos,<sup>9</sup> no obstante, casi al llegar a la cúspide, encontré dos artefactos de obsidiana: una lasca con retoque y una punta de proyectil. Dichos hallazgos indican que los nativos visitaban esporádicamente estos elevados parajes, tal vez como parte de una acción ritual y/o para la cacería del borrego cimarrón, muy abundante en estas abruptas montañas. El borrego cimarrón representa un elemento que pudo haber sido relacionado con deidades o poderes míticos. En las pinturas rupestres de toda la región es uno de los animales más representados (figura 7); durante la travesía se observaron algunos individuos de esta especie. Desde la cumbre de La Virgen se domina una espectacular panorámica de las sierras de San Francisco y Guadalupe, el Golfo de California y el Océano Pacífico.

Estos volcanes son, por mucho, el rasgo fisiográfico más conspicuo de la región. Su imponente elevación y la manifestación de antiguos eventos eruptivos y tectónicos pudieron haber sido razones suficientes para que por derecho propio, los habitantes de estas tierras les asignaran un significado especial. Estoy convencida de que su sola percepción en lontananza, incidió profundamente en la conciencia y el actuar de las poblaciones indígenas, por lo tanto considero que todo el sistema volcánico es un extraordinario Lugar Natural (Bradley, 2002), pero además, el probable carácter mitológico de su origen pudo haber sido reforzado por la presencia de otros elementos del paisaje que se albergan bajo sus dominios, rasgos naturales que fueron "...culturizados y codificados con significado" (Strang, 2006, p. 68); como mencioné, hacia las estribaciones occidentales del sistema se han localizado importantes yacimientos de materias primas como piedra pómez, obsidiana y pigmentos minerales (óxidos de hierro y yeso), afloramientos de concha fósil, así como un manantial de aguas termales vinculado a un abrigo rocoso que exhibe un arte rupestre insólito, totalmente diferente al que se manifiesta en la región.

Los Lugares Naturales son espacios de importancia simbólica relevante que se vinculan a rasgos destacados o excepcionales del paisaje, presentan escasa o nula evidencia arqueológica, predominando en ellos el elemento natural (Bradley, 2002).<sup>10</sup> Por lo común se trata de sitios alejados de los espacios habitacionales y prácticamente no están afectados por las actividades que en ellos sucedieron, pasando desapercibidos para aquellos que desconocen su existencia o ubicación. Paradójicamente, estos lugares han conservado sus formas a través de largos periodos, sin embargo, el modo en el que han sido percibidos los ha

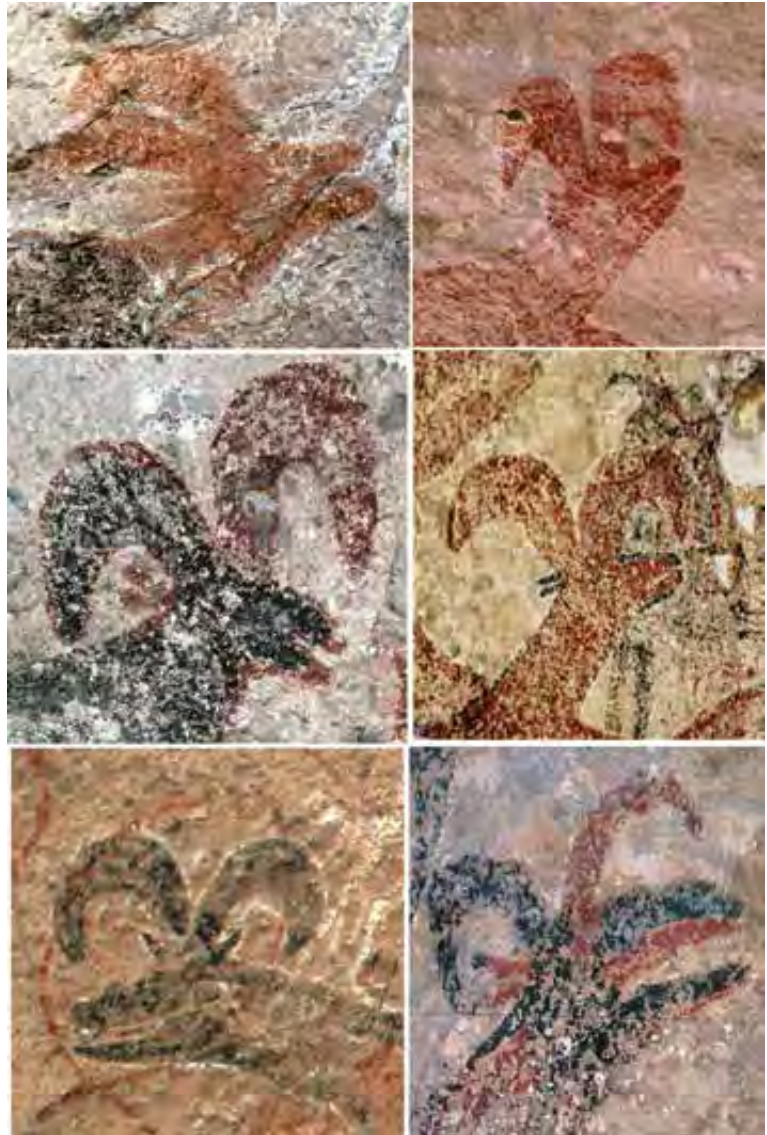


Figura 7. Algunos ejemplos de representación de borrego cimarrón en la pintura rupestre de las Sierras de San Francisco y Guadalupe.

9 Además de ser un volcán muy popular entre los excursionistas regionales y foráneos, en este lugar se ubican dos antenas (repetidores) de radio, las cuales son visitadas periódicamente para su mantenimiento. Por estas razones es muy posible que, si la cumbre albergaba algún tipo de evidencia arqueológica, ésta fuera removida en tiempos recientes.

10 Pueden ser volcanes, montañas, cerros, colinas, peñascos y malpaisales, bosques, manantiales, ríos, pantanos, lagos y cascadas, cuevas, grietas, ínsulas y penínsulas y afloramientos de materias primas, entre otros.

“alterado” en cierta medida (Bradley, 2002, p. 33). Esta alteración tiene lugar en el momento en que la mente humana toma conciencia de su existencia y les asigna un significado y un poder.

Los lugares naturales no pueden ser considerados monumentos pues no son resultado de la acción humana. Entonces, en muchas ocasiones su origen puede ser explicado en términos mitológicos: “estos lugares pudieron haber sido formados por los ancestros o por fuerzas sobrenaturales” y “tienen una arqueología porque alcanzaron un significado para las personas del pasado” (Bradley, 2002: 35, citado en Gutiérrez, 2013).

¿Cómo *percibieron* los indígenas esta elevada *presencia* y el vasto espacio que la rodea? ¿Qué significado le asignaron? ¿Cómo fueron experimentados, interpretados y vinculados a ellos los lugares en donde se concentran productos de antiguos eventos eruptivos? ¿Constituyeron “centros de actividad corporal, significado humano y accesorio emocional”? (Tilley, 1994: 15). Los Volcanes ocupan un espacio prístino, en términos de su percepción a la distancia, que se ha mantenido casi inalterado a lo largo de milenios, y considero que su importancia simbólica en el mundo-de-la-vida indígena no sólo derivó de su prominente ubicación en este paisaje semidesértico, sino también de los significados particulares que fueron asignados a los lugares naturales que alberga y articula a través de diversos contextos situacionales. En este orden de ideas, propongo que los Volcanes y sus productos eruptivos jugaron un papel fundamental en la cosmovisión de estos pueblos y actuaron como agentes sociales en la formación y reafirmación de sus identidades personales y grupales y en la integración del proceso de su reproducción social (Gutiérrez, 2013). A continuación describiré brevemente estos elementos.

## El yacimiento de obsidiana Valle del Azufre

El origen geológico de este yacimiento de obsidiana es principalmente Cuaternario, por lo que proporcionó grandes nódulos de excelente calidad para la elaboración de artefactos, especialmente de puntas de proyectil en una diversidad de tipos, algunos de ellos muy antiguos. Como mencioné, la explotación de esta fuente se empezó a dar desde el Holoceno temprano, tal y como lo demuestra la punta Clovis realizada con obsidiana proveniente de dicha fuente, a la que ya me he referido. El registro arqueológico de la obsidiana proveniente de este yacimiento está bien documentado y su distribución alcanzó lugares tan lejanos hacia el sur como la región de Loreto (Gutiérrez y Hyland, 2002; Shackley et al., 1996).

Ser el único yacimiento de obsidiana de calidad que existe para esta extensa región pudo haber sido razón suficiente para que los indígenas lo consideraran un lugar de importancia excepcional. Sin embargo, dicha importancia no sólo se relacionaría con la posibilidad de obtener este apreciado vidrio volcánico, sino además, la toma de conciencia de este estado de excepción por parte de los indígenas, pudo haber vinculado su origen con entidades sobrenaturales.

## El yacimiento de Pigmentos del Cañón de Azufre

Este yacimiento de pigmentos es la fuente de óxidos de hierro rojos más grande registrado hasta el momento en la región, presentando una amplia gama de tonalidades. También contiene yeso y, en menores cantidades, óxidos de hierro amarillos (figura 8). Dada la importancia de la producción de pintura rupestre y pintura corporal entre la sociedad indígena Cochimí, esta fuente de pigmentos debió ser muy apreciada por los habitantes de toda la región. Otro elemento que llama la atención cuando se camina por este cañón y que pudo haber incidido en la conciencia de los indígenas como algo significativo, son los afloramientos de concha fósil, infinidad de bivalvos que se encuentran incrustados en un soporte pétreo muy deleznable y de intenso color rojo.

Hacia la desembocadura de este cañón, en una parte elevada del terreno se localizó un lugar con evidencia arqueológica relacionada con la extracción del pigmento. Entre los materiales destacan dos lascas de obsidiana y tres tajadores, dos de basalto y uno de obsidiana. Cabe destacar que sobre el lecho del arroyo no se conserva ninguna evidencia arqueológica debido a las fuertes avenidas del arroyo durante la época de lluvias.



Figura 8. Yacimiento de Pigmentos del Cañón del Azufre



## El Manantial de Aguas Termales y Sulfurosas

Cuando visité por primera vez este manantial en 1992, se encontraba rodeado de un pequeño bosquecillo de mezquites y huisaches, así como de piedras de gran tamaño, sin embargo, la incidencia de los huracanes que impactaron la región en los últimos años ha transformado varias veces la topografía del cauce en esta parte del arroyo, debido a las fuertes avenidas. No obstante, el agua sulfurosa sigue fluyendo del manantial, aunque ahora casi no presenta vegetación en su entorno (figura 9).

Además de lo útil que resultó esta fuente de agua para saciar la sed durante el acopio de los pigmentos, es posible que los indígenas hayan percibido en este peculiar manantial un simbolismo inherente a su *excepcionalidad*. Strang (2008, p. 127) señala que “en paisajes áridos la rareza de las fuentes de agua les otorga una particular y poderosa influencia”; esta autora considera también que el agua proporciona “un vasto potencial imaginativo para expresar significados culturales...” (Strang, 2008, p. 124).



Figura 9. El Manantial de aguas termales.

Agua caliente brotando de la piedra, olor a azufre y pequeñas columnas de vapor. Fuente inagotable del elemento vital en un constante fluir y, además, abrevadero del borrego cimarrón. Desde el manantial se observa el abrigo rocoso con arte rupestre y viceversa, el vínculo entre estos dos lugares parece innegable y los círculos concéntricos pintados en el abrigo rocoso parecen confirmar esta idea. Este motivo se ha encontrado grabado en asociación con algunas tinajas de las montañas circundantes, representando, tal vez, un signo que puede leerse como “agua”; la codificación de este motivo puede deberse a los ondas concéntricas que se forman cuando un objeto es arrojado a un depósito que contenga este muy apreciado recurso.

## El sitio rupestre “El Viejo” del Cañón del Azufre

Aproximadamente a 700 metros de la Boca del Cañón del Azufre, sobre su ladera sur, se localiza el abrigo rocoso con pintura rupestre al que me he referido y que he denominado “El Viejo” (figura 10). Hasta el momento, es el único sitio rupestre reportado para este cañón y para el área de Los Volcanes. Su panel rupestre es totalmente atípico, si lo comparamos con las otras tendencias de representación visual que predominan en la región. Cabe destacar que el Cañón del Azufre se localiza a una distancia equidistante de las sierras de San Francisco y Guadalupe, donde se manifiesta, principalmente, la tradición pictórica de los Grandes Murales. No obstante, a pesar de su contenido inusual, en el panel destaca un motivo que es recurrente en muchos de los lugares con pintura rupestre de las sierras mencionadas. Se trata de un motivo al que se ha denominado bastón



Figura 10. “El Viejo del Cañón del Azufre”, sector central del panel rupestre del enigmático sitio.



ceremonial-símbolo fálico (Gutiérrez y Hyland, 2002; Gutiérrez, 2007, 2013); en el panel de El Viejo, estos singulares motivos se presentan por lo menos 12 veces (figura 11).

Sin duda, la profusa representación de este motivo en el pequeño panel, codifica el lugar y le otorga un significado destacado que trasciende el tiempo y el espacio y que, además, permite vincularlo con las montañas aledañas, donde su manifestación es muy recurrente, tanto en pintura rupestre como en petrograbado; en estos espacios los indígenas estructuraron otras actividades habituales y rituales, entre las que destaca la producción de pintura rupestre monumental (Gutiérrez, 2013).

Por el momento es muy difícil tratar de explicar el inusual contenido de este panel, por un lado, porque la deconstrucción de su imaginería aún está en proceso y por el otro, por la enorme ambigüedad de las figuras y motivos que agrupa. En esta intrigante escena, la representación de antropomorfos se limita a la presencia de dos motivos-compuestos, conformados cada uno por tres antropomorfos sumamente esquematizados, tomados de las manos. Los antropomorfos ubicados en el extremo izquierdo de cada terna exhiben un brazo extremadamente largo con enormes manos, una con tres dedos y la otra con cuatro; sobre uno de los tríos, se encuentra un ave en vuelo y ambos conjuntos están rodeados de bastones ceremoniales-símbolos fálicos. En el panel lateral derecho se manifiesta un singular antropomorfo que luce lo que al parecer es una *capa*; figuras similares con *capas* han sido observadas en algunos sitios rupestres de la región.

La importancia de este lugar es innegable, no sólo porque se ubica adyacente a la fuente de pigmentos, sino también por estar justo frente al manantial de aguas termales (y, como dijimos anteriormente, los círculos concéntricos que aquí se expresan, vinculan simbólicamente el sitio rupestre con el manantial).

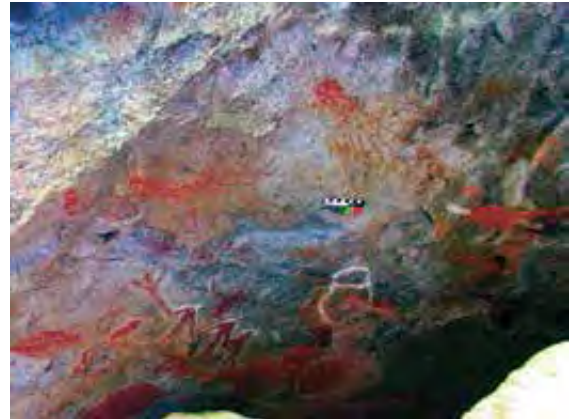


Figura 11. Motivo denominado bastón ceremonial-símbolo fálico, el cual se representa en el panel de "El Viejo", por lo menos doce veces.

## Tras las huellas de los primeros pobladores de América

A lo largo de este artículo he tratado de desenmarañar, parcialmente, la compleja y tupida red de evidencia arqueológica que se entrelaza en el tiempo y el espacio, y le otorga una importancia trascendental a una de las regiones más asombrosas de la península de Baja California: su región central. Este angosto territorio se sitúa entre el apacible Golfo de California con sus aguas tranquilas y tibias, y el impetuoso Océano Pacífico; aquí se eleva una impresionante serie de cordilleras, que, junto con los mares que abrazan la tierra, ofrece interesantes contrastes entre el mar, el desierto y la montaña. Esta diversidad de ambientes proporcionó abundantes recursos de todo tipo, creándose las condiciones óptimas para el desarrollo de poblaciones humanas a lo largo de milenios. ¿Cuántos milenios? Para el sector peninsular no tenemos aún una respuesta contundente, sólo aproximaciones (Gutiérrez y Hyland, 2002), sin embargo para la Isla de Cedros se sabe con certeza que ya estaba habitada al menos 12.000 años atrás (Des Lauries, 2006, 2008, 2010).

La imaginería pintada y grabada es quizás el valor cultural más "llamativo" y conocido de la región, que, además, asume una trascendencia externa o paralela a sus sentidos iconográficos, integrando un elemento fundamental en la configuración del paisaje; asimismo, constituye un importante desarrollo cultural que extiende el campo del significado más allá del panel rupestre y del sitio para considerar el extenso contexto de la geografía social. Su producción fue tan masiva y su diversidad tan "abrumadora" que hay motivos para reflexionar acerca de que la práctica de grabar y pintar pudo haberse originado milenios atrás. Cabe destacar la gran cantidad de yacimientos de petrograbados que conforman parte de esta red semiótica relacional y referencial, algunos de los cuales han recuperado completamente la patina en el lugar donde fue desplazada la corteza pétreo para perfilar la imagen grabada. En estos sitios se percibe una existencia añeja.

El objetivo de este escrito ha sido mostrar algunos lugares de México donde se ha encontrado evidencia arqueológica muy antigua, relacionada tal vez con la llegada de los primeros pobladores al continente americano; a la vez se ha argumentado que por sus características y ubicación geográfica, estos sitios originados durante el Pleistoceno Terminal y el Holoceno (Arcaico temprano, medio y tardío) están vinculados, al menos espacialmente, a excepcionales tradiciones de arte rupestre: de ninguna manera se está equiparando la antigüedad probada de yacimientos arqueológicos fechados o artefactos arqueológicos diagnósticos de esta antigua migración humana, con el surgimiento del arte rupestre, pero es necesario intensificar la investigación de la prehistoria antigua para entender los procesos y ajustes culturales que aquí tuvieron lugar, y dedicar



Figura 12. Panorámica del paisaje desde la cumbre del volcán La Virgen.

estudios paralelos en el abundante arte rupestre asociado a estos enclaves del hombre temprano en México. En estos términos, la península media nos ofrece una serie de elementos que permiten hipotetizar acerca de la posible antigüedad de ciertas tradiciones rupestres presentes en esa región.

¿Qué condiciones climáticas y medioambientales prevalecían en la región central peninsular cuando los primeros humanos arribaron a ella? ¿Qué impresión les causó el peculiar paisaje de montaña, planicie y mar que se extendía en todas direcciones? Una vez que se haya profundizado en la prehistoria antigua de la región, será posible responder a la primera pregunta; la respuesta a la segunda es todo un reto e implica tomar en cuenta la aproximación fenomenológica (véase Gutiérrez, 2013, pp. 37-58).<sup>11</sup>

En otro lado se ha propuesto que es necesario recrear un modelo del mundo antiguo que estudiamos:

a través de la deconstrucción de elementos esenciales de la materialidad del pasado que están cargados de sentido y significado y que, además, son potencialmente productivos para entrever la naturaleza de la relación de las personas y la de los lugares que habitaron, y cómo experimentaron su cotidianidad y entendieron su existencia (Thomas, 1995, p. 28). (Gutiérrez, 2013)

Por supuesto, esto no significa que logremos conectarnos al pensamiento de esos hombres desaparecidos, sin embargo, considero que mientras más capaces seamos de percibir la materialidad del mundo antiguo como producto de la experiencia inmediata, la toma de conciencia y la acción humanas, y entendamos que los vestigios que estudiamos son portadores de intenciones, ideas y reflexiones de quienes los crearon, más nos acercamos a la posibilidad de “ensayar la recreación de pensamientos afines a los de las sociedades pretéritas; esto podría ser un hilo conductor para develar una realidad paralela que al menos, nos aproxime a su conocimiento” (Gutiérrez, 2013, p. 39).

Los grupos humanos que arribaron a la península durante el Holoceno eran portadores de una “estructura” que incluyó sus tradiciones culturales, organización social, conductas, acciones, memoria y pensamientos; sin embargo, la propia evolución de las personas y los paisajes ha desvanecido casi por completo los indicios de los componentes de esa “estructura”, y sólo la percibimos de manera fragmentaria, lo que en ocasiones la hace aparecer como algo “inexistente”.

Para Giddens (2006, p. 396), la estructura alberga parcialmente la noción de la materialidad, pero también aquella que involucra las relaciones sociales; ambas son generadas por conductas y acciones, que tienen lugar en un tiempo y un espacio, y no en otro. Identificar la estructura de esta sociedad puede ser viable a través de la búsqueda de sus “huellas mnémicas”,<sup>12</sup>

11 En palabras de Heidegger (1953, p. 44), fenomenología significa “hacer ver desde sí mismo aquello que se muestra, y hacerlo ver tal como se muestra desde sí mismo”.

12 Giddens (2006, p. 395 y 396, citado en Gutiérrez, 2013: 53) entiende la Estructura como “el elemento y el resultado de la conducta que ella organiza recursivamente” y que sólo es posible rastrear a través de sus huellas mnémicas “es la base orgánica de un entendimiento humano, actualizada en una acción”.

cuyos rastros se han desvanecido casi por completo; sin embargo, estos escasos y difusos vestigios constituyen razón suficiente para continuar la investigación arqueológica regional y, ante la levedad de la evidencia, será importante buscar “apoyo fenoménico para fijar la mirada en el Mundo” (Heidegger, 1953, p. 62), en este caso en un mundo muy antiguo:

Buscar apoyo fenoménico para fijar la mirada en el mundo, resulta una posibilidad muy tentadora y enriquecedora, que induce a tomar conciencia, sentir y pensar en situaciones, sujetos y objetos que antes no importaron, o que incluso pasaron desapercibidos. Esta experiencia conlleva un redescubrimiento de nuestros sentidos y la posibilidad de desarrollar nuestras atrofiadas capacidades sensoriales, lo que puede resultar muy estimulante y aleccionador, y lo más importante, puede llevarnos a experimentar, en la actualidad del mundo bajo análisis, visiones, situaciones e intencionalidades de ese mundo antiguo. La cotidianeidad del vivir-habitar el mismo espacio, permite entrever, intuir sutilmente, parte de esa lejana realidad (Gutiérrez, 2013, p. 40).

## Conclusiones

Como señalé anteriormente, la península media es el reservorio de una serie de elementos y vestigios que, me parece, no están aquí por casualidad: la presencia dominante de los volcanes y su percepción a la distancia, los yacimientos de obsidiana y pigmentos minerales que están “bajo sus dominios”, los abundantes afloramientos de basaltos de extraordinaria calidad, la presencia, hasta cierto punto “recurrente”, de puntas Clovis en contexto insular y peninsular y la antigüedad probada mediante fechamiento por radiocarbono en depósitos arqueológicos de la Isla de Cedros (12.000 años AP), donde dos de estas arcaicas puntas han sido encontradas (Des Lauries, 2011, p. 168). Si a esto añadimos la abundancia de recursos alimenticios de todo tipo que permitía asegurar la subsistencia a lo largo del año en este aparentemente “riguroso” medio ambiente, entonces estamos ante un escenario ideal para indagar el porqué de las peculiares características de la evidencia arqueológica que aquí se concentra.

Hasta el momento, el recuento total de puntas Clovis encontradas en esta región es el siguiente: dos en la Isla de Cedros (Des Lauries, 2010), cinco en el área de los Ranchos San Joaquín (Aschman, 1952) y El Batequi (Gutiérrez y Hyland, 1994; Hyland y Gutiérrez, 1996; Gutiérrez et al., en prep.), una en la Sierra de San Francisco (Gutiérrez y Hyland, 2002) lo que da un total de ocho.<sup>13</sup> Una de las Clovis recientemente encontradas en las inmediaciones del rancho El Batequi, (Gutiérrez et al., en prep.) es de obsidiana, y a pesar de que aún no se ha realizado su análisis químico, todo parece indicar que el yacimiento del que proviene es el del Valle del Azufre. Se podría argumentar que esta concentración de evidencia arcaica en la media península, puede ser el resultado de que se trata de una de las áreas más investigadas de la región, sin embargo, no podemos descartar que desde el Holoceno temprano aquí se dieron condiciones óptimas, para que las personas moraran estas tierras temporal o permanentemente.

Des Lauries hace una interesante reflexión en torno a los hallazgos extremadamente insólitos de este tipo de puntas en las costas de California y en la parte central de la península de Baja California, especialmente, en la Isla de Cedros:

The seemingly „out-of-place“ context for these points was noted decades ago by Rogers (1966) in reference to a smattering of fluted points recovered from „San Dieguito“ 67; Warren and True (1961) sites in the Southern California deserts. These Alta California sites –and Rogers’s concept of San Dieguito– were much more closely linked to what would today be referred to as some variant of the many stemmed point traditions, so common in the culture histories of the Far West (Bryan 1980; Faught 2008; Haynes 2007:256; Willig and Aikens 1988). The absence of Pleistocene megafauna, the atypical coastal/insular location, and their apparent association with a maritime-focused economy all combine to place these examples of fluted points in contradiction to common assumptions of strict association with big-game-hunting, high mobility foraging groups (Des Lauries, 2010).

Como señalé anteriormente, prueba irrefutable y destacada de la presencia milenaria del hombre en Isla de Cedros son los fechamientos AMS obtenidos de muestras provenientes de dos depósitos excavados en el sur de la Isla, lo que demuestra la presencia de isleños ocupando este territorio desde épocas muy remotas. Es muy posible que desde entonces los isleños realizaran expediciones hacia la cercana costa occidental de la península y, ¿por qué no?, tierra adentro, hacia las montañas, y allende éstas, hasta el campo volcánico Tres Vírgenes, lugar donde se localizan los yacimientos de obsidiana y pigmentos

13 Existe una novena punta Clovis completa, realizada en cuarzo cristalino y que fue donada por un coleccionista privado al Museo Regional de Antropología e Historia de La Paz, B.C.S. A decir del donante, la punta fue encontrada en alguna parte de los llanos de Hiray, al norte de Cd. Constitución,, mucho más al sur de la región que nos ocupa (Zuñiga de La Toba, com.per.).

referidos con anterioridad. Es muy significativo que la punta Clovis de El Batequi muestre una fuerte similitud tipológica y de dimensiones con las puntas acanaladas isleñas.

Indudablemente, a 62 años del hallazgo y reporte de la primera punta Clovis de la región (Aschmann, 1952), tener el reporte de siete puntas acanaladas más en esta muy localizada región de la península central viene a reafirmar el interesante enigma que rodea a esta antigua industria lítica del continente americano y en particular nos hace reflexionar el porqué de su “relativa frecuencia” en el contexto geográfico, peninsular e insular al que me he referido. Des Lauries señala muy acertadamente lo siguiente:

If the bearers of the Clovis tradition were, in fact, highly mobile, terrestrially focused foragers, then the archaeological traces of such groups on the Peninsula may represent short-term forays into uncharted territory that did not ultimately lead to extensive colonization by follow-on groups practicing similar strategies. They came, they saw, they left. Conditions may not have been suitable, or sustainable, for groups with narrower technological requirements and subsistence strategies. The actual initial colonization of the Peninsula, whether earlier, contemporary, or later than Clovis, would therefore have been accomplished more effectively by technologically flexible, broadly skilled opportunists (Des Lauries, 2011: 174)

No obstante, es necesario contar con más información. Conforme se profundice en la investigación de la Prehistoria antigua de la península media, a través de proyectos arqueológicos multidisciplinarios de mediana y larga duración y se establezcan las estrategias para que sean encontrados esos elementos que permanecen *encubiertos* por la propia evolución del paisaje, dilucidar todas estas interrogantes será más fácil y productivo. Es necesario estudiar esta región a través de la investigación puntual de sitios que presentan un gran potencial para encontrar contextos sub-superficiales inalterados, que corroboren la antigua presencia de estos migrantes milenarios que arribaron a América e hicieron un alto temporal, o bien se establecieron en la región y que permitan trazar con rigurosa científicidad, su trayectoria por estas tierras y/o su navegar por estos mares, durante el Pleistoceno terminal y los inicios del Holoceno por lo menos desde 12.000 AP.

Asimismo, es necesario avanzar en la investigación arqueológica sistemática, pero *regional* de espacios peninsulares prácticamente desconocidos, los cuales se ubican aproximadamente al norte del paralelo 28° y al sur del paralelo 26°10'; esto es de importancia trascendental para complementar la información fragmentaria con la que se cuenta, y así lograr una comprensión más acabada de los primeros colonizadores del continente americano y las rutas que tomaron para concretar su aventura migratoria, la cual definitivamente diversificó sus destinos y, con ello, las posibilidades de arraigarse o no a la tierra, de acuerdo con las oportunidades que estos territorios desconocidos les ofrecían. Quienes se quedaron, renovaron su equipo tecnológico a través de desarrollos locales que derivan de la tecnología de puntas acanaladas y otro tipo de artefactos primigenios.

Otro asunto que debe ser abordado es la depuración de la cronología del arte rupestre de esta región, mediante dos procesos: la excavación de sitios pictóricos cuyo arte rupestre ha producido fechas de gran antigüedad, con el objetivo de encontrar evidencia fechable de la actividad pictórica (Watchman et al., 2002); de este modo será posible vincular la antigüedad de la ocupación de los sitios rupestres con el evento pictórico. Asimismo, es esencial que se continúen aplicando nuevas metodologías de datación directa AMS en paneles que ya han sido fechados, y otros que tengan potencial para la obtención de fechas antiguas, esto para corroborar los primeros resultados cronológicos obtenidos o desecharlos por posible contaminación. Por supuesto, el panel rupestre de “El Viejo” del Cañón del Azufre, deberá ser estudiado exhaustivamente; este sitio es clave para indagar las razones que los indígenas tuvieron para significar de esta manera portentosa este pequeño abrigo rocoso.

Ascender el volcán y observar los mares, desiertos y montañas que lo rodean, me permitió experimentar el paisaje desde otra perspectiva. Antes sólo había observado la visión panorámica de este paisaje y sus volcanes desde el sentido opuesto: las cumbres elevadas de las sierras circundantes (figura 12). Pero desde aquí, tuve la sensación de estar en el centro de una organizada aunque enigmática tierra, donde cada lugar “natural”, localidad arqueológica y panel rupestre formaron parte de diversas narrativas que, desafortunadamente, aún no se pueden desentrañar del todo, pero que igual es posible distinguir, aunque vagamente. El paisaje entonces se dinamiza y se reconoce como la entidad que estructuró las prácticas sociales y al mismo tiempo fue estructurado por la acción humana de morar el mundo (Gutiérrez, 2013).

Los volcanes eran visitados periódicamente por los indígenas para abastecerse de obsidiana y de pigmentos. Es posible que estas fuentes tuviesen significados mitológicos. El abrigo rocoso con pinturas rupestres puede ser considerado un lugar sagrado, quizás de peregrinaje, donde se realizaban actos de veneración hacia las fuerzas naturales o divinas que encontraron aquí recurrente manifestación: temblores frecuentes, géiseres, aguas termales, el borrego cimarrón, la obsidiana y los apreciados

pigmentos. Especialmente estos últimos ocuparon un importante lugar en el mundo de la vida indígena, pues fueron esenciales para desarrollar la práctica de la pintura corporal y la producción de las abundantes pinturas rupestres de la región.

Por otro lado, existe evidencia adicional que demuestra la importancia que tuvieron los volcanes en la formación de estas identidades, especialmente con respecto a la elaboración de pinturas rupestres: el origen "mítico" de los pigmentos, el cual en muchos pueblos es relacionado con la "sangre de los ancestros". Atribuirle poderes a las montañas y sus lugares sagrados demandó el uso de objetos simbólicos, en este caso las pinturas del pequeño abrigo rocoso, las cuales fueron esenciales en la construcción cultural de este paisaje.

Las dinámicas de este proceso pueden ser comprendidas más claramente a través de un enfoque sobre el papel que jugaron como agentes sociales, estos prominentes rasgos del paisaje y los seres físicos y espirituales que "los moraban": ellos "forzaron" la realización de peregrinaciones hacia sus dominios, "permitieron" el acceso a sus dones y las personas retornaban simbólicamente a sus orígenes. Entonces, los nativos pudieron pintar sus cuevas y sus cuerpos con los pigmentos, "sustancia dadora de vida de sus ancestros" que bien pudo haber sido considerada una reliquia.

En este orden de ideas, si los indígenas peregrinaban hacia el cañón para el acopio ritual del pigmento, y si el yacimiento de obsidiana se encuentra a tan solo 3,5 kilómetros del cañón, y dicho yacimiento tiene una probable explotación de por lo menos 11.000 años, entonces se propone la hipótesis de que el yacimiento de pigmentos fue aprovechado en la misma época. No es posible definir si los pigmentos extraídos eran para hacer pintura rupestre, o para realizar la práctica de la pintura corporal, muy común entre este tipo de sociedades pretéritas y practicada por muchos pueblos originarios que aún subsisten. En síntesis, la posibilidad de que el inicio de explotación de ambos yacimientos fuese contemporáneo no puede ser descartada del todo. Probarlo resulta complicado, pero siempre quedará como un postulado difícil de desechar. Si se pudiese saber con certeza cuándo empezó la explotación de los pigmentos del Cañón del Azufre, entonces, la antigüedad que se ha obtenido del fechamiento de algunos sitios Gran Mural sería congruente pues quedaría en el margen de aprovechamiento del yacimiento de pigmentos del citado cañón.

Y es que cuando uno se acerca a los volcanes desde las planicies desérticas occidentales, desde una gran distancia es posible apreciar el rojo intenso del cañón, que "se muestra" con persistencia. Es lógico pensar que las expediciones de los nativos a los dominios de los Volcanes para el acopio de la obsidiana, eran aprovechadas también para recolectar el pigmento mineral, esencial para pintar sus cuevas y sus cuerpos.

Finalmente, Los Volcanes y los lugares codificados que se encuentran interrelacionados en el vasto espacio de sus dominios, representan un claro ejemplo de cómo estos pueblos se relacionaron con su entorno no-humano a través de signos naturales; las personas no sólo establecían relación y comunicación con sus semejantes y con "los otros", o bien evadían a estos últimos, sino que también era posible relacionarse con seres inanimados de diversa índole y poder o, también, evadirlos (Gutiérrez, 2013)..

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# Conservation of Palaeontological Sites in Mexico: Legal, Research and Communication Measures for Integrated Approaches

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## Resumen

En México, el patrimonio paleontológico está conformado por los bienes (colecciones y yacimientos) que representan la evidencia del pasado geológico y biológico del país. A partir de la adición del Artículo 28bis a la Ley Federal de Monumentos y Zonas Arqueológicas, Artísticos e Históricas, así como de la modificación de la Ley Orgánica del Instituto Nacional de Antropología e Historia, es competencia de esta institución la investigación, la conservación, la protección y la difusión de este singular patrimonio.

Con el objetivo de poder dar cumplimiento a esta nueva tarea, el INAH convocó en 1994 a la formación de un consejo consultivo en materia paleontológica donde se reunió a especialistas que representaban a la institución académica y que a nivel nacional desarrollaban investigación en la materia. Estos especialistas elaboraron una propuesta de procedimientos para el desarrollo de las investigaciones paleontológicas, las actividades educativas y turísticas en los yacimientos paleontológicos, los criterios para el resguardo de los materiales paleontológicos y las colecciones, así como del registro de localidades y la protección de éstas; además de establecer las definiciones que permitieran establecer límites entre los bienes arqueológicos así como los fósiles que tienen una utilidad industrial.

En la actualidad, a través del Sistema Único de Registro Público de Monumentos y Zonas Arqueológicas e Históricas, se tiene el formato de inscripción tanto de colecciones como de localidades paleontológicas. Asimismo, se ha comenzado con la delimitación de localidades paleontológicas para con ello establecer criterios de protección y conservación tanto de los fósiles como de su yacimiento.

En cuanto a las actividades de turismo ecológico-cultural, se ha comenzado con la regulación de localidades paleontológicas que cuentan con visita pública no regulada. Para ello se está trabajando en el desarrollo de los planes de manejo adecuados al contexto del paisaje y de las características del yacimiento, pero sobre todo en la recuperación de la información académica generada por los investigadores que los estudiaron, así como el seguimiento de dónde se encuentra resguardado el material recuperado.

Así, a casi 30 años de asignar a una institución que velara por la regulación de la investigación, la conservación, la protección y la difusión del patrimonio paleontológico en México, no se han podido establecer al cien por ciento los mecanismos para hacerlo a nivel nacional. Por ende, sólo la difusión de los casos, así como los éxitos y fracasos de todo el proceso, permitirán establecer los procedimientos de gestión en todo el país.

## Introducción

El territorio que actualmente forma México tiene una historia geológica compleja, aspecto que tiene consecuencias en su geografía, su fisiografía y la gran riqueza biológica que posee (Arroyo-Cabrales et al., 2008) (figura 1). Para analizar esta complejidad histórica, actualmente se está empleando la unidad espacial denominada provincia morfotectónica y con ello comprender el desarrollo de procesos como la evolución, la migración, la especiación y la extinción de muchos taxa en conjunto con el registro fósil (Ferrusquía-Villafranca, 1993, 1998; Ferrusquía-Villafranca et al., 2010) (figura 2).

Los fósiles, definidos como cualquier evidencia de vida preservada en las rocas, son una fuente de información muy importante para comprender el desarrollo y la evolución de la vida en la Tierra. Dadas las etapas a las que se ven sometidos los restos originales de los organismos desde su muerte hasta su preservación en las rocas, y al ser recuperados como consecuencia de los procesos de erosión, cada fósil es único y no sustituible (Aguilar Arellano y Polaco Ramos, 2006).



En el país, el registro fósil que se encuentra preservado es diverso y de amplia temporalidad, aproximadamente desde hace 1.600 millones de años hasta finalizar el Pleistoceno (10 mil años antes del presente) (Mirambell et al., 1988) (figura 3). Gran parte del trabajo paleontológico ha estado vinculado a la exploración de recursos mineros y energéticos y al conformarse grupos de investigación en instituciones académicas se han desarrollado indagaciones específicas según el grupo biológico de interés.



Figura 1. Mapa de México mostrando las características de su relieve. © CONABIO (2003).

### El aspecto legal, la protección de los fósiles

Si se considera que la tradición paleontológica en México comenzó a finales del siglo XIX (Gío-Argáez, 2004) se esperaría que existieran leyes y reglamentos que regularán las actividades y se contemplara un estado de protección; sin embargo, esto no sucede de manera explícita (Carreño y Montellano-Ballesteros, 2005), salvo en la Ley General de Bienes Nacionales (Artículo VI, apartado XVIII), donde se indica que las colecciones de piezas paleontológicas forman parte del patrimonio nacional (Aguilar Arellano y Polaco Ramos, 2006; Cristín y Perrilliat, 2011).



Figura 2. Regiones en las que se divide México considerando su historia geológica, paleontológica y ambiental.

Así, es hasta el 13 de enero de 1986 que se publica en el Diario Oficial de la Federación la adición del Artículo 28bis de la Ley Federal sobre Monumentos y Zonas Arqueológicas, Artísticas e Históricas, que a la letra dice (INAH, 1995):

Para los efectos de esta Ley y de su Reglamento, las disposiciones sobre monumentos y zonas arqueológicas serán aplicables a los vestigios o restos fósiles de seres orgánicos que habitaron el territorio nacional en épocas pretéritas y cuya investigación, conservación, restauración, recuperación o utilización revistan interés paleontológico, circunstancia que deberá consignarse en la respectiva declaratoria que expedirá el Presidente de la República.

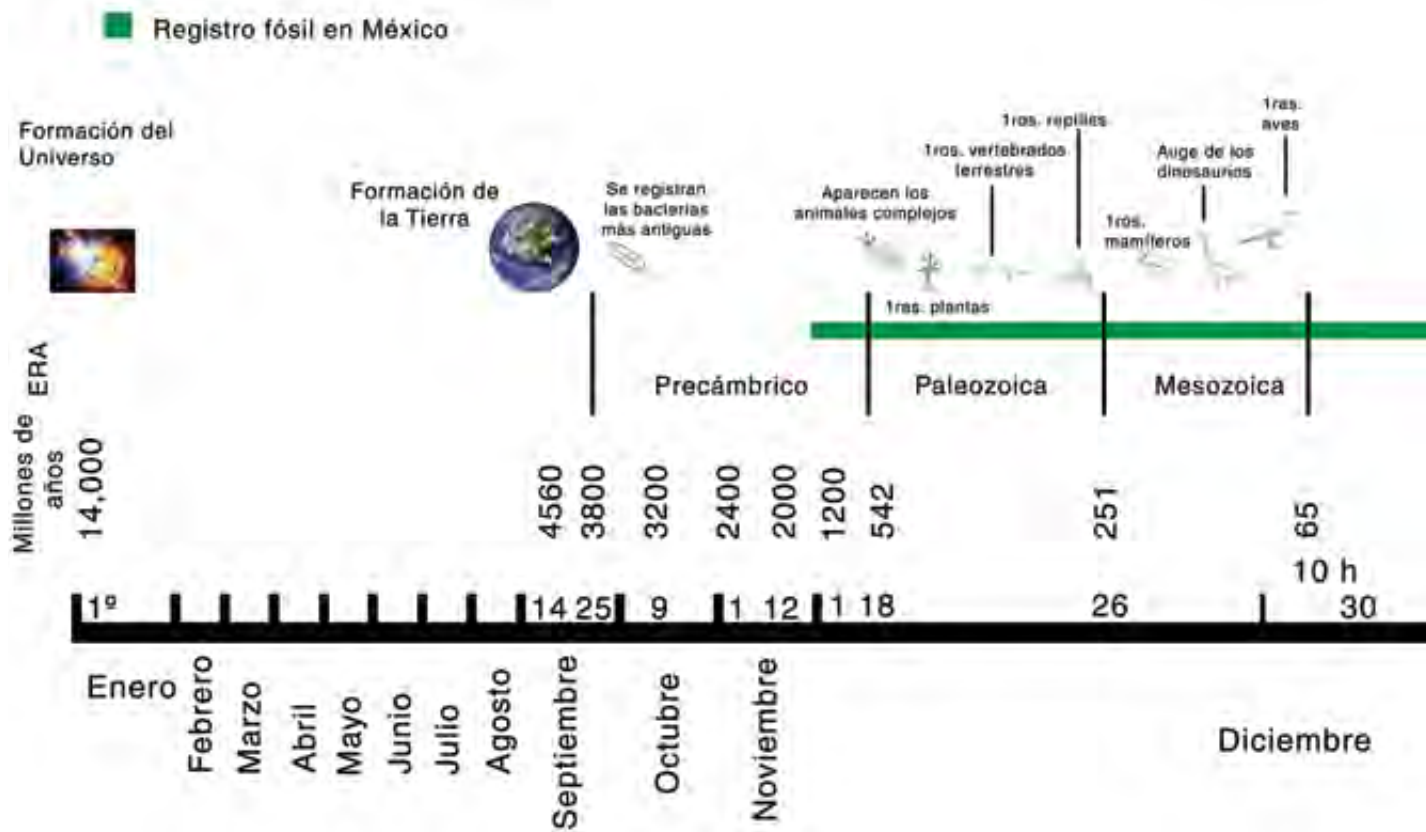


Figura 3. Escala del Tiempo Geológico, mostrando el registro fósil presente en México y un comparativo con un año. Se resaltan los eventos biológicos principales. Gráfico elaborado por Felisa J. Aguilar Arellano, 2011.

Es entonces que se le da una protección jurídica al patrimonio paleontológico al equiparlo con el arqueológico (Aguilar Arellano y Polaco Ramos, 2006). Asimismo, a partir de la misma fecha, al modificar la Ley Orgánica del Instituto Nacional de Antropología e Historia (INAH), el patrimonio paleontológico queda bajo la jurisdicción de la Secretaría de Educación Pública (SEP) a través del INAH, con los objetivos de proteger, conservar, restaurar, recuperar, promover y difundir este patrimonio (Aguilar Arellano y Polaco Ramos, 2006; Carreño y Montellano-Ballesteros, 2005).

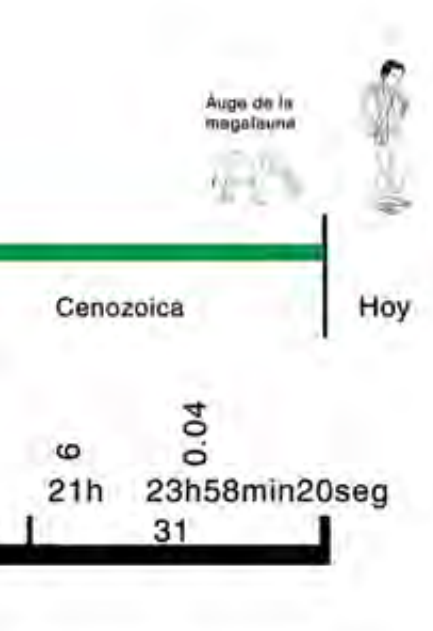
Estas nuevas tareas, tanto en la comunidad académica externa como en el interior del INAH, fueron discutidas con especial énfasis en las diferencias entre el patrimonio paleontológico y el arqueológico, tales como la distribución temporal, la espacial, el estado de propiedad, la unicidad de los monumentos y su integración como parte del patrimonio cultural (García-Bárcena, 1986), lo que complicaba su equiparación en términos jurídicos con el arqueológico (Mirambell et al., 1988). En su momento, el Ingeniero Joaquín García-Bárcena (1986) realizó un documento analizando los pros y contras de la nueva asignación indicando que

el poder legislativo decidió que el patrimonio paleontológico deberá estar bajo la responsabilidad del INAH, con la distorsión en sus funciones que esto implica; por tanto, mientras la legislación vigente no cambie, el INAH deberá de tomar las medidas para cumplir adecuadamente con esta nueva función que le ha sido asignada.

De esta forma, el INAH creó el Consejo Nacional de Paleontología, un órgano consultivo, que tenía como uno de sus objetivos el crear un reglamento propio para el patrimonio paleontológico (Amador, 2005; Carreño y Montellano-Ballesteros, 2005). La constitución del mismo consistió en reunir a un grupo multidisciplinario e interinstitucional mediante invitación del director del INAH a las instituciones de educación superior e investigación involucradas con dicho patrimonio (cuadro 1), comenzando sus labores en mayo de 1994.

Tras un consenso de sus integrantes, este órgano generó definiciones sobre los diferentes tipos de fósiles, así como sobre la regulación de actividades de investigación y económicas rentables. Finalmente, aprobó un proyecto de disposiciones reglamentarias para la aplicación del Artículo 28bis (García-Bárcena et al., 1995).

El documento generado establece en 48 artículos los criterios de protección durante la investigación y otras actividades en localidades o zonas paleontológicas, sobre el tipo de materiales (al diferenciar los fósiles en esenciales y extraordinarios) y



Cuadro 1. Instituciones que formaron el Consejo Nacional de Paleontología, órgano consultivo del INAH, en 1994.

Institución	Cargo
Instituto Nacional de Antropología e Historia	Presidente y dos vocales
Universidad Nacional Autónoma de México	Vocal
Universidad Autónoma de Baja California	Vocal
Instituto Politécnico Nacional	Vocal
Universidad Autónoma de Nuevo León	Vocal
Instituto Mexicano del Petróleo	Vocal
Sociedad Mexicana de Paleontología, A. C.	Vocal

su resguardo en colecciones (científica, no científica institucional, no científica privada y de enseñanza), así como el registro y la protección de las localidades y zonas paleontológicas. Este documento sirvió de base para una propuesta de ley que protegiera el denominado patrimonio paleontológico conservable, es decir, aquellos vestigios o restos de seres orgánicos que no se utilizan en la industria y no se encuentran asociados a un contexto cultural (Aguilar y Polaco, 2005). Dicha ley fue presentada ante la Comisión de Cultura de la LVII Legislatura del Senado de la República y turnada a la Cámara de Diputados, por lo que aún sigue en proyecto (Amador, 2004a; Carreño y Montellano-Ballesteros, 2005).

De manera paralela, el INAH ha venido trabajando en la salvaguardia del patrimonio paleontológico a través de la aplicación del concepto "protección por convicción", fomentando en la población el valor que tienen los fósiles no sólo como fuente de información sobre el pasado, sino como promotores de identidad al ser parte de la herencia cultural y natural local (Aguilar Arellano y Polaco Ramos, 2006, 2009).

## El registro, las colecciones y las localidades paleontológicas

A partir de 2009, dos aspectos han sido retomados por el INAH: la situación del resguardo de los materiales paleontológicos y sus colecciones (tanto las particulares como las institucionales), así como el registro y la protección de las localidades paleontológicas. Estas actividades han sido encomendadas a la Dirección de Registro Público y Monumentos y Zonas Arqueológicas del INAH, como lo marca la Ley Federal sobre Monumentos y Zonas Arqueológicas, Artísticas e Históricas (INAH, 1995), que las realiza con apoyo de los especialistas en el área de paleontología de la misma institución (e. g. Aguilar y Porras-Múzquiz, 2009) como aquellos adscritos a instituciones de educación superior, tales como la UNAM.

Con el registro de las colecciones paleontológicas, se da fe pública de la existencia física de los bienes paleontológicos, ya que es la primera medida académico-legal destinada a preservar los bienes únicos y no renovables (Martínez-Muriel, 2009), además de asignar la responsabilidad legal de la custodia y protección de los fósiles que la componen al responsable de la misma (Cristín y Perrilliat, 2011).



En el caso de las localidades paleontológicas, uno de los criterios empleados para iniciar su registro son aquellas que son empleadas como atractivos turísticos y que cuentan con visita pública no regulada (Amador, 2004b; Expedición, 2005; Aguilar Arellano y Polaco Ramos, 2006, 2009) (figura 4) o bien que pueden ser afectadas por el crecimiento urbano. Inicialmente se tomó la cédula de registro empleada para los sitios arqueológicos, anexando la descripción de las evidencias paleontológicas presentes in situ, y en la actualidad ya se cuenta con una definida para tal patrimonio. Se está exhortando a los investigadores a que hagan el registro de sus localidades para contar con una base de datos que permita en su momento ayudar en la planeación de proyectos de rescate o salvamento, como ocurre con lo arqueológico.



*Figura 4. Vista de la localidad de dinosauricnitas Las Águilas, Porvenir de Jalpa, General Cepeda, Coahuila, México.*

También se ha iniciado la delimitación de zonas paleontológicas, siguiendo los aspectos técnicos involucrados en la elaboración de las poligonales de las zonas arqueológicas: 1) elección de la localidad, 2) delimitación (definición del área paleontológica con el trazo de la poligonal envolvente), 3) la formación del expediente técnico, y 4) la elaboración de la propuesta de declaratoria (Escartín Adam, 2009). Por lo menos en Coahuila ya se cuenta con dos poligonales de protección para localidades paleontológicas (Aguilar, 2012a) (figura 5), y en el caso de una de las localidades tanto el trazo de la poligonal como el expediente técnico sirvieron de base para la elaboración del Decreto Estatal de Área Natural Protegida con carácter de zona paleontológica (Aguilar, 2012b).

Hoy en día, a través del Sistema Único de Registro Público de Monumentos y Zonas Arqueológicas e Históricas, se tiene el formato de inscripción tanto de colecciones como de localidades paleontológicas, con lo que se espera incrementar el interés de particulares y de instituciones en el registro de colecciones y localidades para salvaguardar la riqueza paleontológica que el país posee.



*Figura 5. Panorámica de la localidad paleontológica Rincón Colorado, General Cepeda, Coahuila, México, primera en contar con un decreto estatal de zona paleontológica. © José Luis Gudiño Maussán, 2012.*

## Perspectivas

En la actualidad, los recursos paleontológicos del mundo están desapareciendo rápidamente como consecuencia del desarrollo económico, la construcción, la industrialización, el vandalismo y la recolecta continua de fósiles por profesionales y aficionados, así como por la ambición de algunos colectores comerciales (Lipps, 2009).

Aunado a estas causas se suma la falta de una cultura de protección de dichos bienes, que debería ser considerada como una "pérdida de biodiversidad". En los países en desarrollo, dos de los factores principales que propician esta situación son la falta de principios éticos que rijan el trabajo tanto profesional como aficionado, y la corrupción, aspecto que ya está siendo ampliamente discutido (Smith et al., 2003).

Si bien existe ya una preservación de los especímenes colectados en colecciones científicas y museos, es necesario dar fe legal de la existencia de las mismas, pero sobre todo un seguimiento para que éstas no desaparezcan.

En el caso de las localidades paleontológicas, a nivel mundial se están desarrollando estrategias para la protección y conservación de los restos paleontológicos, principalmente al asociar la investigación científica con áreas como la educación, la recreación y el turismo, o bien utilizando las figuras de paleoparques (Lipps, 2009), de zonas paleontológicas (Andrés Moreno, 2006), además de interrelacionar la protección de este patrimonio junto con planes que involucren al medio ambiente (Montes Lasheras, 2006) y a la población que vive con dicho patrimonio (Muñoz Collazos, 2006). Estas experiencias, en general exitosas, se han implementado ya en China, España, Estados Unidos, Francia, Nueva Zelanda y Turquía (Aguilar, 2012a).

Así, a casi 30 años de asignar al INAH la regulación de la investigación, la conservación, la protección y la difusión del patrimonio paleontológico en México, no se han podido establecer al cien por ciento los mecanismos necesarios para hacer tal cosa a nivel nacional. En este sentido, sólo la difusión de los casos, así como los éxitos y fracasos de todo el proceso, permitirán establecer los procedimientos de gestión en todo el país y estar a la par del proceso de conservación de este singular patrimonio a nivel mundial.

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## The First Colonization of Brazil: A Review of the Pleistocene-Holocene Transition, Chronologies and Routes

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In the Pleistocene-Holocene transition, the eastern lowlands of South America had already been occupied by hunter-gatherer populations that developed diversified strategies to adapt to the transformation of the landscape. In chronological terms, such diversity involves an initial occupation earlier than those assumed by traditional models. Radiocarbon dating that supports the hypothesis of a Pleistocene initial settlement of South America have been obtained for several archaeological sites in Brazil; but the validity of these data has been questioned, as they pertain to isolated contexts whose discrete characteristics make it difficult to identify any association with human activities (Dias, 2004; Dias and Bueno, 2013; Bueno, 2011; Bueno et al., 2013; to additional critical analysis to Brazilian Pleistocene sites, see also Meltzer et al., 1994; Prous, 1997; Schmitz, 1987, 1990).

Likewise, some models suggest that the pioneer colonization route of eastern South America occurred mainly through the Atlantic Coast, and the dispersal movements into the interior happened only in the Early Holocene, when the environment became more productive (Araújo et al., 2012; Dillehay, 2000; Dillehay et al., 1992; Dixon, 2001; Miotti, 2003, 2006; Miotti and Salemme, 2003). These models generally consider the geographical conditions of the Atlantic shore as a facilitating agent for pioneer population movements, and to some extent assume that the presence of tropical forests in the north of South America constituted an ecological barrier that inhibited an ancient human presence. However, recent archaeological, bio-anthropological and palaeoenvironmental research suggests that the process of initial colonization of the South American eastern lowlands entailed multiple strategies that included ancient inland routes related to the exploitation of fluvial settings and forest habitats.

However, recent archaeological, bio-anthropological and palaeoenvironmental research suggests that the process of initial colonization of the South American eastern lowlands entailed multiple strategies that included ancient inland routes related to the exploitation of fluvial settings and forest habitats.

Bueno et al. (2013) document the quantity, quality and distribution of archaeological  $^{14}\text{C}$  dates for Brazilian territory between 13,000 and 8,000 BP. Analysing the resulting database, the authors indicate 277 dating samples for 90 sites distributed all over Brazil. The inclusion criteria for  $^{14}\text{C}$  dates required information be available on: 1) type of material dated, method of analysis and sample lab number; 2) stratigraphic provenience of dated sample; 3) cultural associations (artefacts, features) with the dated sample; and 4) statistical uncertainty of the date (with the additional criterion that the standard error bars should be no greater than 300 years).

The authors analysed the dynamics of population expansion and cultural diversification, and their core hypothesis is that the colonization of the South America eastern lowlands involved two phases: *pioneering* and *establishment*. They may have been



Figure 1. Hypothetical main routes for the initial colonization of the eastern South American lowlands. Dias and Bueno, 2013, p. 351.

initiated at different times and left distinctive demographic and cultural signatures in the archaeological record. The *pioneering* phase would have involved entering, exploring and gaining familiarity with the landscape, with the selection of specific places as foci of recurrent activity to facilitate exploitation of previously uninhabited lands. This process led to an archaeological record of low average population density, but concentrated in physically distinctive places that could have been frequently re-occupied. Regarding rates of population expansion and regional cultural diversification in inner Brazil, an archaeological threshold seems to have been reached in all occupied regions at c. 10,500  $^{14}\text{C}$  BP. The number of sites increased, as supported by the evidence of settlement of all biomes and, most importantly, there is clear evidence of inter-regional cultural diversity. In this sense, the 11<sup>th</sup> millennium  $^{14}\text{C}$  yr BP represents the *establishment* phase of the colonization process of Brazil. From the beginning of the Holocene onwards, human populations expanded radially along branching routes and in an increasing range of locations, as part of a process of social and cultural construction of a landscape whose geographical structure was now familiar. There is cultural evidence of regional variation, possibly associated with the definition of smaller territories, with greater local density of occupation and regular cycles of annual mobility. The Early Holocene was the first phase of a more permanent settlement of inner Brazil, with delimitation of territorial boundaries associated with a peopling process, which involved multiple routes and dispersal dynamics (Bueno et al., 2013; Dias and Bueno, 2013).

Based on the results of the radiocarbon database and following the original hypothesis of Sauer (1944), Dias and Bueno (2013) suggest at least three main routes for the *pioneering* phase of human colonization of the eastern South American lowlands (Figure 1).

São Francisco Basin Route would be the oldest inland route with dates from the Pleistocene-Holocene transition. Associated with unifacial lithic industries (Itaparica Tradition), it probably was related to another *pioneering* settlement route linking the Caribbean, the northern Atlantic Coast and eastern portions of the Andean Chain. In this route, the São Francisco River may have linked the Atlantic Coast with north-eastern and central Brazil. This process continued in an *establishment* phase of the colonization process during the Early Holocene, with a radial expansion connecting other important hydrographic basins of central Brazil, such as Araguaia-Tocantins and La Plata.

During the early Holocene, a second *pioneering* route through the Amazon basin could have connected the northern Guyana Plateau, Venezuela and Colombia, entering Brazil by the rivers of the northern part of the country and by the lower Amazon. This hypothesis is based on the chronology and stylistic similarities noted between the Guyana and the lower Amazon basin archaeological record. The Brazilian data for this period support the idea of an early adaptation to tropical forests, also confirmed by the Colombian archaeological record. It can also be proposed that this northern route was related to the ancient sites of the middle Orinoco valley and the inland mountains of Colombia. The connection with northern Brazil could have been facilitated by rivers such as the Branco, the Trombetas and the Paru do Leste.

In the early Holocene, a third inland *pioneering* route to south and south-eastern Brazil is represented by bifacial lithic industries with projectile points (Umbu Tradition), which may have followed the fluvial systems of the Paraguay, the Paraná and the Uruguay rivers. Although there is still scant archaeological evidence for this area, the available information in Brazil seems to support the idea that the Bolivian llanos seem to have been a 'hot-spot' for population dispersals into southern South America. In this scenario, the La Plata Basin would have been a primary pathway connecting the east Andes with the Atlantic Coast, and even with the Amazon basin. Towards the mid-Holocene evidence of an *establishment* phase is represented by the growing number of sites in southern and south-eastern Brazil, stimulated by the spreading of the Atlantic Forest biome. It is also possible that this same scenario was present in similar ecological settings in Paraguay and north-eastern Argentina, where the archaeological record for this period still is poorly known.

### The São Francisco Basin Route: The importance of Serra da Capivara and the Peruaçu Regions to Settlement of America Models

The pioneering phase of São Francisco Basin human colonization is represented by the regions of Serra da Capivara and Peruaçu. The location of several contemporary sites in these two areas, thousands of kilometres apart, support the idea that river valleys were one of the first main dispersion routes into the South American interior (Bueno, 2011, 2013; Bueno et al., 2013; Dias and Bueno, 2013).

The Serra da Capivara region is located in Piauí State, north-eastern Brazil. Archaeological research in this area was initiated in the 1970s by a French-Brazilian scientific mission, coordinated by Niéde Guidon (Guidon, 1978). The Serra da Capivara National Park was created in 1979 and has an area of 129,139.9 hectares, with a perimeter of 214.2 km. In 1991 it was inscribed on the UNESCO World Heritage List and in 1998, a proposal was submitted to the UNESCO Tentative List to incorporate three





Figure 2A. Boqueirão da Pedra Furada site, Serra da Capivara, Brazil © Sirlei Hoeltz, 2010

contiguous Permanent Preservation Areas to the Park, with an additional 35,000 hectares (Guidon, 2007; Pessis and Guidon, 2007).

Serra da Capivara National Park spreads over a geological border where an extensive cliff separates the Piauí-Maranhão sandstone plateau from the São Francisco River plain. On both the slopes of the escarpment and the inner valleys, there are many rockshelters with paintings. Sites with rock engravings are also numerous on rock outcrops located on the banks of ancient and now intermittent rivers. The rock art is characterised by anthropomorphic figures and representations of a narrative nature, by compositions illustrating daily life and ritual scenes of the human groups that lived in the region. They also represent very diverse themes, such as dancing and hunting, but also sex and violence depicted in the form of battle, capture and execution scenes (Pessis, 2003; Pessis and Guidon, 2007) (Figure 2).



Figure 2B. Boqueirão da Pedra Furada site, Serra da Capivara, Brazil © Sirlei Hoeltz, 2010

In the park area there is a record of more than 900 prehistoric archaeological sites, 657 of them with rock art. One of these sites is Boqueirão da Pedra Furada rockshelter, which presents Pleistocene dates. It is associated with a sandstone cliff, carved by waterfalls that contributed to the deposit formation. Between 1978 and 1987 an area of approximately 400 m<sup>2</sup> was excavated in the eastern and central portion of this site, revealing thousands of charcoal fragments in all levels, 156 archaeological features (interpreted as hearths) and around 8,000 lithic artefacts, 600 of them in the Pleistocene layers. The rockshelter's sedimentation is the result of two different phenomena: 1) the desegregation of the sandstone wall in the protected portion of the site; and 2) the quartzite pebbles which originated from the upper conglomerate that in times of major precipitations





Figure 3. Lapa do Caboclo 2, Peruaçu, Brazil ©: Andrei Isnardis, 2014

are dragged and projected over the slopes of the scarp. Due to the homogeneity of sedimentation there are no macroscopically different levels, but lenses of burnt remains which have discontinuous planimetric development. As a consequence, part of the excavated remains has a poor correlation with the dated structures (Parenti, 1996).

In the 1990s, Guidon and her research team considered that Boqueirão da Pedra Furada rockshelter had reliable radiocarbon dates ranging from 6,150 to 50,000  $^{14}\text{C}$  yr BP. Two principal cultural phases were identified. The oldest is the Pedra Furada Phase, with 32 radiocarbon dates from the Upper Pleistocene. It is characterised by debris of artefacts and choppers and chopping tools made of locally occurring quartzite and quartz that constitutes the walls of the upper conglomerate of the rockshelter. The Pedra Furada Phase lacks bones, wood and other organic remains, save for diffuse pieces of charcoal; and was divided into three chronological periods: PF1, with dates from 50,000 to 35,000 BP; PF2, with dates from 32,000 to 25,000 BP; and PF3 with dates from 21,000 to 13,000 BP. Additional AMS dates on charcoal and thermoluminescence on burnt quartz pebbles suggest dates between 30,000 and 100,000 BP for the layers PF1 and PF2, but there is no evidence that the heating was related to human activities. The second phase is the Serra Talhada Phase, with 6 radiocarbon dates between 9,500 and 10,400 BP. It is associated with a unifacial lithic industry (Itaparica Tradition), also present in other 15 sites of Serra da Capivara Park, with additional 25 radiocarbon dates between 12,440 and 9,000 BP. It includes artefacts of local quartzite and exotic chert, abundant rock art, human remains, and fire structures (Guidon, 1986, 1989; Guidon and Delbras, 1986; Guidon and Arnaud, 1991; Guidon et al., 1994; Lourdeau, 2010, 2012; Martin, 1997; Parenti, 1992, 1996; Santos et al., 2003; Valladas et al., 2003).

Two other sites from the Serra da Capivara Park present chronological evidence from the Pleistocene-Holocene transition. Toca do Gordo do Garrincho site has a date of  $12,210 \pm 40$   $^{14}\text{C}$  BP associated with a human tooth articulated in a maxillary fragment and its stratigraphical location, above a stalagmite, provides a secure chronological reference point. At Toca do Sítio do Meio there is a clear stratigraphic association between a charcoal sample dated to  $12,440 \pm 240$   $^{14}\text{C}$  BP and an Itaparica Tradition lithic assemblage characterised by flakes, cores, scrapers and *limaces* made of siltite, quartz and quartzite. This site has been recently investigated by Eric Böeda and his team, and test excavations reveal dates of  $20,280 \pm 450$  and  $25,170 \pm 140$

$^{14}\text{C}$  BP for charcoal fragments, but there is no other kind of cultural association to the dates (Böeda et al., 2013; Guidon et al., 1994; Peyre et al., 1998).

The Pleistocene dates of Boqueirão da Pedra Furada site stimulated a broad debate (Guidon et al., 1994, 1996; Meltzer et al., 1994; Parenti et al., 1996; Prous, 1997; Prous and Fogaça, 1999; Schmitz, 1987, 1990); and its results can be compared with two other Pleistocene sites recently investigated in the same area: Vale da Pedra Furada and Toca da Tira Peia (Boëda et al., 2013, 2014; Lahaye et al., 2013). All these sites have the same problematic, unresolved issues: a) a lack of information about the contextual relationship between dated samples and artefacts; b) a lack of specific palaeoenvironmental, geoarchaeological and formation process studies for supporting a better understanding of the cultural and natural differences between the occupational phases of the Serra da Capivara region. The methodology of dating is not the main issue here, but the absence of palaeoecological studies on factors other than human activity that could be responsible for the Pleistocene charcoal lenses (Dias and Bueno, 2014).

Another important aspect in this debate is that dates between 50,000 and 100,000 BP for PF1 not only questioned the Clovis Horizon as indicating the initial settlement of the American Continent, but contradicted the accepted evolutionary chronology for the modern human *Africa diaspora*. Important arguments in this debate are offered by the studies of palaeoparasitology on human coprolites found in Boqueirão da Pedra Furada, although it only demonstrated a tendency for coastal patterns of colonization that also included the Bering route (Araújo et al., 2008).

The same chronological controversies occur in relation to the Boqueirão da Pedra Furada rock art. The site has around 1,000 figures on its walls, whose age was first estimated at around 20,000 years ago by association with radiocarbon dates of some rock blocks with paintings discovered during the excavation. However, all the dates have standard error bars of more than 300 years, suggesting contamination:  $17,000 \pm 400$  BP (GIF 5397);  $26,300 \pm 800$  BP (GIF 6309); and  $29,860 \pm 650$  BP (GIF 6651) (Pessis and Guidon, 2007). More controversial data related to dating techniques for rock art in the Serra da Capivara region was published by Watanabe et al. (2003). Using thermoluminescence and EPR dating for calcite formation found on a painting at Toca da Bastiana rockshelter, an age of 35,000 to 43,000 BP was obtained. This paper was strongly criticised by Rowe and Steelman (2003) whose analysis on the same site and other sites in the Serra da Capivara Park indicate a chronology between 3,700 and 1,200 BP for these paintings.

Located in Minas Gerais State, in the south-eastern region of Brazil, the Caves of the Peruaçu Federal Environmental Protection Area and Veredas do Peruaçu State Park are two continuous areas, of 180,702 hectares, that were nominated to the UNESCO

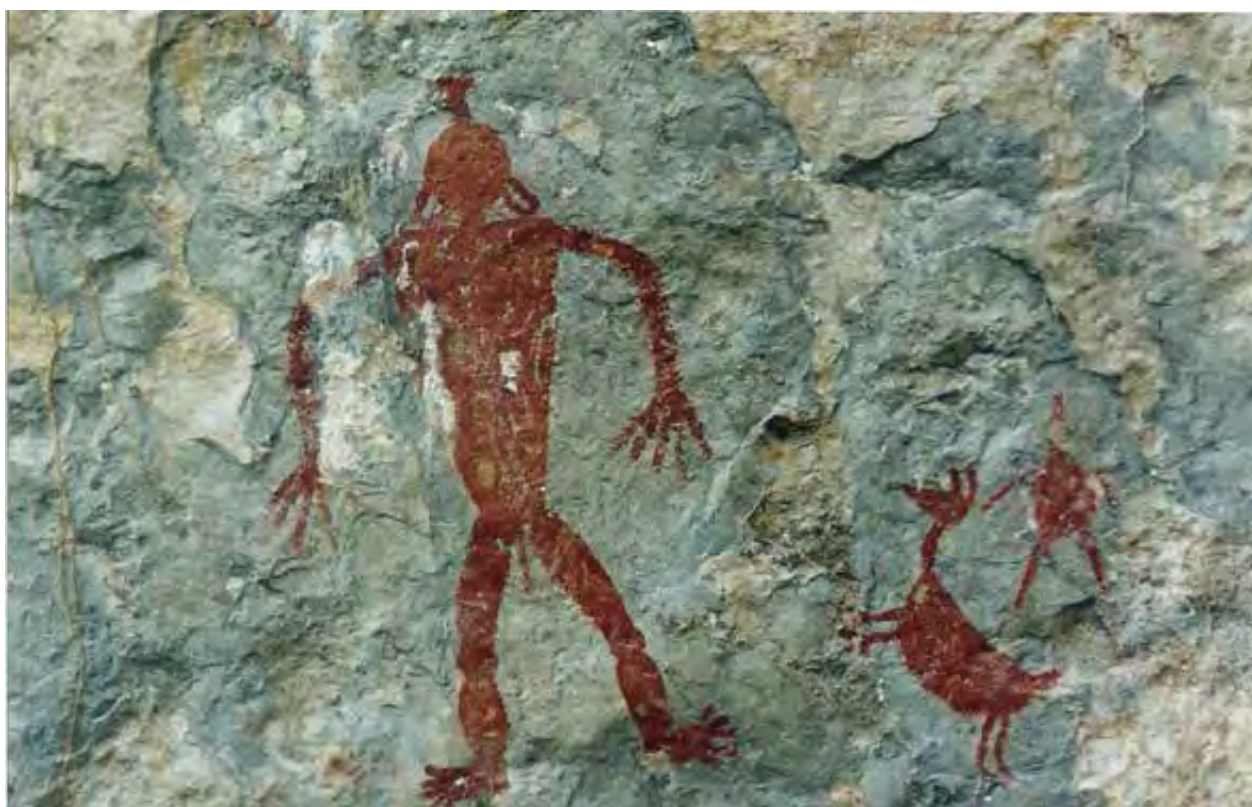


Figure 4. Santa Elina site, Serra de Araras, Brazil.



Tentative List in 1998. Peruaçu River is one of the few permanent tributaries of the São Francisco River on its course from sub-humid tropical Savanas's (*Cerrado*) where it started, towards the semi-arid regions (*Caatinga*) of north-eastern Brazil. The Peruaçu River flows through a deep canyon, boarded by high limestone cliffs with caves, holes and secondary galleries. It is crossed by impressive limestone 'bridges' and in some stretches still flows underground through monumental caves.

Archaeological investigations in the Peruaçu region were initiated in 1978, when the first surveys were conducted by Alan Bryan, Ruth Gruhn and Carlos Magno Guimarães. Between 1981 and 1999, André Prous coordinated a French-Brazilian scientific mission in this area that recorded 84 prehistoric sites; mostly rock shelters, 64 of them with rock art. The superposition of drawing in a same panel, associated with radiocarbon dating of layers with pigments and buried fragments of panels, suggests a chronology of production of rock art for between 9,000 and 2,000 BP (Figure 3). Although it is difficult to relate the paintings from different styles with specific cultural occupational periods, cronostylistic studies in Peruaçu and in the near region of Montalvânia suggest that the tradition of painting large panels with geometrical figures made with two or three colours, some of them with more than 15 m high (São Francisco Tradition), began during the Middle Holocene. Later, cultural diversification in this area is represented by other rock art stylistic variations represented by animals (mostly birds and deer) and human beings superimposed on these geometric panels (Stylistic Units Piolho do Urubu and Desenhos) (Isnardis, 2004; Prous and Ribeiro, 1996/1997; Prous and Rodet, 2009; Ribeiro, 2006).

Situated in the centre of the Peruaçu Canyon, Lapa do Boquete Cave is one of the oldest sites in the region. The excavations here occurred between 1988 and 1996 and extended over an area of 150 m<sup>2</sup>, revealing the existence of nine stratigraphic units which were subdivided into 27 archaeological occupational levels. Units VII and VIII were dated between 12,070 and 9,870 <sup>14</sup>C BP. These levels have a rich lithic industry, bone instruments, pit structures, hearths, food remains and red pigments. The lithic assemblage from the lower levels is associated with hearth features and is essentially a unifacial industry, classified as the Itaparica Tradition. It consists of large utilised flakes, small cores, thick scrapers, end and side scrapers and *limaces*. A big engraved block with pecked figures, polished grooves and cupules was discovered under the unit VI dated at 9,350±80 BP. An area of 25 m<sup>2</sup> was excavated in the western part of the cave, along a large fallen stalactite that constituted a kind of wall. In this area a big anvil used to break nuts and a ball of red pigments occupied the centre of an empty circular area. An accumulation of flint waste was around this cleaned area; and also a fragment of a bifacial projectile point. A deep cylindrical artificial pit, containing an anvil, several bones, a hammerstone, limestone splinters and several retouched instruments, including nearly all the silicified sandstone artefacts of this level were also found in unit VIII. Three combustion structures with charcoal and ash lenses were located on the boundary of this circle and post holes were found at its limits. Most of the subsistence remains were found near or within the hearths; like concentrations of carbonised palm nuts and other plants seeds and bone refuse, as well thousands of half calcinated bivalvia shells and small freshwater molluscs (*Pomacea* and *Limnea*). Quantitative studies of archaeofaunistic remains of Lapa do Boquete Cave indicate that broad-spectrum hunting strategies were continuous from the Pleistocene-Holocene transition until the Middle Holocene, and mainly focused on medium and small prey, 3 kg or less, such as mocó (*Kerodon rupestris*) and preá (*Cavia aprea*), armadillos (*Euphractus* and *Dasypus*) and reptiles such as teiu (*Tupinambis* sp.) and calango (*Ameiva* sp.). Large mammals such as deer, peccaries and tapirs are also present in the Boquete Cave diet, and there is no evidence of Pleistocene megafaunal exploitation (Fogaça, 2001; Kipnis, 1998, 2002, 2003; Prous and Fogaça, 1999; Rodet, 2006; see also Prous and Ribeiro, 1996/1997; Prous and Rodet, 2009).

Lapa do Dragão rockshelter is the only other ancient Itaparica site in the middle São Francisco Valley, with radiocarbon dates between 10,000±255 and 11,000±300 <sup>14</sup>C BP. However, no hearth structures have been found in this site and the dates come from isolated charcoal pieces. Located 150 km north of Lapa do Boquete site, in the Montalvânia region, it presents a chert and sandstone industry that includes unifacially retouched quartzite instruments and chalcedony and chert flakes (Prous and Ribeiro, 1996/1997; Prous and Fogaça, 1999).

The occupational sequence of Lapa do Boquete Cave continues through the Holocene. Between 7,000 and 4,000 BP there is a cultural rupture with Itaparica Tradition occupation in Peruaçu region and Lapa do Boquete Cave started to be used as a cemetery, with a similar pattern that characterised Lagoa Santa and Santa do Riacho regions in an earlier period. The individual graves were made in pits whose bottoms were covered with limestone blocks. The bodies were covered with red pigments and accompanied by several kinds of lithic artefacts and adornments in shell and vegetal fibers. Between 4,000 and 700 BP Lapa do Boquete Cave began to be used for another ritual proposes, related to agricultural societies. Pottery and an expedient lithic industry is found in association with several small pits (caches), with around 2 kg of volume, containing remains of crops, fruits and artefacts made of feathers (Prous and Ribeiro, 1996/1997; Rodet, 2006).

### Via north and west: first evidence of settlement in the Brazilian Amazon and La Plata Basin routes

The first evidence of a pioneering route in the lower Amazon basin is represented by the lowest cultural level of Pedra Pintada rockshelter, with a radiocarbon date of  $11,145 \pm 135$   $^{14}\text{C}$  BP. This site also has 15 dates between 10,905 and 10,250  $^{14}\text{C}$  BP associated with cultural evidence of a consistent adaptation to the tropical forest biome, with a broad variety of plant and faunal remains that point to the preferential exploitation of fish, bivalve molluscs, turtles, birds, rodents and medium-size mammals. This data has a positive relation with palaeoenvironmental studies conducted at the mouth of the Amazon River that point to low deposits of grass pollen in the Last Glacial Maximum, indicating the persistence of tropical forests during the Pleistocene. The Pedra Pintada site presents a lithic assemblage that comprises scrapers, *limaces*, blade-like flakes, graters and bifacial artefacts, as well as stemmed projectile points with triangular shapes (Colinvaux, 1987; Roosevelt et al., 1996).

Evidence places the establishment phase in the Amazon basin between 10,000 and 8,000  $^{14}\text{C}$  yr BP, and 11 sites have been recorded with 16 dates between 9,570 and 8,050  $^{14}\text{C}$  yr BP. Geographical expansion enlarged, reaching the middle Amazon, near the confluence of the Negro and Solimões Rivers, and the transition zone between the Tropical Forest and Savannahs biomes in the south-western lower Amazon (Carajás region). A tendency towards regional diversification on lithic industries can also be observed here. In the middle Amazon, the assemblage contains both unifacial and bifacial tools made of local raw materials. In the Carajás area the assemblages are dominated by informal artefacts made of quartz, with evidence of bipolar flaking technique (Bueno, 2011).

The initial colonization of La Plata Basin also shows a complex picture. La Plata Basin is one of the main South American lowlands internal fluvial corridors that connect western and eastern parts of the subcontinent. It links the Bolivian *chaco* with the Amazon basin through the Paraguay River. Likewise, the connection between central South America and the Atlantic coast is possible by the Paraná River and with the southernmost parts of the continent by the Uruguay River. For these reasons, this fluvial system that crosscuts a variety of ecological settings also represented a key role in human dispersal and cultural diversification in the Early Holocene. La Plata Basin was probably used in the same period as a gateway to the East for different cultural traditions that would be already present in Central South America. This situation can be illustrated by some of the most ancient evidence of human occupation of Paraguay Basin (Dias and Bueno, 2013).

Santa Elina rockshelter is located in the Serra das Araras, Mato Grosso State, in the geodesic centre of South America. This limestone rockshelter is a flat wall about 30 m high, with approximately 900 paintings of animals, human figures and signs associated with a panel 60 m long and 4 m high. Another low wall, in declivity and covered with sedimentation, is visible in part of the shelter. It lies 3 to 5 m distant from the painted wall, parallel to it and with the same inclination. The dwelling area is delimited by this gap. The site was subject of a French-Brazilian scientific mission, coordinated by Águeda Vilhena-Vialou, Denis Vialou and Levy Figuti. The excavation of the site occurred between 1984 and 2001, covered an area of 90 m<sup>2</sup> and 46 radiocarbon dates were conducted. An assemblage of 8,000 lithic remains was discovered, made in local raw material, mainly the limestone of the rockshelter's walls, as well silex, sandstone and hematite from sources no less than 5 km away from the site (A. V. Vialou, 2003, 2005, 2007).

The chronostratigraphy of the site is divided in three phases. Unit I (80-120 cm deep) has 22 radiocarbon dates from 275 to 6,000 BP, with evidence of intense human activity related to hunting and gathering local resources. The main plant species identified in this unit were jatobá (*Hymenaea* sp.), araticum and pindaíba (*Annonaceae* family), sapucaia (*Lecythis* sp.), ingá (*Inga* sp.), figo (*Ficus* sp.), veludo (*Guettarda viburnoides*) and pitomba (família *Sapotaceae*) (Scheel-Ybert and Solari, 2005). The faunal remains indicate the consumption of red brockets (*Mazama americana*), peccaris (*Tayasu* sp.), armadillos (*Dasyopus novemcinctus* and *Euphractus sexcinctus*), spotted paca (*Agouti paca*), agouti (*Dasyprocta* sp.), mocó (*Kerodon rupestris*) and other small rodents (*Echimyidae* and *Cricetidae*). Reptiles such as calango (*Ameiva* sp.), fish, molluscs (*Megalobuliminus* sp. and *Pomacea* sp.) and bivalves (*Diplodon* sp.) are also present (Figuti, 2005). Levels of red pigments are associated with this unit indicating the chronological association with painting activities. Most of the signs are geometrical and the remaining figures represent humans and groups of deer. Fish, birds, monkeys, tapirs, peccaries and felines are also represented. Santa Elina is the only site in the region with rock art and other sites with rock paintings in Serra das Araras are 200 km south-west (D. Vialou, 2005).

Unit II (100-250 cm deep) has 16 radiocarbon dates between 6,000 and 10,000 BP, and presents an assemblage of hearths aligned with the back wall dated to  $10,120 \pm 60$   $^{14}\text{C}$  BP. Also present in this unit are hundreds of bone remains (osteroderms) of giant sloth (*Glossotherium lettsumi*) with a Uranium-Thorium date of  $13,000 \pm 1000$  BP. The lithic assemblage is composed of 1,055 pieces, mainly limestone flakes and blanks. This unit presents some local evidence of sedimentary disturbance due to an area of fallen blocks (A. Vialou, 2003, 2005, 2007).

Unit III (250-350 cm deep), with Pleistocene dates, has sandy sediments rich in pebbles, but poor in charcoal. In an area of 8 m<sup>2</sup>, there are 200 bone fragments and 4,000 osteoderms of a single giant sloth (*Glossotherium lettsomi*). Two of these osteoderms of 2 cm are pierced and one of them has been abraded. The lithic assemblage is composed of 265 pieces, with 22 retouched limestone artefacts made on blanks or flakes and 4 artefacts in silex flakes, including a micro-scraper. This unit has three dates. One osteoderm was dated by Uranium-Thorium at 27,000±2000 BP; sediments associated with the faunal remains were dated by OSL to 27,600±1500 BP; and small fragments of charcoal were dated by AMS at 23,120±260 <sup>14</sup>C BP (Gif 99177). Two fragments of floated wood were dated by AMS at 22,500±500 <sup>14</sup>C BP (Gif 9366) and 23,320±1000 <sup>14</sup>C BP (Gif 9365) but they were considered contaminated by the disturbance in the base of unit II (A. Vialou, 2003, 2005). These chronological results were considered by Agueda Vialou and her team as coherent, indicating ages around 22,000 and 25,000 <sup>14</sup>C BP to the initial occupation of this site (A. Vialou, 2003, 2005, 2007).

It is important to mention that Santa Elina is located at the boundary of tropical forest and savannah environments, in the upstream area of the Amazonian and several river systems of the Brazilian Central Plateau. Besides the taphonomic issues regarding the Pleistocene unit of this site, this is a very important place in the discussions of early routes and displacements because it would be the western site for the *pioneering phase* of settlement in Brazil and a possible connection between the eastern highlands and western lowlands of South America, indicating the possibility of the initial human colonization of the La Plata basin, at least around the Pleistocene-Holocene Transition.

Similarly, this is the same period when the first evidence of human presence in the Middle Uruguay River was identified. In the Touro Passo region, Rio Grande do Sul State, Pleistocene sediments were deposited all along the lower reaches of the Uruguay River under volcanic ash layer dated at 10,400±110 <sup>14</sup>C BP. On the eroded terraces several bones of *Glossotherium robustus* were found, dated at 12,270±220 <sup>14</sup>C BP. At the same stratigraphic levels, crude basalt and quartzite choppers and flakes were found associated with the rolled bones. However, both the artefacts and their association with the bones (which were found around 4.5 km away from the <sup>14</sup>C sample) are doubtful (Prous and Fogaca, 1999; Dias and Jacobus, 2001).

The oldest evidence of human presence in this area is represented by two open air sites, Laranjito and Milton Almeida, with five radiocarbon dates between 10,800 and 10,200 <sup>14</sup>C BP (Dias and Jacobus, 2001). Related to grassland biomes (*Pampa*), these archaeological sites are associated with lithic industries characterised by the predominance of bifacial technology (Umbu Tradition). It is characterised by a variety of bifacial triangular projectile points, pedunculated and non-pedunculated, some of them with serrated edges and others with unifacial retouch, usually associated with bolas. The technological characteristics point to similarities with contemporary archaeological contexts in Uruguay, possibly indicating a common cultural matrix (Suarez and Lopez, 2003; Suarez and Santos, 2010; Lopez-Mazz, 2013). Nonetheless, based on the absence of fishtail projectile points in these assemblages, it is reasonable to propose that the routes that gave origin to the initial colonization of the Brazilian Pampa could be closely related to the occupation of the Paraguay and the Paraná river basin, still poorly known archaeologically (Bueno et al., 2013; Dias, 2012; Dias and Bueno, 2013; Hadler et al., 2013).

### Regional diversification: Itaparica Tradition, Lagoa Santa Complex and Umbu Tradition

The general process of regional diversification in the South American eastern lowlands continued between 10,000 and 8,000 <sup>14</sup>C BP. Between 9,000 and 8,000 <sup>14</sup>C yr BP, the Itaparica Tradition reaches its greatest spatial extent, with 21 sites in the Araguaia-Tocantins and São Francisco basins, and 42 radiocarbon dates. However, after 8,500 <sup>14</sup>C yr BP some regions of central and north-eastern Brazil seem to have been abandoned. This process was accompanied by an abrupt cultural change in distinct regions, with a tendency for regional differentiation in rock art styles and lithic industries; the latter were mostly characterised by an expedient unifacial technology (Bueno et al., 2013).

Archaeological excavations carried out at rockshelters in the states of Goiás and Minas Gerais indicate that these spaces were used as domestic areas, often associated with rock paintings and human burials. General exploitation of the tropical savannah resources were dominant in the early stages of this occupation, especially the consumption of red brocket (*Mazama americana*), pampas deer (*Ozotocerus benzoarticus*), white-lipped peccary (*Tayassu tajacu*), armadillos (*Cabassous tatouay*, *Euphractus sexcinctus* and *Dasyus novencinctus*), monkeys (*Alouatta caraya*, *Lagothricha lagothrix* and *Cebus apella*), capybaras (*Hydrochoeris hydrochoeris*), lizards (*Tupinambis teguxin* and *Common ameiva*) and turtles (*Chelonia* sp.), as well as several species of fish, birds and gastropods. There is also early evidence of heavy consumption of seasonal fruits like gueroa (*Syagrus oleacea*), jerivá (*Syagrus romanzoffiana*), acumã (*Syagrus flexuosa*), jatobá (*Hymenaea stigonocarpa*), babaçu (*Orbignya* sp.), cashew (*Anacardium* sp.), licuri (*Syagrus coronata*) and pequi (*Caryocar brasiliense*). Studies of settlement systems suggest that the mobility strategies in tropical savannahs were mediated by the rainy season (December to May). The higher productivity of flora in this period would support the concentration of people, these being dispersed in the dry season over areas that could cover up to 2,000 km<sup>2</sup>. The aggregation sites would be marked by regional styles of rock art and lithic debitage which



displayed strategies of territorial demarcation and maintenance of long-distance social networks (Prous and Fogaça, 1999; Kipnis, 1998, 2003).

There is an increase in the number of occupational events in semi-deciduous forests in the middle of the São Francisco Valley, with 81 dates between 9,900 and 8,040  $^{14}\text{C}$  BP for 15 sites (Bueno et al., 2013). The most striking aspect of this record is the presence of human burials in several rockshelters at Lagoa Santa and Santana do Riacho regions, making them the largest and best preserved samples of human remains found in Brazil for this period. The burial practices of Lagoa Santa have been the subject of archaeological studies since the late nineteenth century. The first French-Brazilian scientific mission in Lagoa Santa was coordinated by Anette Laming-Emperaire, between 1971 and 1976 (Laming-Emperaire, 1979). In the excavation of Lapa Vermelha IV, the skull of a woman was deposited in the intermediate levels between 10,200 $\pm$ 220 BP and 11,680 $\pm$ 500 BP. Recently, an AMS date on these human bones was obtained, with a value of 9,330 $\pm$ 60  $^{14}\text{C}$  BP (Beta 84439). In more recent levels, some bones and coprolites of a giant sloth (*Scelidotherium*) are dated c. 9,580 $\pm$ 200  $^{14}\text{C}$  BP (Gif 3208). There were no fireplaces or any typical lithic artefacts of this period. Thus, dating was generally performed on scattered charcoal, probably of natural origin (Prous and Fogaça, 1999). In 2000, Walter Neves began a long-term archaeological research project in the area. Since 2001, four limestone rockshelters (Lapa das Boieiras, Cerca Grande VI, Lapa do Santo and Lapa Grande de Taquaraçu), one palaeontological site (Cuvieri Cave), and two open air sites (Sumidouro and Coqueirinho sites) were excavated. Until today the Lagoa Santa Region has generated a sample of around 300 human skeletal remains, associated with two burial peaks in the area: the older one, between 10,000 and 8,000 BP, and a more recent one between 2,000 and 1,000 BP. It is noteworthy that this second phase of occupation is related to a horticultural population without a biological relationship to the original hunter-gatherer groups (Araújo et al., 2005, 2012).

The results of the bio-anthropological analysis have offered support for the hypothesis that at least two biological components constituted the populations that originally colonized South America. The earliest occupation was carried out by people with a generalized cranial morphology, similar to that currently found among African and Australian indigenous populations, which also prevailed in East Asia for much of the Late Pleistocene. This biologic standard is modified from the mid-Holocene onwards, when a Mongoloid morphology became dominant among the South American population. These data suggest that a second wave of population with a classic Mongoloid morphology entered the Americas during the Early Holocene. The biological changes of present-day Native Americans indicate an abrupt transition, possibly involving population replacement by competition and, to a lesser extent, hybridisation. These features suggest that the time interval between the two population waves with distinct biological features may have been quite short, around two to three millennia at most (Neves et al., 2013; Neves and Hubbe, 2005).

The occupation of south-eastern and southern Brazil follows a different pattern from that recorded in central Brazil, with a growing number of Umbu Tradition sites towards the mid-Holocene. Ten sites have been identified with 21 dates between 9,855 and 8,020  $^{14}\text{C}$  BP. Their geographical distribution mainly follows the Paraná and Uruguay Basins; and the new colonized territories mostly correspond to the Atlantic Forest biome. Even though separated by long distances, in some cases more than 1,500 km apart, Umbu Tradition lithic assemblages in the Paraná and Uruguay basins show technological similarities, with predominant bifacial technologies and a variety of stemmed projectile points made on local raw materials. Furthermore, subsistence studies indicate a pattern that persisted throughout the Holocene, characterised by generalist hunting strategies mainly focused on forest resources. The hunt for mammals was characterised by a preference for armadillos (*Dasybus sp.*), red brocket and pampas deer (*Mazama americana* and *Ozotocerus bezoarticus*), collared peccaries (*Pecari tajacu*) and cavies (*Cavia aperea*). Reptiles were also a hunting priority, especially lizards (*Tupinambis sp.*), and fragments of rhea eggs (*Rhea americana*) are frequent in the archaeological assemblages. Mollusc gathering also played an important role in subsistence, particularly the gastropod *Megalobulimus* and *Pomacea* and the bivalve *Diplodon* (Dias, 2012; Dias and Bueno, 2013; Bueno et al., 2013; Hadler et al., 2013).

### Concluding remarks

Brazilian data for the Pleistocene-Holocene transition reinforce the idea that a *pioneering* phase of the human colonization of South America eastern lowlands was characterised by recurrent activities at salient landmarks or orientation points in a landscape that was still being explored, 'mapped' and encoded into traditional knowledge systems. Such a recurrence would have facilitated mobility and social aggregation into sparsely inhabited or uninhabited landscapes. Large river valleys in north-eastern and central Brazil, in the Amazon and in the La Plata Basin seem to have played this key role during the Pleistocene-Holocene transition, concentrating and directing an expansion that quickly reached new and distant areas without completely filling the vast territory surrounding these early settlement points. Besides being key navigational axes and reference points in the landscape, easily located and recognized, these river valleys also provided diverse and abundant resources for subsistence and technology, which must have been very valuable in situations of little or low knowledge of this large area (Dias and Bueno, 2013).

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# A Millenary Habit Evidenced by Palaeoparasitology: Perspectives on Methodologies and their Contribution to Understanding Human Dispersals in the Americas

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## Abstract

The first finding of a parasite in prehistoric material was reported in 1910 by Sir Marc Armand Ruffer, when eggs of *Schistosoma haematobium* were found in renal tissue of an Egyptian mummy dated to 1250 BC. In 1978, Dr Luiz Fernando Ferreira (FIOCRUZ, Brazil) named the term Palaeoparasitology, defined as the study of parasites found in palaeontological or archaeological material. Palaeoparasitological studies allow the identification of parasite species that affected our ancestors and have been prevalent throughout history. These parasites were disseminated with the conquest of new territories and particularly increased by agriculture and the domestication of animals, which came about from the higher density of human demographics. Prehistoric parasites can be found in mummified tissues, in the sediments deposited on the bones of the abdominal and pelvic cavities, in latrines, septic tanks and in coprolites, which are some of the most abundant biologic material in archaeological sites. The parasitological analysis can be made by classic laboratory methods and by sophisticated molecular biology techniques. An important advance in Brazilian palaeoparasitology took place in 1984, in collaboration with Dr Niéde Guidon, the President of the American Man Museum Foundation (FUMDHAM) and the co-manager of the Serra da Capivara National Park, (Piauí, north-eastern Brazil). There are 1,335 rock art sites registered within the Serra da Capivara National Park in the regions of Serra da Capivara and Serra das Confusões, and investigations of human and animal coprolites from some of these sites continuously produce interesting results. The oldest *Ancilostomatidae* eggs found in the Americas were detected in human coprolites dated from  $7,230 \pm 80$  years, collected in the excavation site of the Boqueirão da Pedra Furada (PI, BR). This finding supports the likelihood of human transmaritime migration to the Americas. As with other geohelminthes, the hookworm eggs and larvae are resistant to environmental conditions, but have narrow tolerance limits, which allow reasoning of their geographical distribution. Northern locations such as Siberia and Alaska do not possess environmental conditions suitable for maintaining this parasite's life cycle. Hence, their introduction in the Americas must have been achieved by alternate ways other than crossing the Bering region. Transmission model studies that demonstrate the speed of infection in a closed human group have shown that one infected subject could infect another 300 individuals in the period of a year. Relating this study with prehistoric populations, one infected person arriving from Asia by boat could infect the South American population. Thus, it is likely that different routes brought prehistoric people (and their worms) to the Americas. Other palaeoparasitological studies with coprolites and archaeological materials include the search for ectoparasites in mummified bodies; the analysis of *Ascaris lumbricoides* DNA sequences (as their eggs are rare in coprolites from South America but common in Europe); studies about the unusual zoonotic parasites also found in human coprolites by the ingestion of new food; the phylogenetic analysis of *Enterobius vermicularis*, a worldwide parasite hosted by humans; the studies of parasites on extinct animals and the host-parasite adaptations through the forest-semiarid transition in the last forty thousand years in the north-eastern region of Brazil.

## Introduction

Palaeoparasitology has generated knowledge about parasites in ancient times and the history of diseases, and has also aided the understanding and reconstruction of the landscapes, migratory routes, habits, behaviours and cultures of their hosts.

The first parasite finding in prehistoric material was reported by Sir Marc Armand Ruffer in 1910, when eggs of *Schistosoma haematobium* were found in renal tissue of an Egyptian mummy dated to 1250-1000 BC (Ruffer, 1910). Subsequently, other parasite findings were made during palaeopathological studies in mummified bodies from Prussia and Europe (Szidat, 1944) and in the analysis of mummified faeces (Taylor, 1955; Fry, 1970).

In 1978, Dr Luiz Fernando Ferreira devised the term Palaeoparasitology during a discussion with his colleagues at the Oswaldo Cruz Foundation (Brazil) about the origins of parasitic infections. His definition conceptualises Palaeoparasitology as the study of parasites found in palaeontological or archaeological material (Ferreira et al., 2014). Dr Ferreira's field of study was about the origins of parasitic infections present in pre-Columbian America and the new parasites that had been introduced by Europeans or Africans. His main interest was to verify the origins of the *Schistoma mansoni* infection in Brazil, which had been classically attributed to the trading of slaves (Fonseca, 1972).

As an interdisciplinary science, the interpretation of results in palaeoparasitology depends on the knowledge of many professionals, and incorporates practical and theoretical knowledge of medicine, biology, archaeology, anthropology, geography, genetics, molecular biology, history and others (Ferreira et al., 2014). Thus, palaeoparasitological studies allow the identification of past parasitic infections; the study of the origins and spreading of parasites and their hosts, and the correlation of parasites with host population dynamics, diet and sociocultural habits. Moreover, it produces clues about the palaeoenvironment, the current environmental, temporal climate changes and the emergence of diseases (Chaves and Reinhard, 2006; Reinhart et al., 2013).

### Perspectives on methodologies

The associations between parasites and hosts can be made by phylogenetic analysis and by biogeographical record distributions (Araújo and Ferreira, 2000; Gonçalves et al., 2003; Leles et al., 2008). These studies indicate which parasite species are inherited from our ancestors and which were acquired through history, with the conquest of new territories and the approach and use of new species of plants and animals, especially with the domestication and the increase of human density due to agriculture (Loreille and Bouchet, 2003; Pearce-Duvel, 2006).

It is possible to find prehistoric parasites in many materials: in tissues from mummified bodies, in the sediment deposited in the abdominal and pelvic cavities of skeletons and also in latrines and septic tanks (Reinhard, 1992; Bouchet et al., 2003). Nowadays, using molecular biology and immunology techniques, it is possible to rescue fragments of DNA from bone marrow, tissues and from other organic materials and sediments (Iñiguez et al., 2003a, 2003b, 2006, 2012, Le Bailly et al., 2008; Lima et al., 2008; Wanke et al., 2013). Nevertheless, the most abundant biological material in archaeological sites is mummified faeces – coprolites.

Coprolites, although abundant and normally well preserved in the sediments, pose the first challenge for any palaeoparasitologist, followed by their identification needed for the posterior correlation of the parasitic results with the archaeological and palaeontological context. In Brazil, the current methodology used for the identification of coprolites establishes parameters for the differentiation between human coprolites from other species by shape, the presence of coal, cooked starch, food remains and species-specific parasites (Chame, 2003; Chame and Sianto, 2014). Another critical point in the study of coprolites, as well as in all archaeological and palaeontological materials, is the necessity to consider the interferences resulting from taphonomic processes such as termite drilling, soil alterations, flooding and other disturbances.

Depending on the importance and complexity of samples, many complementary techniques can be used to obtain data and confirm the parasitological diagnosis found in archaeological sites. Every investigation is initiated by a simple macroscopic identification of materials. The next steps are to use classic methods of parasitological analysis and then the most sophisticated ones, such as electronic microscopy and the techniques of immunology and molecular biology (Reinhard, 1992; Araújo et al., 1998; Frias et al., 2013).

In most cases, because of the nature of the samples it is necessary to rehydrate them prior to preparing them for analysis. The most used method was proposed by Callen and Cameron in 1960 and consists of immersing the samples in a 0.5% solution of sodium triphosphate ( $\text{Na}_3\text{PO}_4$ ) for 48 to 72 hours. To avoid cross-contamination with fungi and bacteria, the samples must be kept at constant conditions, optimally at 4 °C or in preservative solution.

Hair, bones, teeth, seeds, pieces of arthropods and other food items can be found in macroscopic analysis, aiding the understanding of the dynamics of parasite transmission. These materials also help in the identification of the availability and preference of food supply, seasonality and cultural habits, such as selection, technique of preparation and cooking for nourishment. In the microscopic analysis it is possible to find eggs and larvae of helminthes, protozoans, pollen, grains of cooked starches, vegetable epidermis, hair, algae, small arthropods and eggs of aquatic animals. All these items help to complement the puzzle of existing diseases in prehistoric men and animals.

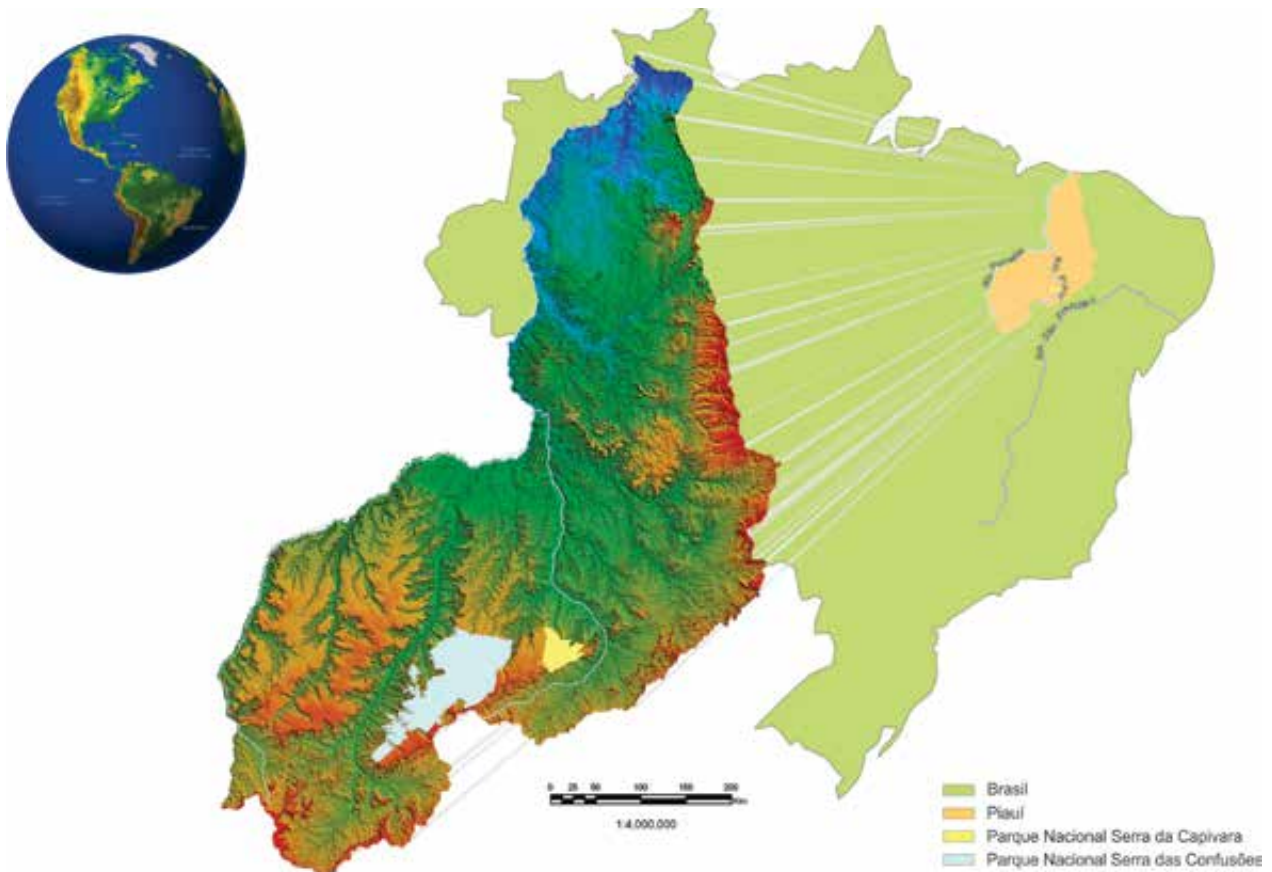


Figure 1. Location of Serra da Capivara National Park, World Heritage Cultural Site in Brazil.

Recently, DNA sequencing by genomics has opened large possibilities for undertaking phylogenetic studies, especially on the virulence of pathogens over time (Reinhard et al., 2013) and the spill-over of zoonotic diseases to new hosts.

### The contribution of Palaeoparasitology to the understanding of human dispersals and adaptation in the Americas

The first studies conducted by Dr Luiz Fernando Ferreira with Palaeoparasitology began in 1970 with the parasitological analysis of coprolites from the State of Minas Gerais, in central Brazil. However, the big boost to Brazilian Palaeoparasitology took place in 1984 when Dr Niéde Guidon invited Dr Ferreira and his group to study the archaeological materials of the Serra da Capivara National Park, in Piauí, Brazil.



Figure 2. Aerial view of Serra da Capivara with the plateau, canyons and plain. © FUMDHAM



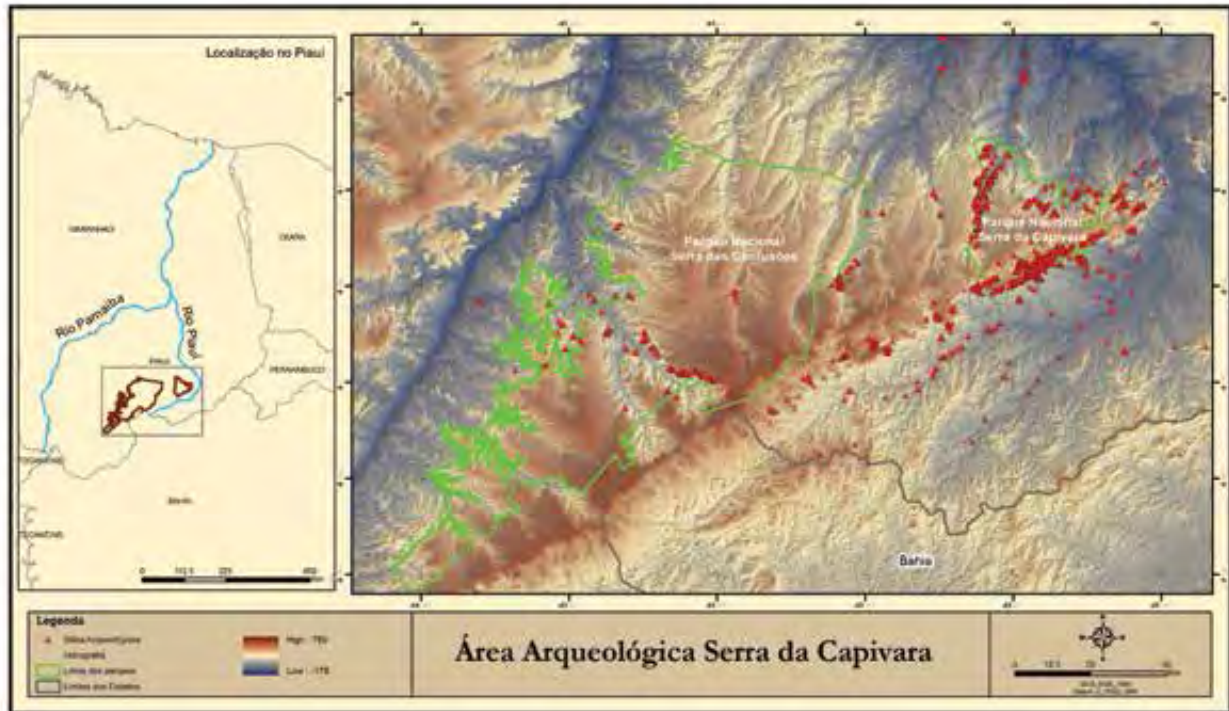


Figure 3. Distribution of archaeological sites in the Serra da Capivara Region, north-eastern Brazil.

Since then, palaeoparasitologists of the Oswaldo Cruz Foundation have become part of the multidisciplinary team coordinated by Dr Guidon. The latter created the American Man Museum Foundation (FUMDHAM) that manages the park in conjunction with the Brazilian government (Guidon and Pessis, 1998; Pessis, 2003; Pessis and Guidon, 2007).

The Serra da Capivara National Park was created in 1979 and was inscribed on the UNESCO World Heritage List in 1991. It is situated in north-eastern Brazil, in Piauí state (Figure 1), and covers an area of 129,140 hectares of Caatinga, an exclusively Brazilian biome, characterised by a mosaic of vegetation and landscape types adapted to a semi-arid climate and with a considerable and still unexplored biodiversity (Emperaire, 1983; Leal et al., 2005; Albuquerque et al., 2012) (Figure 2). The park's protected area is distributed across five municipalities. The climate is hot and dry; favourable to the preservation of archaeological materials. However, the region is poorly developed due to the combination of long periods of drought, inadequate policies on socioeconomic and environmental management and the historical occupation of the region (Pessis, 2003).



Figure 4. Archaeological sites and rock art of the Serra da Capivara National Park, north-eastern Brazil. © FUMDHAM.



Figure 5. Caatinga in dry season, Serra da Capivara National Park, Piauí, Brazil.



Figure 6. Registration of coprolites at the Palaeoparasitology Collection at the Oswaldo Cruz Foundation, Rio de Janeiro, Brazil. © Palaeoparasitology Laboratory, Oswaldo Cruz Foundation, Brazil.



Figure 7. The site of Boqueirão da Pedra Furada, Serra da Capivara National Park, Piauí, Brazil.

The combination of these facts makes the preservation of the Park and its archaeological sites a quest of great political and financial effort.

The area of study includes the Serra da Capivara and its surroundings that still cover the National Park of Serra das Confusões. Together they house 800,000 hectares where 1,335 rock art sites are registered, some of which may be more than 30,000 years old (Figure 3).

The high concentration of archaeological sites and their antiquity designates the Serra da Capivara as one of the most significant archaeological sites worldwide (Guidon, 1995, Guidon and Pessis, 1998; Pessis and Guidon, 2007) (Figure 4). Evidence of hunter-gathering human settlements that may be older than 40,000 years brought new elements to the classic theories of American human migration through Beringia (Guidon and Delibrias, 1986; Guidon, 1987, Guidon and Arnaud, 1991; Guidon et al., 1994) and important palaeoparasitological evidence make the origins of man in South America even more intriguing (Ferreira et al., 1987; Araujo et al., 1988, Ferreira and Araujo, 1996, Montenegro et al., 2006, Ferreira et al., 2014).

Although the discussion about the antiquity of the arrival of pre-historical humans in the Americas is a controversial subject (Meltzer et al., 1994, Guidon et al., 1996), new studies point to other entry routes of prehistoric man in the colonization of the Americas. Since 1994, the discussions have evolved based on new findings, data and techniques in the Serra da Capivara region and also in other areas in South America (Meltzer et al., 1997; Dillehay, 2010, Watanabe et al., 2003, Lahaye et al., 2015; Boëda et al., 2013, 2014, Skoglund et al., 2015). Among the new evidence of the ancient presence of the Serra da Capivara pre-historic man, it is important to highlight the works of the team of Dr Lahaye (2015) and Dr Boëda (2013, 2014). Dr Boëda is currently undertaking a new excavation next to the original excavation carried out by Dr Niède Guidon. This new excavation is away from the rock matrix and until now Dr Boëda's team have found human remains dated to 24,000 years. This certainly allows us to expect even older data as found in the original excavation.

The Serra da Capivara region also includes villages, camps, lithic workshops, burial sites and 172 archaeological sites prepared for visitation.

In the past 40,000 years, the region has suffered an important environmental transformation (Ab'Saber, 1977; Chaves and Renault-Miskovsky, 1996; Behling et al., 2000; Chaves, 2002; Pennington et al., 2004). At this time the region was a junction of the Amazon and Atlantic Forest presenting open areas such as grasslands, inhabited by megafauna and humans (Guérin 1991; Guérin et al., 1996; Brooks and Bowman, 2002). Ribeiro and colleagues (2013) made recent compilation of Brazilian Quaternary megafauna data for the northeast region of Brazil and new studies support the meeting of them in period coincide with the presence of prehistoric man in the Serra da Capivara National Park region and in the north-east region of Brazil.





Figure 8. Coprolite excavation on the site of the Boqueirão da Pedra Furada, Piauí, Brazil, and the hookworm egg found dated from 7,230 ± 80 years BC. © Palaeoparasitology Laboratory, Oswaldo Cruz Foundation, Brazil.

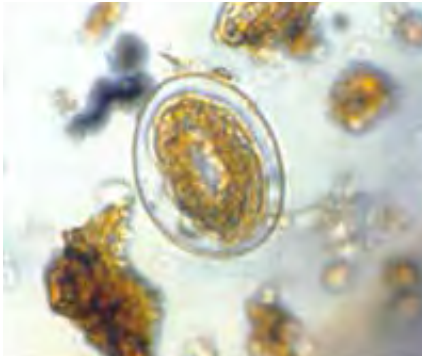
Kionshita and colleagues (2014) dated Toxodontinae and Gomphotheriidae from 7 ka up to 71 ka on a temporary lake in the southern region of Serra da Capivara National Park – Lagoa dos Porcos, and Dr Hubbe (2013) discussed the simultaneous presence of megafauna and humans in the Pleistocene / Holocene transition.

In the past ten thousand years, the region has gone through a regional process of desiccation and the forest and prairies gave way to Caatinga, a scrubland biome (Oliveira et al., 2005) (Figure 5). Although a deciduous forest remains inside the large and deep canyons and along of edges of the sierras, the dominance of shrub vegetation on the plateau and plains (Emperaire, 1983) and the loss of the biggest and perennials rivers impact not only the human life, but also the life strategy of many species, including parasites.

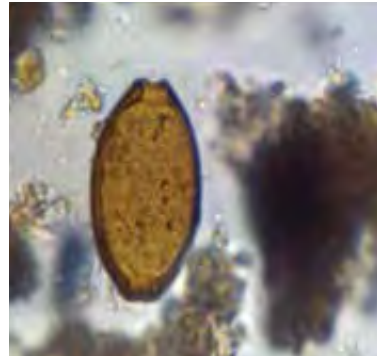
Research materials collected by the FUMDHAM archaeological team over the past 30 years have been stored and preserved at the Oswaldo Cruz Foundation Palaeoparasitology Collection, which contains about 2,800 samples of coprolites, latrine samples, tissues, bones, teeth, hair and sediment (Figure 6). The collection includes materials from other Brazilian archaeological and palaeontological sites, as well as from other South America countries, Europe and the United States, due to scientific collaboration with research groups in these regions. Most of the sample collection is composed of coprolites; about 954 of them are from Serra da Capivara, of which 127 are human.

Throughout the decades, very interesting results have been obtained from analysing human and animal coprolites in the region, especially from samples collected in the excavation site of Boqueirão da Pedra Furada (Ferreira et al., 2014) (Figure 7). The most special sample was from a human coprolite containing the oldest hookworm egg ever found: dated from 7,230 ± 80 years BC. These results have an important historical meaning as they reinforce the likelihood of transmaritime human migration to the Americas (Meggers & Evans, 1966; Ferreira et al., 1987; Sorenson & Johannessen, 2006; Araujo et al., 2008, Montenegro et al., 2006) (Figure 8). Recently two new studies (Raghavan et al., 2015; Skoglund et al., 2015) have reinforced the paleoparasitological results. Skoglund and colleagues show that indigenous communities from the Brazilian Amazon and from the central part of Brazil had their populations founded by people more closely related to indigenous Australians, New Guineans and Andaman Islanders than to any present day Eurasians or Native Americans. The genetic signature found in Brazilian people is not present nowadays to the same extent in Northern and Central Americans (Raghavan et al., 2015) or even in the Clovis associated genome. They show a more diverse set of genes responsible for the foundation of populations of the Americas than previously accepted.

Most intestinal parasites that infect the human population nowadays also infected prehistoric humans. Amongst them are parasites with direct life cycles. These parasites are transmitted directly from person to person without going through the environment or another host or vector. This is the case of the *Enterobius vermicularis* which is still endemic in human populations from different climates, including the Arctic (Araújo et al., 1985; Iñiguez, 2003a). Other parasites such as *Ascaris*, *Trichuris* and hookworms (Ancilostomatidae) are geohelminthes, because their eggs and larvae develop as free-living forms in the soil, before infecting a new host. Despite their resistance to different environmental conditions, these worms have narrow tolerance limits, which allow inference of their geographical distribution. Other parasite species like *Diphyllobothrium*, a common marine mammal parasite, use several intermediate hosts, such as fish, before infecting their definitive hosts, who become infected by eating these (Ferreira et al., 1984) (Figure 9). Infection in humans is caused by eating raw fish.



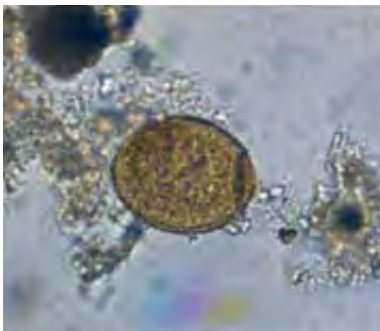
Ancylostomatidae



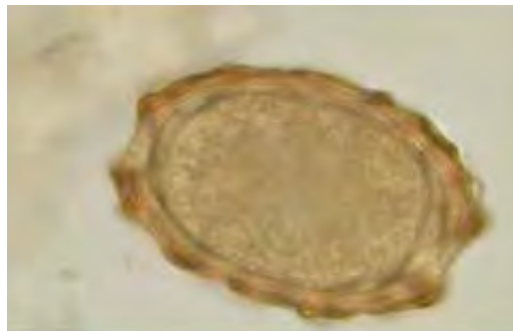
Trichuris trichiura



Enterobius vermicularis



Diphylobothrium spp.



Ascaris lumbricoides

Figure 9. Parasite eggs found in prehistoric human coprolites and in present data. © The Palaeoparasitology Laboratory, Oswaldo Cruz Foundation, Brazil.

When studying different parasite transmission scenarios, much can be learned from the pre-Columbian hookworm, which highlights new routes on human prehistoric migration to the Americas. Hookworm disease or ancylostomiasis can be caused by the infection of two species, the *Ancylostoma duodenale* and *Necator americanus*. These parasites, alone or associated, are widespread in tropical and subtropical regions and can cause different anaemia levels by intestinal spoliation (Rey, 2001). It has been accepted that they have different dispersion centres, with *A. duodenale* originating from Northern Africa and Asia and *N. americanus* from the south-eastern Sahara and southern Asia, in an ancient relationship with humans (Montenegro et al., 2006; Rey, 2001; Ferreira et al., 2014; Mitchell, 2015).

In 1974, Allison and colleagues were the first to find adult worms still attached to the intestinal mucosa of a Peruvian mummy they examined, dated 900 years BP. In Brazil, the first article related to the finding of hookworms and whipworms in coprolites was published in 1980 by Dr Ferreira and colleagues. The material analysed was about 2000 years old and was collected in Gentio II Cave at Minas Gerais. After these, others hookworm eggs were reported from North and South America (Iñiguez et al., 2003a; Montenegro et al., 2006), but the record of the Boqueirão da Pedra Furada remains the oldest so far (Ferreira et al., 1987, 2014).

The palaeoparasitological finding of the Boqueirão da Pedra Furada started discussions about the origin of parasitism in South America and possible ways of the parasites' arrival, since the limits of tolerance in the free-life cycle of the two species could not have allowed their survival amongst humans reaching the Americas through Bering Strait migration (Araújo et al., 1981, 1988; Dillehay, 1991; Hawdon and Johnston, 1996; Fuller, 1997; Reinhard et al., 2001, Mitchell, 2015).

Based on the biological cycle of hookworm and *Trichuris trichiura*, on climate modelling and on epidemiological data and transmission experiments, Dr Ferreira and Dr Araújo have proposed that the introduction of the hookworm in the Americas could not have happened by crossing the Bering region (Marasciulo, 1992; Ferreira and Araújo, 1996; Araujo et al., 2008; Montenegro et al., 2006). A series of assumptions was used for the formulation of their theory regarding the trans-Pacific origin of ancylostomiasis in the Americas. Among them, hookworms and *Trichuris trichiura* have phylogenetic origins and were already present in the ancestors of hominins. It is theorised that these parasites accompanied their human hosts from Africa to other territories through environments distinct from those in which they originated and that these regions allowed the life cycles of these worms to be maintained, perpetuating parasitosis. Where the weather allowed, hookworm and whipworm spread with human migration. Based on the proposed dates for populating the Americas, the cold temperatures of Siberia and Alaska could not have provided suitable conditions for maintaining the cycle of these parasites. Interestingly, in 1925 the French anthropologist, Paul Rivet, proposed the trans-Pacific alternative route to the Americas at the same time that the Portuguese anthropologist, Mendes Corrêa, proposed transatlantic migrations to the Americas, through the use of sea currents and periods of lowering of sea levels.

In the life cycle of a hookworm, the eggs need soil temperatures between 17 °C and 35 °C, 25 °C to 30 °C being an optimum range for the eggs to evolve into infective larvae in moist and oxygen-rich soils. In these conditions, eggs can survive for 30 days and the infective larvae can be ready after 5 to 14 days. Infective larvae can resist for 2 to 10 months when environmental conditions are good, but they are incapable of surviving under 14 °C (Cox, 1982; Schad and Warren, 1990). It is important to point out some biological differences between these two parasite species. *A. duodenale* can get in hypobiosis inside their hosts in regions with severe climatic conditions, such as the semi-arid areas of India, while *N. americanus* prevalence is higher in more humid regions (Ferreira et al., 2014).

Other hypotheses considered by Dr Ferreira, Dr Araújo and colleagues included models of transmission that focused on the speed of infection in a closed human group. Experiments performed with 300 volunteers have shown that one infected individual introduced into the group could infect them all in the period of a year (Marasciulo, 1992). By correlating their model with the prehistoric populations, an infected person arriving by boat from Asia could infect the South America population. Combining the palaeotemperature knowledge with the distances to be covered by migrating populations walking from Asia to North America via Bering and Alaska, and the life span of the parasites, Montenegro and colleagues (2006) have modelled different climate scenarios in search of a reasonable explanation for the presence of hookworm parasites in pre-Columbian Americas. They have concluded that the Bering route would not have allowed the presence of hookworms in any scenario tested.

There are a few ideas that can be discussed to explain the presence of hookworms in the Americas (Ferreira et al., 2014). The first one is that the human migrations in cold climates were rapid and occurred over a period of eight years, the average life span of adult worms in the intestines of hosts (Cheng, 1986). There is no precedent for this hypothesis. As such, prehistoric humans would have gone directly from Siberia to American mild areas, as discussed by Montenegro et al. (2006). Secondly, the migrants became infected in places where temperatures allowed the development of eggs and larvae in the soil. The palaeotemperature data demonstrates that it is unlikely that shelters in Siberia and Alaska had mild conditions allowing worm development. Even today, the temperatures in the caves are much lower than 17 °C. The third hypothesis is that hookworms brought by migrants were able to develop in environments with much lower temperatures. Again, there is no register of species varieties tolerant to such low temperatures and this hypothesis should also be discarded. Hence, the Palaeoparasitology data indicates that different routes were used by prehistoric men to reach the Americas, which included mild environmental conditions of 25 °C in the soil ensuring the concomitant survival of worms requiring these temperatures. Palaeoparasitologists hope that archaeologists discover these new routes allowing new multidisciplinary studies.

Like hookworms, other parasites were found in Serra da Capivara materials and allowed not only to identify their presence in the past, but also to correlate them with other species and human's and animal's way of life. Among these, lice were found in the hair of the mummified body (Araújo et al., 2000) and *Ascaris lumbricoides* DNA sequences were identified in negatives coprolites samples where eggs were not visible by microscope observation.

Recent *Ascaris* DNA studies have shown how the negative data should be treated with caution. Presently, ascariasis incidence is the commonest helminthiasis in Brazil, but *A. lumbricoides* are rare in coprolites from South America, using traditional parasitological techniques (Gonçalves et al., 2003; Leles et al., 2010), but common in Europe (Bouchet et al., 2003). DNA tests have revealed that this parasite existed in prehistoric Andean populations and in the Brazilian lowlands, as well in Serra da Capivara coprolites (Leles et al., 2008). The diminished prevalence of this parasitosis is probably a consequence of waterborne transmission in these semiarid regions, associated with the great mobility and small number of individuals in the hunter-gatherers groups where the best preserved archaeological sites are found (Ferreira et al., 2014). Accordingly, a low prevalence of *A. lumbricoides* is still observed in human Serra da Capivara populations presently, corroborating with the environmental limitations imposed in the Caatinga.

The low occurrence of *Enterobius vermicularis* eggs in coprolites can be partially explained by the parasite's life cycle. Female worms lay their eggs in the perianal region of the host, not in the intestinal lumen, explaining why the eggs are not abundant in the faeces. The transmission and dispersion of eggs between hosts occurs through hand contamination after intense anal itching. The direct oral transmission protects the parasite from harsh environmental conditions facilitating its spreading, including populations of very cold environments (Iñiguez et al., 2003a). Although *E. vermicularis* was present in Chile for at least 6,000 years, all other encounters of this parasite were recorded only on the Pacific Coast and northern Argentina (Zimmerman and Morilla, 1983; Ferreira et al., 1989). However, it is probable that infection was dispersed among other human groups in South America, but to find traces of this new techniques must be tested.

Consequently, the Oswaldo Cruz Foundation Palaeoparasitology Laboratory recently initiated a new DNA study about the phylogenetic analysis of *Enterobius vermicularis* in coprolites that may provide an understanding about the relationship between the biogeographic distributions of this oxyurid in human populations.

Other remarkable parasites were found in human coprolites from the Serra da Capivara sites. Alimentary habits have been revealed by the presence of unusual parasites in human coprolites, demonstrating the consumption of undercooked bush meat (Sianto et al., 2009, 2012; Reinhard et al., 2013). An example is the finding of the Nematoda Pharyngodonidae, a worm found in the intestine of a lizard, unable to infect humans, whose eggs and flakes were found in human coprolites dated from 10,640 and 400 years from the Toca dos Coqueiros and Toca da Baixa dos Caboclos sites (Sianto et al., 2009, 2012). Another possibility that must be considered in Serra da Capivara, and certainly in other prehistoric sites, is that parasites may have been acquired by the interaction of prehistoric humans with animals approaching their shelters in search of food. The habit of concentrating food consequently attracts small animals, their predators and inevitably insects. *Hymenolepis nana* is a little tapeworm found in rodents and beetles as hosts and accidental ingestion of these small beetles or even contaminated food with rodent faeces is not uncommon. The finding of these eggs in coprolites 3,800 years old from the Baixão do Perna I allows the inference that this site was a permanent dwelling (Martin, 1999), with a reasonable density population since the eggs remain viable on the soil for only 10 days.

The synthesis of the palaeoparasitological studies in Serra da Capivara show richness of parasites species from ancient times until the present, especially with the colonization and introduction of domestic animals species. In these analyses, it is important to consider the relativity of the data, with its limitations of analysis of the material that has been found in the sites. Additionally, there are methodological difficulties in identifying unknown parasite species, especially when it comes to wildlife. Despite this, and with the available data, it is possible to observe the increase of parasites over time, even when the environment changes from forest to Caatinga.

In order to better understand the effects of environmental changes on the permanence of the parasites in the Caatinga, new studies are linking landscape parameters with the occurrence of hosts and parasites. The model of occurrence of parasites over time and environmental changes uses the *Kerodon rupestris* (Caviidae: Rodentia) and the parasite *Trichuris* sp. as a study case, since this rodent's coprolites were found uninterruptedly from 30,000 years to the present in Serra da Capivara. Preliminary approaches used the mathematical technique of genetic programming that is an inspired symbolic optimisation in the evolutionary process of natural selection, to infer relationships between environmental standards and the occurrence of *Trichuris* sp. Initial results indicate a significant association between 100 environmental parameters, including vegetation type, geomorphology, presence of water, human impacts, based on 900 samples of recent faeces and 200 coprolites for the presence of parasites in samples collected at altitudes of 438 m to 800 m (Chame et al., 2013). The explanation for this distribution is consistent with the fact that *K. rupestris* is now restricted to rocky areas, in metapopulations, especially in the mountains and canyons offering food, water and mild climate. The environmental changes from forest to Caatinga, rather than extinguishing the parasites, expanded the population density of *K. rupestris* in these areas and increased the rate of transmission of parasites. Interestingly, occurrence modelling using BIOCLIM data indicates that the parasite-favourable areas are the same as the occurrence of archaeological sites, and this deserves new and more tests.

Over the last 30 years of study, palaeoparasitology has not only brought new data on the origin of the diseases, but together with archaeology, has enabled further discussions and contributions to new theories. The results of the palaeoparasitological studies are still applied to wildlife management of the Serra da Capivara National Park and are available to the government to guide health policy. The region's biodiversity is unique and the Park is the most representative of the original conditions of the Caatinga preserved by the biosphere reserve. Archaeological studies in the region extrapolate research goals and contribute to regional economic development, education and public health. It is crucial a major and regular support for archaeological sites and biodiversity conservation to face the great challenges.

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# Adaptaciones humanas tempranas y dispersión de la población durante la colonización del Río de la Plata y Río Uruguay

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## Resumen

El presente capítulo presenta los principales avances sobre el poblamiento temprano en la cuenca del Río de la Plata, focalizándonos en el Río Uruguay medio, donde en las últimas décadas, se ha producido nueva información. Existe una importante base de datos con más de 30 sitios tempranos de los cuales 14 tienen 60 edades radiocarbónicas. Se comparan desde una perspectiva amplia los resultados de investigaciones realizadas en Uruguay y el sur de Brasil. Los cazadores-recolectores durante el poblamiento utilizaron dos estrategias de movilidad, por un lado movimientos frecuentes entre los sitios residenciales del Río Uruguay medio y, por otro lado, estrategias logísticas donde debieron utilizar circuitos planificados de movilidad para aprovisionarse de rocas específicas como el ágata. La información disponible indica que humanos colonizaron las planicies del sureste de América del Sur hace 14.000 años cal AP. Posteriormente hacia el año 13.000 cal AP surge una tradición cultural bifacial orientada hacia la producción de artefactos bifaciales que incluyen núcleos, puntas, preformas y cuchillos. La evidencia stratigráfica, cronológica y arqueológica de diferentes sitios tempranos (Pay Paso 1, K87, Laguna Canosa, RS-I-69, RS-I-70 entre otros) sugiere que por el Río Uruguay medio-alto circularon diferentes diseños de puntas tempranas. Se ha reconocido en la región desde la década de 1960 el clásico diseño de puntas cola de pescado (fishtail) que a nivel regional ha sido datado en 12.800-12.200 años cal AP. Recientemente, a partir de las investigaciones actuales hemos reconocido dos nuevos diseños de puntas tempranas que se denominan Tigre, datadas entre 12.200 y 11.200 años cal AP, y Pay Paso, datadas entre 11.000 y 10.065 años cal AP. Las planicies vinculadas al Río Uruguay medio fue una región del Sureste de América del Sur donde se sucedieron importantes transformaciones e innovaciones tecnológicas y culturales durante el poblamiento inicial. La aparición de las puntas Tigre es posiblemente una respuesta tecnológica asociada a la reorganización del armamento de los cazadores recolectores a los cambios en los parámetros climáticos, ambientales y faunísticos que se suceden al iniciarse el Holoceno, vinculado a una fase climática más cálida y húmeda iniciada hace 12.400 años cal AP.

## Introducción

La cuenca del Río de la Plata incluye diferentes regiones ecológicas caracterizadas por planicies bajas (Pampa, Campos y Pantanal), una extensa y ramificada red hidrográfica, bosques subtropicales y monte en galería que se localiza en las márgenes de ríos y arroyos; ésta es la segunda cuenca de América con una superficie aproximada de 3.200.000 km<sup>2</sup>. El Río de la Plata se forma donde desembocan los ríos Paraná y Uruguay, actualmente es un estuario, sin embargo hacia finales del Pleistoceno, debido al menor caudal, el paleocauce discurría entre bañados y zonas bajas desembocando en el Océano Atlántico, frente a la costa uruguaya.

El poblamiento temprano de esta región se realizó a partir de la costa Atlántica, utilizando los grandes ríos (del Plata, Uruguay y Paraná) como vías naturales de ingreso de pequeños flujos humanos hacia el interior del continente (Miotti, 2006; Suárez, 2011a). Existe un patrón de asentamiento, donde los sitios tempranos se ubican asociados al Río Uruguay medio y al Río Negro medio en la desembocadura de sus afluentes, ya sean ríos, arroyos o cañadas. La línea de costa sobre el Océano Atlántico al final del Pleistoceno se ubicaba entre 100-150 km mar adentro. Los grandes cursos de agua como los ríos de la Plata y Río Uruguay tenían menor caudal que el que presentan hoy. Sin embargo, estos importantes ríos concentraron variados recursos como fauna (mamíferos, peces y aves), rocas silicificadas para producir artefactos, así como agua dulce y leña que minimizaron los riesgos durante el proceso inicial del poblamiento.

El Río Uruguay medio y sus afluentes son un excelente laboratorio para investigar las adaptaciones humanas tempranas asociadas al poblamiento del sureste de América del Sur. Actualmente afloran en diferentes lugares de la cuenca depósitos sedimentarios que se extienden desde antes del Último Máximo Glacial hasta el final del Holoceno. Existen más de 30 sitios arqueológicos con evidencia de ocupaciones tempranas de los cuales 14 (figura 1) presentan más de 60 dataciones radiocarbónicas (véase tabla 1).

Este capítulo se enfoca en el Río Uruguay medio y sus afluentes. Las investigaciones en esta región han sido discontinuas y se iniciaron en la margen brasileña a finales de la década de 1960 con los trabajos de E. Miller (1987 p. 41), quien generó la primera base de datos cronológica de 18 edades radiocarbónicas. Luego, la UNESCO dirigió la Misión de Rescate Arqueológico de Salto Grande (MRASG) (MEC, 1989), un programa tendiente a evitar el impacto arqueológico que sufrirían los bienes patrimoniales-arqueológicos con la construcción de la represa de Salto Grande. Estos trabajos se desarrollaron entre 1976 y 1979, y participaron equipos de investigación de diferentes países (Francia, Estados Unidos, Brasil, Canadá, Alemania) liderados originalmente por Annette Laming-Emperaire y, luego de su trágica muerte, por Niedé Guidón (Laming-Emperaire y Guidón, 1980). Uno de los principales aportes de la MRASG fue haber obtenido las primeras dataciones radiocarbónicas en sitios tempranos en Uruguay (MEC, 1989).

En el año 1999 se inició en la margen uruguaya del Río Uruguay medio un programa de investigación multidisciplinario que continúa hasta el presente, cuyo objetivo es avanzar en diferentes aspectos relacionados con las ocupaciones tempranas, la evolución paleoambiental y climática desde el final del Pleistoceno vinculado al poblamiento inicial de la región (Suárez, 1999, 2002, 2003, 2006, 2010, 2011a, 2011b, 2014, 2015a, 2015b, Suárez y Piñeiro 2002, Suárez y Santos 2010).

Las investigaciones sobre el poblamiento temprano no son homogéneas en la cuenca del Plata, hay importantes áreas que aguardan el inicio de investigaciones sistemáticas. Debido a las características geológicas y geomorfológicas, existen extensas zonas donde los sitios tempranos posiblemente no se hayan conservado. Sí existen, se ubican estratigráficamente a decenas de metros de profundidad bajo planicies de inundación sedimentarias que se sucedieron durante el Holoceno (ej. Río Paraná bajo). Hay otras regiones con escasa visibilidad arqueológica en relación a la arqueología del final del Pleistoceno. Existen, además, amplias regiones de las cuencas del Río Paraná, Paraguay, Pilcomayo y Bermejo (Bueno y Dias 2015) donde actualmente no existe información disponible sobre las ocupaciones tempranas, por lo cual considerarlas dentro de modelos de poblamiento tiene ciertos problemas empíricos y metodológicos.

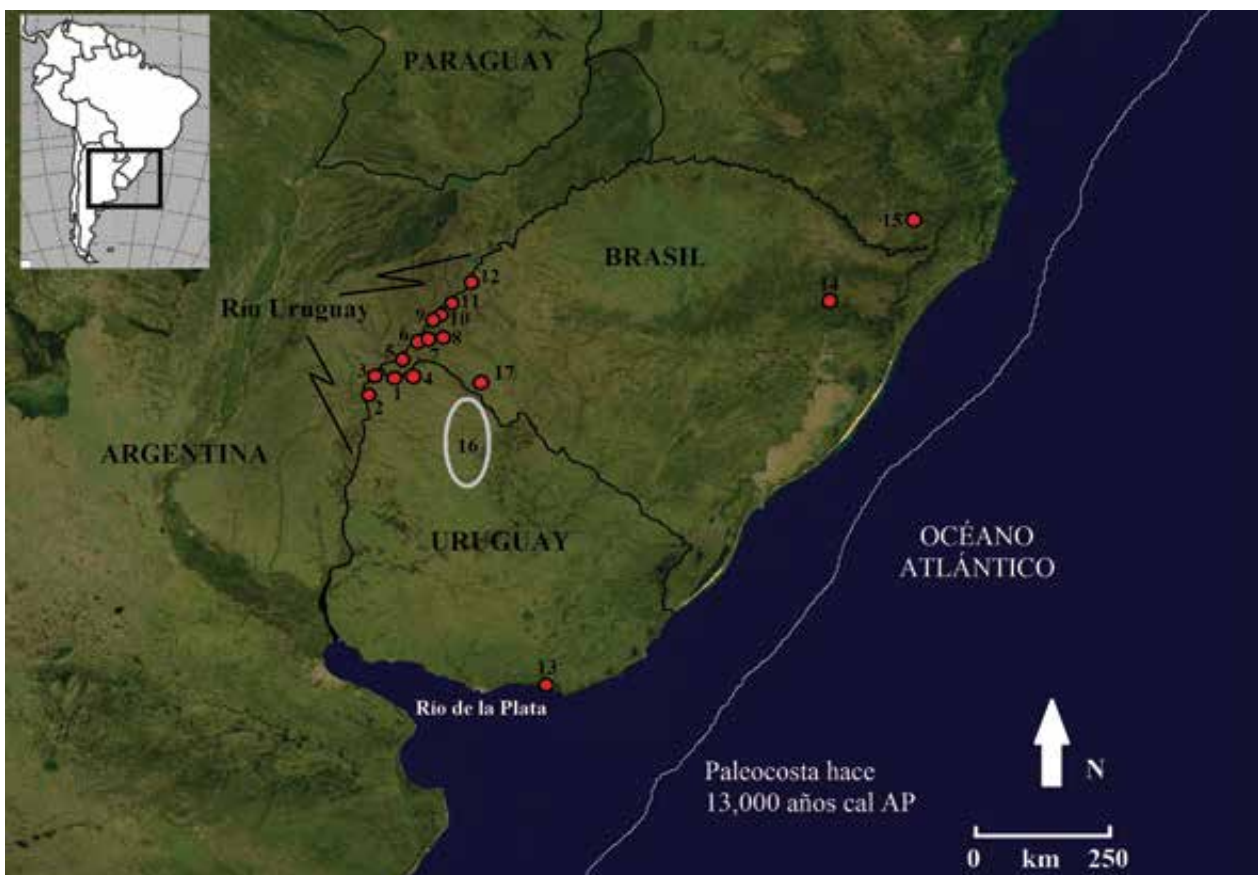


Figura 1. Ubicación de los principales sitios referidos en el texto. Del 1 al 13, sitios tempranos con dataciones radiocarbónicas. Del 14 al 15, sitios del sur de Brasil con puntas Tigre y Pay Paso. (1) Localidad Pay Paso, (2) Sitio K87, (3) Laguna Canosa, (4) Boca del Río Cuaró, (5) RS-I-98, (6) RS-I-67, (7) RS-I-66, (8) RS-I-68 y RS-I-97, (9) RS-I-70 y RS-I-69, (10) RS-I-72, (11) RS-I-99, (12) RS-I-IJ67, (13) Urupez. Sitios del Sur de Brasil (14) Sitio das Flechas, (15) Sitio Avenal Baixo (Urubici), (16) Región Arqueológica Catalanes Nacientes Arapey, (17) Areal.

Tabla 1. Edades <sup>14</sup>C obtenidas en sitios arqueológicos de la cuenca del Río Uruguay medio y Río de la Plata, en Uruguay y Brasil.

Sitio/País	Edad radiocarbónica (C14yr BP)	Edad Calibrada	Número laboratorio	Referencia
Urupez 2/Uruguay	12,000 ± 40	13,998-13,703	Beta 394639 a	Meneghin, 2015
Urupez/Uruguay	11,690 ± 80	13,708-13,292	Beta 211938	Meneghin 2004
RS-IJ-68/Brasil	11,555 ± 230	13,791-12,835	SI-3750 b	Miller 1987
K87/Uruguay	11,320 ± 40	13,236-13,057	UCIAMS 145429 a	Suárez, 2016
RS-I-69/Brasil	10,985 ± 100	13,035-12,698	SI-3106 b	Miller 1987
Pay Paso 1/Uruguay	10,930 ± 20	12,802-12,705	UCIAMS 21631 a	Suárez 2011a
Pay Paso 1/Uruguay	10,910 ± 30	12,797-12,698	UCIAMS 27738 a	Suárez 2011a
Pay Paso 1/Uruguay	10,895 ± 30	12,786-12,693	UCIAMS 27744 a	Suárez 2011a
Pay Paso 1/Uruguay	10,880 ± 25	12,759-12,692	UCIAMS 27745 a	Suárez 2011a
RS-I-66/Brasil	10,810 ± 275	13,205-11,823	SI-2622 b	Miller 1987
RS-I-69/Brasil	10,800 ± 150	13,034-12,387	N-2523 b	Miller 1987
Urupez/Uruguay	10,690 ± 60	12,713-12,436	Beta 165076	Meneghin 2006
Pay Paso 1/Uruguay	10,680 ± 20	12,674-12,558	UCIAMS 21637 a	Suárez 2011a
Pay Paso 1/Uruguay	10,630 ± 25	12,655-12,440	UCIAMS 21636 a	Suárez 2011a
Pay Paso 1/Uruguay	10,595 ± 30	12,642-12,430	UCIAMS 27746 a	Suárez 2011a
Pay Paso 1/Uruguay	10,580 ± 20	12,618-12,429	UCIAMS 21644 a	Suárez 2011a
Pay Paso 1/Uruguay	10,555 ± 20	12,552-12,426	UCIAMS 21645 a	Suárez 2011a
Pay Paso 1/Uruguay	10,540 ± 35	12,629-12,174	UCIAMS 27747 a	Suárez 2011a
Pay Paso 1/Uruguay	10,520 ± 20	12,551-12,177	UCIAMS 21643 a	Suárez 2011a
Pay Paso 1/Uruguay	10,500 ± 25	12,548-12,114	UCIAMS 27740 a	Suárez 2011a
Pay Paso 1/Uruguay	10,465 ± 30	12,429-12,058	UCIAMS 28692 a	Suárez 2011a
Pay Paso 1/Uruguay	10,450 ± 25	12,422-12,064	UCIAMS 28682 a	Suárez 2011a
K87/Uruguay	10,420 ± 90	12,552-11,840	KN 2531	MEC, 1989b
RS-I-69/Brasil	10,400 ± 110	12,554-11,773	N-2521 b	Miller 1987
Pay Paso 1/Uruguay	10,390 ± 30	12,400-12,001	UCIAMS 27741 a	Suárez 2011a
Pay Paso 1/Uruguay	10,320 ± 70	12,401-11,767	RT 5257 b	Suárez 2011a
Pay Paso 1/Uruguay	10,285 ± 25	12,051-11,821	UCIAMS 21639 a	Suárez 2011a
RS-I-69/Brasil	10,240 ± 80	12,367-11,404	SI-3106	Miller 1987
Pay Paso 1/Uruguay	10,225 ± 70	12,251-11,406	RT 5256 a	Suárez 2011a
Pay Paso 1/Uruguay	10,205 ± 35	12,008-11,629	UCIAMS 21632 a	Suárez 2011a
RS-I-69/Brasil	10,200 ± 125	12,384-11,273	N-2522 b	Miller 1987
Pay Paso 1/Uruguay	10,180 ± 20	11,974-11,623	UCIAMS 21634 a	Suárez 2011a
RS-I-98/Brasil	10,180 ± 110	12,362-11,268	SI-3752 b	Miller 1987
Pay Paso 1/Uruguay	10,115 ± 25	11,795-11,399	UCIAMS 21633 a	Suárez 2011a
Pay Paso 1/Uruguay	9890 ± 90	11,700-10,887		Austral 1995
RS-IJ-67/Brasil	9855 ± 130	11,708-10,763	SI-2637 b	Miller 1987
RS-I-67/Brasil	9840 ± 105	11,608-10,782	N-2519 b	Miller 1987
L. Canosa/Uruguay	9730 ± 30	11,213-10,826	UCIAMS 27739 a	Suárez 2011a
RS-I-69/Brasil	9620 ± 110	11,202-10,590	SI-2631 b	Miller 1987
RS-I-97/Brasil	9605 ± 120	11,205-10,572	SI-3754 b	Miller 1987
RS-IJ-67/Brasil	9595 ± 175	11,265-10,299	SI-2637 b	Miller 1987
Pay Paso 1/Uruguay	9585 ± 25	11,081-10,711	UCIAMS 21641 a	Suárez 2011a
Pay Paso 1/Uruguay	9555 ± 25	11,070-10,685	UCIAMS 21642 a	Suárez 2011a
Pay Paso 1/Uruguay	9550 ± 20	11,069-10,679	UCIAMS 21647 a	Suárez 2011a
Pay Paso 1/Uruguay	9545 ± 20	11,068-10,666	UCIAMS 21635 a	Suárez 2011a
Pay Paso 1/Uruguay	9545 ± 20	11,068-10,666	UCIAMS 21646 a	Suárez 2011a
Pay Paso 1/Uruguay	9525 ± 20	11,064-10,595	UCIAMS 21640 a	Suárez 2011a
Pay Paso 1/Uruguay	9525 ± 20	11,064-10,595	UCIAMS 21638 a	Suárez 2011a
RS-I-72/Brasil	9450 ± 115	11,089-10,293	SI-2634 b	Miller 1987
Pay Paso 1/Uruguay	9280 ± 200	11,124-9,901	Uru-248 b	Suárez 2011a
RS-I-67/Brasil	9230 ± 145	10,752-9,915	SI-2625 b	Miller 1987
Pay Paso 1/Uruguay	9120 ± 40	10,353-10,176	Beta-156973 a	Suárez 2011a
RS-I-70/Brasil	9120 ± 340	11,185-9,471	SI-2632 b	Miller 1987
RS-I-99/Brasil	9035 ± 100	10,389-9,739	SI-3755 b	Miller 1987
ZT-1/Uruguay	8770 ± 30	9,877-9,554	UGAMS 7459 a	Suárez et al. 2011
ZT-1/Uruguay	8750 ± 30	9,882-9,546	UGAMS 7460 a	Suárez et al. 2011
RS-IJ-67/Brasil	8585 ± 115	9,898-9,274	SI-2636 b	Miller 1987
Pay Paso 1/Uruguay	8570 ± 150	10,119-9,093	Uru-246 b	Suárez 2011a
Boca río Cuaró/Uruguay	8405 ± 20	9,466-9,303	UCIAMS 27743 a	inédita

Notas: a AMS; b Método standard. Calibración realizada con Calib 7.0. SHcal13.14. Hogg et al. 2013.

Este trabajo tiene como objetivo presentar los avances de las últimas décadas relacionados con las adaptaciones durante el poblamiento temprano, la movilidad y dispersión de la población durante el final del Pleistoceno y Holoceno temprano. Además, se plantean diferentes aspectos de la tecnología lítica como la presencia de una tradición tecnológica bifacial durante la exploración y colonización de la región que incluye diferentes diseños de puntas de proyectil, núcleos y cuchillos bifaciales, la accesibilidad y preferencias de determinadas materias primas para manufacturar conjuntos de artefactos durante el proceso inicial de ocupación de la cuenca del Río Uruguay.

### Condiciones paleoambientales y paleoclimáticas

Una característica de la cuenca del Río de la Plata es el paisaje de praderas y planicies bajas que ocupan parte del este de Argentina (provincias Buenos Aires, Entre Ríos y Corrientes), el sur de Brasil (estado de Rio Grande do Sul) y parte del actual territorio de Uruguay. Esta región contiene pendientes levemente onduladas y planicies, así como algunas sierras modeladas por la acción fluvial durante el Terciario. El paisaje presenta colinas con formas alargadas, cerros y una amplia red fluvial muy ramificada con gran cantidad de ríos, arroyos, cañadas, lagunas y bañados. Los sitios más antiguos conocidos son sitios al aire libre o cuevas y abrigos rocosos, siempre relacionados o situados junto a cursos de agua como ríos, arroyos, lagos, lagunas, etcétera.

Al terminar el Último Máximo Glacial (ca. 18.000 años AP), el paleocauce del Río de la Plata iniciaba su recorrido inmediatamente después de la desembocadura de los ríos Paraná y Uruguay, próximo a la costa Argentina; luego se extendía y recorría la costa de Uruguay frente a la actual ciudad de Montevideo (Violante y Parker, 2004), para desaguar en el Océano Atlántico.

Durante las glaciaciones del Pleistoceno, la cuenca del Plata permaneció libre de mantos de hielo como una zona periglacial. El principal efecto de las glaciaciones se registra en los depósitos de loess y dunas de arena generadas por la acción eólica (Iriondo, 1999; Rabassa et al., 2005).

A partir del final del Último Máximo Glacial, el nivel del mar comienza a subir. Así, durante el final del Pleistoceno las condiciones climáticas generales comienzan a mejorar, haciéndose menos rigurosas, pasando de frías y secas a ligeramente áridas y frías, sub-húmedas/húmedas en Uruguay, Pampa (Argentina) y el sur de Brasil (Dias, 2012; Behling et al., 2005; Iriondo, 1999; Prieto, 2000).

Para el sur de Brasil, Pampa y Uruguay, extensas praderas de gramíneas dominan el paisaje antes y durante el final del Último Máximo Glacial, el final del Pleistoceno y durante el Holoceno (Behling et al., 2005, Behling and Pillar 2008, Iriondo, 1999, Prieto, 2000, Suárez 2011a). Al final del Último Máximo Glacial, las heladas se debieron repetir y las temperaturas durante el invierno alcanzarían los -10 °C.

En el norte de Uruguay, el registro palinológico de tres sitios Pay Paso 1, Pay Paso 0 (turba) y Pay Paso 2 indica que hace 13.000 años cal AP el clima seco y frío de finales del Pleistoceno fue gradualmente remplazado por condiciones más húmedas y templadas hace 12.400 años cal AP, marcando el inicio del Holoceno (Suárez, 2011a). Hace 12.800 años cal AP la hierba *Chenopodiaceae-Amarathus* comienza a establecerse y colonizar las márgenes del río Cuareim, próximo a su desembocadura en el Río Uruguay. Hacia 12.400 años cal AP, *Amarathus* desciende en el registro polínico, cuando comienza la expansión de una variada comunidad arbustiva subtropical-seca. Árboles de gran porte que superan los 20 metros de altura como *Jacarandá*, *Jacaratia*, *Astronium* "Urunday", *Protium*, arbustos *Ambrosia*, *Rhus*, plantas adaptadas a suelos húmedos *Cyperaceae* y *Typha* (paja totora) y a condiciones de alta humedad como helechos *Selaginella*, permiten sugerir que el bosque o "monte" comenzó



Figura 2. Núcleo bifacial en arenisca silicificada de grandes dimensiones (227 mm de largo por 170 mm de ancho) proveniente de las canteras y talleres del Arroyo Catalán Chico, Región Arqueológica Catalanes Nacientes Arapey.



a establecerse en los márgenes del Río Cuareim afluente del Río Uruguay hace 12.400 años cal AP, lo que, asociado con el aumento en la temperatura y precipitaciones, indicarían el inicio del Holoceno.

## Diversidad cultural e innovaciones tecnológicas durante el poblamiento

Los datos y la evidencia recuperada en dos sitios arqueológicos en el sur y el norte de Uruguay sugieren que las praderas del sureste de América del Sur estaban pobladas por lo menos 1.000 años antes de la aparición de los grupos portadores de las puntas cola de pescado. En los sitios Urupez 2 y K87 (arroyo del Tigre) recientemente se han obtenido interesantes datos cronológicos y culturales que indican presencia humana entre aproximadamente 14.000 y 13.300 años cal AP (Meneghin, 2015; Suárez, 2016). Estas son evidencias de migraciones humanas que ingresaron al interior del continente durante una etapa de dispersión inicial. Los datos recuperados en Uruguay deben ser confirmados con nuevas investigaciones y con nuevas dataciones radiométricas de esos y otros contextos arqueológicos para garantizar la confiabilidad de los resultados. A nivel regional, es importante señalar que en el sitio Arroyo Seco 2 en Pampa (Argentina) se han recuperado evidencias cronológicas y culturales que indican ocupaciones humanas de entre 14.000-13.100 años cal AP (Politis et al., 2014), similares a las recientemente obtenidas para Uruguay. Estos datos amplían la evidencia que indica ocupaciones humanas que rondan 14.000-15.000 años cal AP al este como al oeste de los Andes en el Cono Sur (Dillehay, 2008; Politis et al., 2014; Suárez, 2014).

Posteriormente, a este evento de dispersión inicial la investigación que se viene realizando en la cuenca del Río Uruguay permite sugerir la presencia de una tradición cultural orientada hacia la producción de artefactos bifaciales entre 12.800 y 10.065 años cal AP. Se reconocen tres grupos culturales con diferentes diseños o tipos de puntas de proyectil (Suárez, 2015b). Esta tecnología bifacial se caracteriza por su alto grado de conservación y mantenimiento, versatilidad y utilización de las mejores rocas disponibles, así como el reciclaje de los artefactos bifaciales como puntas a otras formas funcionales (Suárez, 2006). Los grupos humanos debieron adaptarse a las cambiantes condiciones climáticas, faunísticas, paisajísticas y botánicas que se sucedían durante la transición del Pleistoceno al Holoceno. La producción de artefactos bifaciales se orientó hacia la manufactura de núcleos bifaciales (figura 2), puntas de proyectil (figuras 3, 4 y 5) y cuchillos bifaciales (figura 6).

Dentro de esta tradición cultural se han identificado hasta el presente tres grupos culturales que se caracterizan por tener diferentes diseños en su armamento de caza (puntas de proyectil). A medida que las investigaciones en los sitios tempranos del Río Uruguay medio comienzan a ser sistemáticas, emerge una interesante diversidad en el diseño y estilo de las puntas de proyectil (Suárez, 2015a). Las puntas tempranas definidas provienen de excavaciones arqueológicas y contextos estratigráficos que tiene muy buena resolución arqueológica y cronológica, como por ejemplo el sitio Pay Paso 1 (figura 7) y el sitio K87 Arroyo del Tigre (figura 12).

La investigación en sitios estratigráficos en la margen uruguaya del Río Uruguay (sitios Pay Paso 1, K87, Laguna Canosa) (Suárez, 2011a), contrastada con la información regional obtenida principalmente en el sur de Brasil en los sitios (sitios RS-I-66, RS-I-69 y RS-I-70, Areal y Das Flechas) (Corteletti, 2008, Mentz Ribeiro et al., 1995, Miller, 1987) indica que durante el poblamiento de esta región existieron redes sociales de intercambio de información y conocimiento (Borrero, 2015) que se extendieron por amplios territorios del sureste de América del Sur, concebidos como paisajes sociales (Gamble, 2002). Aspectos tecnológicos, económicos, simbólicos y uso del espacio posiblemente fueron compartidos por los grupos tempranos que circulaban por el Río Uruguay medio, nacientes del Río Uruguay, río Negro medio y la costa atlántica durante el final del Pleistoceno y el Holoceno temprano.

El nombre de cada uno de los tipos de puntas de proyectil (Tigre y Pay Paso) se relaciona directamente con el sitio donde estas puntas fueron datadas por primera vez. La distribución de estas puntas incluye el actual territorio de Uruguay y sur de Brasil. La margen argentina del Río Uruguay medio no se está investigando sistemáticamente.

## Puntas cola de pescado o “fishtail”

Las puntas cola de pescado (figura 3) son un artefacto diagnóstico de los cazadores-recolectores tempranos que ocuparon extensas regiones del Cono Sur (Uruguay, Pampa, Patagonia y Tierra del Fuego). Fueron recuperadas por primera vez en estratigrafía asociadas a fauna extinguida del Pleistoceno en Cueva Fell (Bird, 1938). Un pionero de la arqueología uruguaya publica a finales del siglo XIX —sin saber obviamente que estas puntas eran tempranas— una clasificación morfológica de puntas de proyectil, distinguiendo en su muestra dos clásicos ejemplares de puntas cola de pescado provenientes de contextos superficiales de la costa Atlántica (Figueira, 1892, p. 210).





Figura 3. Puntas cola de pescado (fishtail points) ca. 12.800-12.200 años cal AP. Obsérvese en el ejemplar B acanaladura basal y el ejemplar D punta reciclada probablemente a un artefacto de corte (nótese filo redondeado).

Este diseño o tipo de punta se ha recuperado con mayor frecuencia en sitios de superficie y en menor medida en sitios estratigráficos en Pampa y Patagonia (Argentina y Chile) (Flegenheimer et al., 2013), el sur de Brasil (Miller, 1987, Dias, 2012) y Uruguay (Suárez, 2003, 2011a). Estas puntas presentan variaciones tecnológicas, morfológicas y estilísticas ligadas al mantenimiento, reciclaje, y/o a diferentes calidades técnicas que se pueden observar en la confección de las mismas, distinguiendo en el conjunto si fueron manufacturadas por aprendices o expertos talladores (Suárez, 2003, 2006). Aunque, en otros casos, las variaciones pueden representar estilos o diferencias culturales locales o regionales (Suárez, 2003).

Entre los aspectos tecnológicos, el tratamiento de la base de la muestra de Uruguay indica que 38.6% (n = 34) de las puntas tienen acanaladura, en tanto que 61.4% (n = 54) no tiene acanaladura; en este último caso la base fue adelgazada por medio de retoque.

Estas puntas sufrieron un intenso proceso de mantenimiento, rejuvenecimiento y reciclaje. Las causas del mantenimiento de estos artefactos no están vinculados a la falta de materias primas como se sugiere tradicionalmente (Bamforth, 1986; Binford, 1979; Shott, 1996; Shott y Ballenger, 2007), pues puntas altamente mantenidas y ejemplares reciclados se han registrado en zonas donde existe excelente disponibilidad de rocas de alta calidad, como es el caso del Río Negro medio (véase figura 3D). La figura 3 presenta ejemplares en caliza silicificada (chert) donde se puede observar las diferentes etapas de vida útil por las que pasan estos artefactos para prolongar su vida útil como armas de caza (figura 3, ejemplos B y C), hasta que son reciclados a artefactos cortantes (cuchillos) (figura 3, D) (Suárez, 2006). Además, las puntas cola de pescado de Uruguay, al igual que las de Ecuador y Pampa incluyen puntas unificiales (Suárez, 2009).

### Puntas Tigre

Este diseño de puntas se distribuye geográficamente en el norte y centro de Uruguay, así como el sur de Brasil. Las puntas Tigre fueron recuperadas en estratigrafía y reconocidas primeramente en el sitio K87, Arroyo del Tigre, durante los trabajos de la MRASG-UNESCO (MEC 1989), pero fueron mejor definidas a partir de evidencia cronológica, arqueológica y estratigráfica en los sitios Pay Paso 1 y Laguna de Canosa (Suárez, 2011a, pp. 185-188). Las puntas Tigre fueron datadas con seis edades radiocarbónicas en tres sitios y los datos cronológicos indican que tienen entre 12.200 y 11.213 años cal AP (10.200 a 9.730 años  $^{14}\text{C}$  AP) (tabla 1). En el sur de Brasil, estas puntas han sido registradas en el estado de Rio Grande do Sul, en los sitios RS-I-69 y RS-I-70 (véase Miller 1987, p. 54, figura 13, puntas b, c y d), y en el sitio "das Flechas" (Corteletti, 2008), este último sitio fuera pero muy próximo a la cuenca del Río Uruguay (figura 1, 14-15).

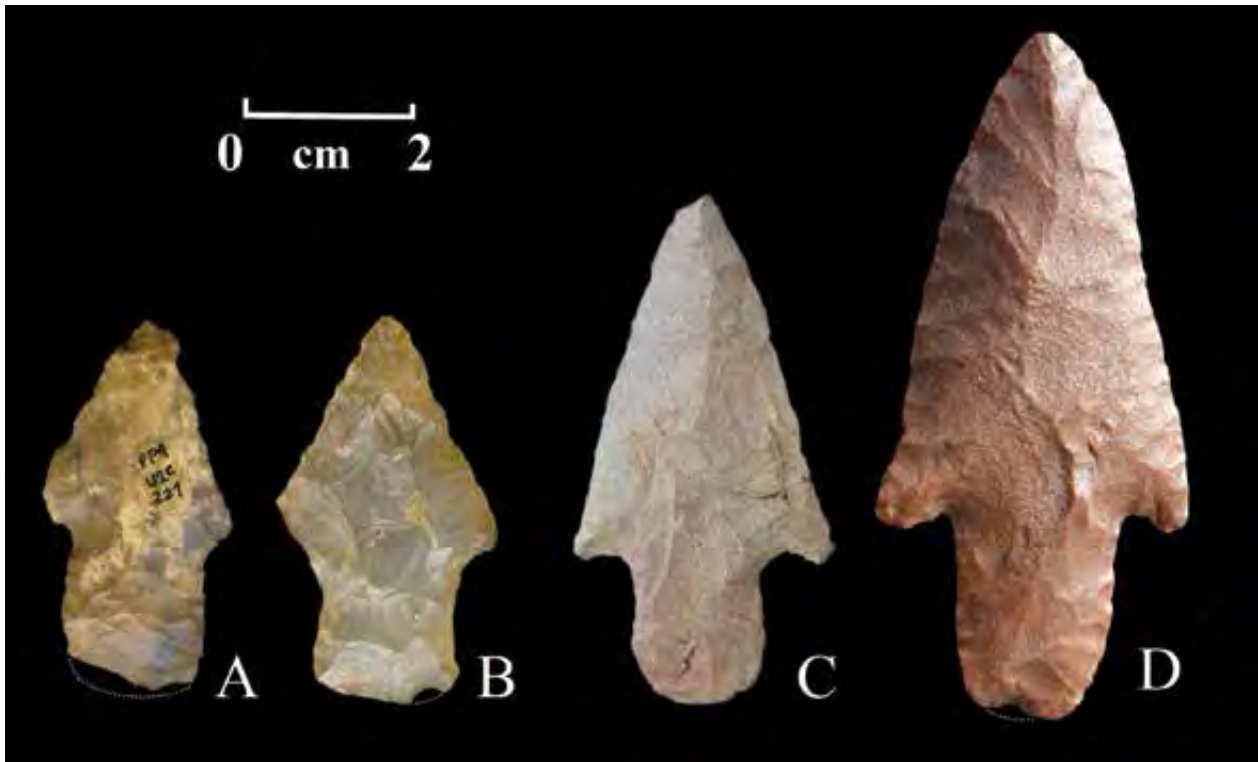


Figura 4. Puntas Tigre del Río Uruguay medio. (A) Proveniente de la excavación del sitio Pay Paso 1, componente 2 datado en 12.000 años cal. AP, manufacturada en madera silicificada; (B) proveniente de excavación en la Laguna Canosa, datada en 11.213 años cal AP, manufacturada en ágata traslúcida; (C) superficie sitio Pay Paso 1; (D) Río Uruguay, arenisca silicificada.

Las características morfológicas y tecnológicas principales de las puntas Tigre (figura 4) son pedúnculo ancho con lados rectos o levemente convexos, base convexa o convexa atenuada generalmente adelgazada por retoques, aletas u hombros muy pronunciados con ángulos de entre 70°-90° para ejemplares escasamente rejuvenecidos, limbo triangular corto para las puntas que han sido muy reavivadas y limbo triangular largo en las puntas que están al inicio de su vida útil. Estas puntas tienen adelgazamiento bifacial completo, fueron manufacturadas a partir de preformas bifaciales (véase figura 10 C). A medida que estas puntas son utilizadas como armas en actividades de caza y/o guerra, tienden a perder las aletas que se modifican hacia hombros muy o poco pronunciados, debido al rejuvenecimiento.

Las puntas Tigre que se han recuperado en contextos estratigráficos datados por  $^{14}\text{C}$  han sido altamente mantenidas y rejuvenecidas, indicando que han tenido una larga vida útil (figura 4, A y B). Estas puntas representan un diseño secundario-rejuvenecido, resultante de una tecnología conservada orientada a extender su vida útil, que debió ser diferente del diseño original-primario o prototipo con escaso mantenimiento (figura 4, C y D).

Recientemente, López Mazz (2013, pp. 99) denomina a las puntas Tigre puntas “pedunculadas triangulares con aletas” “*stemmed triangular with wings*” (STW), omitiendo el nombre que originalmente le dimos a este diseño. Este tipo de punta temprana fue definido como tal en la tesis de doctorado de R. Suárez realizada en 2010 que se publicó un año después (véase Suárez 2011a, pp. 185-188). Previamente a que definiéramos este diseño (año 2010), López Mazz et al., (2009a, 2009b), en trabajos referidos al poblamiento temprano de Uruguay, no hace mención a la existencia de este diseño o tipo de punta de proyectil. De cualquier manera, lo importante aquí es señalar que nombrar un tipo de puntas tempranas “*pedunculadas triangulares con aletas*” es impreciso. Primero, porque se basa en atributos generales como las aletas y forma triangular del limbo. Las aletas y la forma del limbo son atributos modificados durante la vida útil de estos artefactos, debido al constante proceso de rejuvenecimiento que sufren estas armas para ser funcionales en actividades de caza. Segundo, porque puntas “*pedunculadas triangulares con aletas*” se han recuperado en diferentes periodos cronológicos de la prehistoria de Uruguay: desde la transición Pleistoceno Holoceno (Suárez, 2011a), en contextos arqueológicos del Holoceno medio datados entre 4.190 a 3.460 años  $^{14}\text{C}$  AP (Iriarte, 2003, figura 4.17) y en sitios del Holoceno reciente (Hilbert, 1991). Tercero, y relacionado con el punto anterior, es un término ambiguo. La gran mayoría de puntas de proyectil provenientes de contextos superficiales y estratigráficos en Uruguay son puntas “*pedunculadas triangulares con aletas*”, y tienen una significativa variabilidad en la morfología del pedúnculo, forma de las aletas, y forma del limbo. Por lo tanto, el nombre “*puntas pedunculadas triangulares con aletas*” es general, impreciso y ambiguo. El principal problema es de orden cronológico pues se puede incluir en esta denominación puntas de diferentes periodos, o sea puntas tempranas (final del Pleistoceno) como puntas más recientes (Holoceno medio y Holoceno final). Si un criterio similar se hubiera utilizado para denominar los diferentes tipos de puntas

tempranas en América del Norte, se las hubieran denominado "*apedunculadas lanceoladas sin aletas*", de esta forma se incluirían en un mismo tipo a las puntas Clovis, Folsom, Agate Basin, Mesa y Goshen (Stanford et al., 1999).

En los sitios Pay Paso 1, Laguna Canosa, y K87, las excavaciones realizadas permitieron recuperar bifaces, láminas, raspadores y otros artefactos que formaban parte del conjunto de artefactos utilizados por los grupos humanos que portaban las puntas Tigre (figura 8, C y D).

### Puntas Pay Paso

Las puntas Pay Paso fueron definidas por Suárez (2003) y datadas a partir de una base cronológica de 10 edades radiocarbónicas entre 11.081 y 9.930 años cal AP (9585-8570 años  $^{14}\text{C}$  AP). Hasta el presente, se han registrado un total de 40 puntas Pay Paso en Uruguay y 5 en el Sur de Brasil.

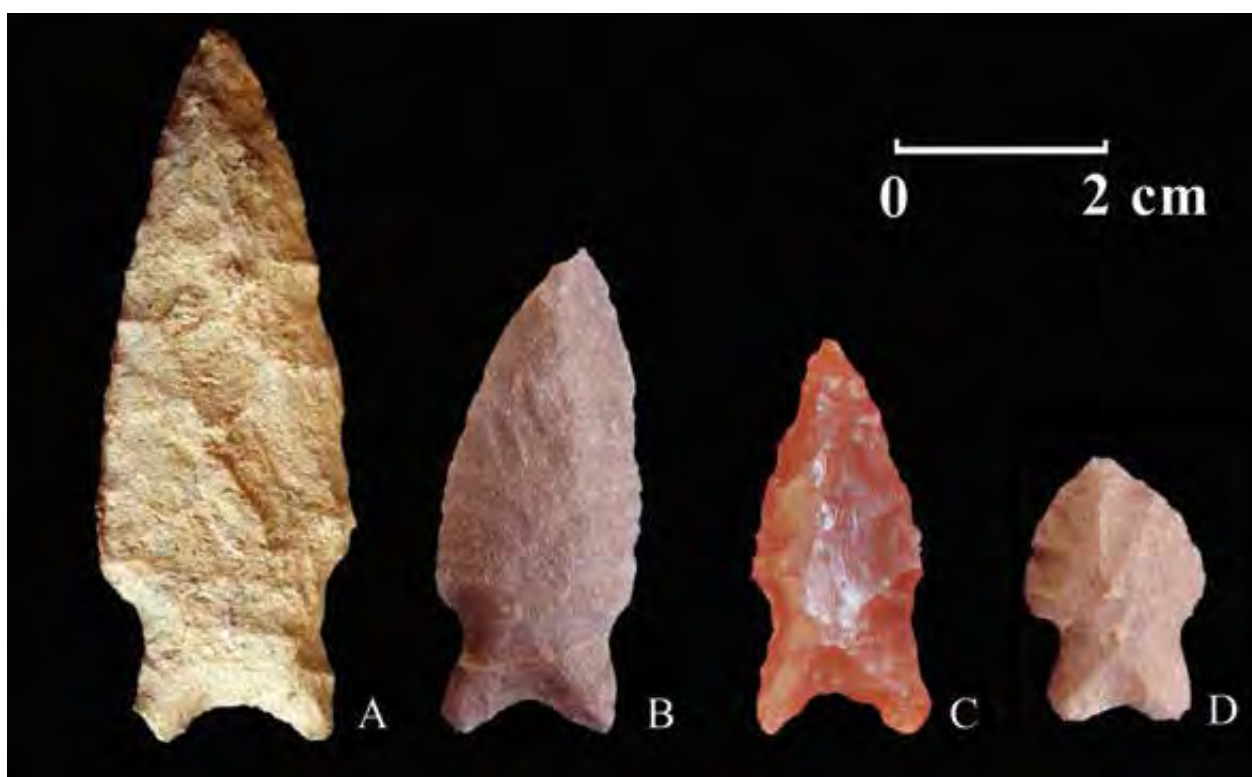


Figura 5. Puntas Pay Paso de tres regiones de Uruguay. (A) Proveniente de los arenales del Río Tacuarembó Grande; (B) recuperada en excavación arqueológica del sitio Pay Paso 1, componente 3 datado en 11.081-10.800 años cal AP, arenisca silicificada; (C) Río Negro medio, caliza silicificada; (D) sitio Pay Paso 1 (superficie) arenisca silicificada. Obsérvese en los ejemplares B, C y D el negativo de lascado triangular en la base, característica de este tipo de puntas de proyectil.

Figura 6. Cuchillos bifaciales asimétricos tempranos del Río Uruguay medio. (A) Río Uruguay, Salto Grande manufacturado en caliza silicificada; (B) sitio Pay Paso 4 desembocadura río Cuareim, en ágata traslúcida; (C) Río Uruguay medio (tiene una fuerte pátina negra que no permite la identificación de la materia prima). A scale bar indicates 0 to 4 cm.





Figura 7. Vista panorámica del sitio Pay Paso 1. © Natalia Azziz.

El diseño y principales características tecno-morfológicas de las puntas Pay Paso (figura 5) incluyen pedúnculo corto, base cóncava profunda, lados del pedúnculo cóncavos divergentes expandidos hacia la base, lados del limbo convexo o recto, retoque laminar regular en el limbo y tratamiento de la base muy cuidadoso realizado con un negativo triangular (Suárez, 2003).

Hemos registrado 40 puntas Pay Paso en varios sitios tempranos del Río Uruguay medio, río Cuareim, río Negro y río Tacuarembó. Este mismo tipo fue identificado en el sur de Brasil en los sitios Areal (Mentz Ribeiro et al., 1995) y "das Flechas" en estado de Rio Grande do Sul y en la región de Urubucí en el sitio Avenca Baixo 1 en el estado de Santa Catarina (Corteletti 2008, p. 41, Corteletti 2013). Los sitios del sur de Brasil están localizados aproximadamente a 802 y 610 km respectivamente del sitio tipo Pay Paso. Esto nos muestra el vasto territorio ocupado por los cazadores-recolectores que manufacturaron las puntas Pay Paso. Al igual que las puntas cola de pescado y las Tigre, las puntas Pay Paso sufrieron un intenso proceso de rejuvenecimiento y mantenimiento.

Una de las características distintivas de las puntas Pay Paso es la presencia de un lascado triangular profundo de la base (véase la figura 5, B, C y D). Además, generalmente el ancho del pedúnculo en la base es mayor al largo del pedúnculo, esto causa que el diseño de esta punta se vea como una punta de pedúnculo corto.

## Movilidad y dispersión de la población durante la colonización inicial

La distribución y frecuencia de las puntas cola de pescado, Tigre y Pay Paso permiten comprender diferentes aspectos ligados a la movilidad y ambientes ocupados por los grupos humanos que colonizaron la región durante el poblamiento inicial de la cuenca del Plata.

Bamforth (2009, p. 146) indica que las puntas de proyectil fueron una clase de artefacto importante para los grupos humanos que las produjeron. Tienen características morfológicas propias en su diseño y se distribuyen por amplias regiones geográficas. Presentan un alto grado de mantenimiento y en muchos casos fueron recicladas. Todas estas características se pueden observar en las puntas tempranas que circularon por la cuenca del Plata y Río Uruguay. Podemos conjeturar entonces que las puntas cola de pescado, Tigre y Pay Paso fueron transportadas y descartadas en diferentes sitios y ambientes de una amplia región geográfica (Bamforth, 2009; Binford, 1979; Shott, 1986, 1996; Shott y Ballenger, 2007), como lo es el sureste de América del Sur. De esta forma es importante poder observar la frecuencia y distribución de las puntas tempranas en esta región del continente porque permite definir un vasto territorio donde hay evidencias de ocupaciones tempranas.

La distribución de las puntas cola de pescado se registran en Pampa-Patagonia en Argentina y Chile, todo Uruguay, sur de Brasil, en ambientes de praderas con pasturas; así como en otras regiones y ambientes de América del Sur (Ecuador, centro de Chile, Perú). En el Cono Sur se distribuyen desde la costa del océano Atlántico hasta el océano Pacífico.

Las puntas Tigre y Pay Paso tienen una distribución más restringida, son frecuentes en el norte, centro y sur de Uruguay, en las cuencas de los ríos Uruguay medio, Negro medio y Tacuarembó grande; en el sur de Brasil se registran en el Río Uruguay medio-alto, en los estados de Río Grande del Sur y Santa Catarina (Corteletti, 2008, 2013; Miller, 1987). El límite sur del territorio utilizado por estos cazadores-recolectores fue la desembocadura del Río Uruguay (34°10'S - 58°09'O), no hay evidencia arqueológica



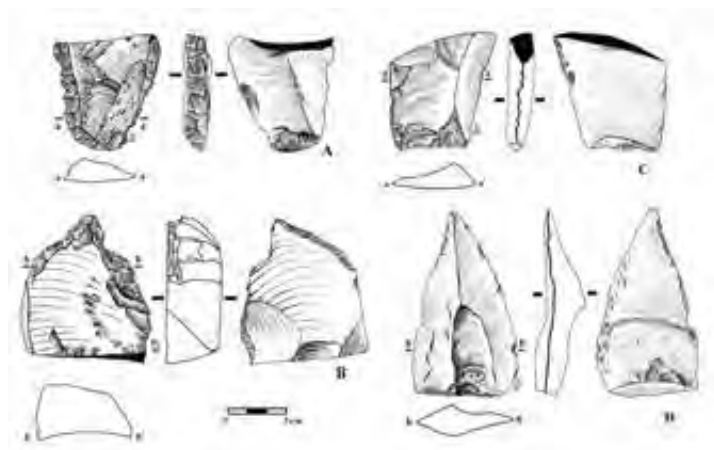


Figura 8. Artefactos formatizados recuperados en la excavación del sitio Pay Paso 1, componente 2 datado entre 12.008 y 11.400 años cal AP, asociados con puntas Tigre. (A) Raspador denticulado de filo largo (arenisca silicificada); (B) raspador de filo extendido (caliza silicificada); (C) artefacto de filo retocado (basalto); (D) lasca de arista con filo natural utilizado (arenisca silicificada).



Figura 9. Artefactos unifaciales y desechos de talla en ágata traslúcida recuperados en los componentes tempranos del sitio Pay Paso 1.

arqueológica, estratigráfica y cronológica (Suárez, 2011a). El sitio tiene más de 30 edades radiocarbónicas que datan los tres componentes entre 12.800-9.600 años cal AP (figura 7) (Suárez, 2011a, tabla 5.2, p. 93) donde el segundo recurso lítico más utilizado fue ágata traslúcida tanto en artefactos formatizados (14,41%) como en desechos de talla (*debitabe*) (10,71%) (figura 9). El sitio Pay Paso 1 es el único del Río Uruguay donde se recuperó fauna del Pleistoceno (caballo americano extinguido *Equus* sp. y Gliptodonte) asociada con artefactos líticos. El tercer sitio que ofrece información sobre la utilización de ágata traslúcida durante el poblamiento de la región es el sitio Laguna de Canosa, localizado 47 km al norte del sitio K87 y a 20 km al oeste del sitio Pay Paso 1. En el nivel antiguo del sitio datado en 11.200 años cal AP se recuperaron artefactos en ágata traslúcida, así como una punta Tigre muy rejuvenecida (véanse las figuras 4, B, y 10, A).

Los componentes tempranos de los sitios estratigráficos K87, Pay Paso 1 y Laguna Canosa comparten la presencia de artefactos formalizados manufacturados en ágata traslúcida.

La presencia de grandes cuchillos bifaciales en ágata traslúcida que superan los 110 mm de largo en los sitios residenciales del Río Uruguay medio y desembocadura del Río Cuareim (figura 6, B) sugieren el uso de preformas y formas bases que debieron superar los 180-150 mm de largo. Las canteras o afloramientos de rocas para manufacturar estos artefactos se ubican a 170 km al este de los sitios residenciales del Río Uruguay medio (figura 1, 16). En la Región Arqueológica Catalanes Nacientes Arapey la disponibilidad y accesibilidad de ágata traslúcida en forma de geodas es apropiada para iniciar la reducción y/o adelgazamientos de series completas de artefactos bifaciales que culminan en la producción de bifaces que superan los 110 mm de largo (figura

de puntas Tigre y/o Pay Paso más al sur en Pampa (Argentina). Además, no se han registrado estos diseños en contextos superficiales o estratigráficos en esta región geográfica.

Por otro lado, los recursos líticos y fuentes de materias primas han atraído interés pues permiten conocer diferentes aspectos de la movilidad y organización de la tecnología de los cazadores-recolectores (Amick, 1996; Binford, 1980; Kelly 1983; Odell 1996).

En el norte de Uruguay, recientemente se definió un corredor de 100 km de largo por 40 km de ancho donde hay talleres, canteras de aprovisionamiento de recursos líticos silicificados y afloramientos de ágata traslúcida, arenisca silicificada, jaspe, ópalo y otras materias primas para hacer artefactos de piedra (Suárez, 2010). Esta área fue denominada *Región Arqueológica Catalanes Nacientes Arapey* (RACNA) (figura 1, 16). Los nuevos datos obtenidos permiten plantear pautas sobre la accesibilidad y transporte de rocas y artefactos durante la prehistoria de la región, ligados a la movilidad de los cazadores-recolectores tempranos.

Existen tres sitios residenciales sobre el Río Uruguay medio con muy buena información sobre el uso de ágata traslúcida durante la transición Pleistoceno Holoceno. El sitio K87 (30° 37'38, 20" S - 57° 50'17, 00" W), se localiza sobre el Río Uruguay próximo a la desembocadura del arroyo del Tigre, fue datado por la misión de la UNESCO en 10.420 ± 90 años <sup>14</sup>C AP (MEC, 1989, p. 60). En los niveles antiguos del sitio fueron recuperados artefactos en ágata traslúcida (MEC 1989, p. 50-54; Suárez, 2011b). El sitio Pay Paso 1 (30° 16'06, 60" S - 57° 27'38, 30" W), se ubica en la margen izquierda del río Cuareim a 53 km del sitio K87, tiene una muy buena resolución



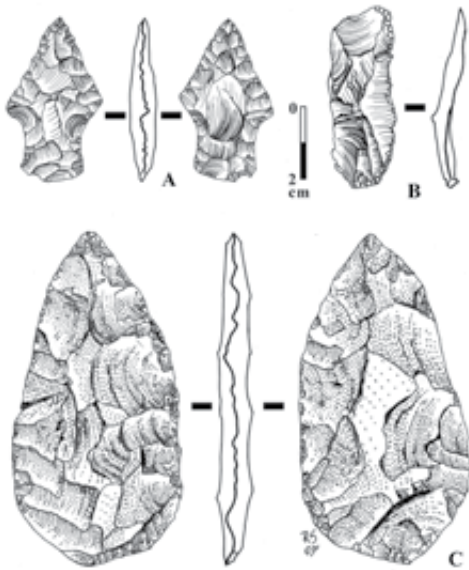


Figura 10. Artefactos del sitio Laguna Canosa (Río Uruguay) datados en 11.200 años cal. AP. (A) Punta Tigre en ágata traslúcida; (B) lámina con filo natural utilizado en madera silicificada; (C) preforma bifacial en arenisca silicificada.

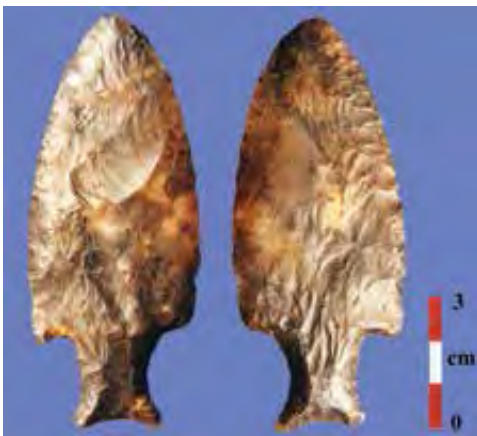


Figura 11. Variante de punta cola de pescado recuperada en superficie en el sitio Laguna Canosa (Río Uruguay medio), obsérvese aleta y hombro muy pronunciado y limbo triangular largo, manufacturada en caliza silicificada.

6, B) como los que se han recuperado en los sitios residenciales del Río Uruguay medio. En esta región es interesante señalar la presencia de importantes canteras prehistóricas de abastecimiento de ágata traslúcida, entre los sitios arqueológicos más importantes de esta región se ubican los sitios sobre el arroyo Catalán Seco y arroyo Catalán Chico. Estos sitios se encuentran en serio peligro de destrucción debido al avance de la explotación minera de ágatas y amatistas que se desarrolla en la zona. Aún hay posibilidad de generar acciones tendientes a preservar-conservar in situ estos sitios arqueológicos donde durante la prehistoria diferentes grupos humanos se aprovisionaron de ágata traslúcida. Además, estos sitios arqueológicos tienen un valor agregado, pues son el único lugar reconocido donde la actividad humana que desarrolla nuestra sociedad actualmente (canteras de ágatas) es exactamente la misma actividad que realizaron los grupos de cazadores recolectores prehistóricos que recorrieron la zona hace 12.800-10.000 años cal AP que utilizaron los afloramientos de ágata como canteras y talleres para manufacturar artefactos de piedra.

## Discusión y conclusiones

Los datos generados en los diferentes países (Uruguay-Brasil por ejemplo) deben necesariamente integrarse en una base de datos que vaya más allá de los límites naturales o arbitrarios de los países, pues durante el poblamiento no existían las fronteras políticas actuales. Este trabajo va en ese sentido, integra la información generada en Uruguay y sur de Brasil, falta integrar los datos de la margen Argentina del Río Uruguay, donde aún no comenzaron las investigaciones sistemáticas en relación al poblamiento temprano.

El ingreso los primeros flujos humanos hacia el interior del continente se produce desde la costa Atlántica, el acceso por la red fluvial donde las cuencas del Plata y del Río Uruguay son una de las principales vías de ingreso y dispersión de la población, habría minimizado los riesgos de explorar y colonizar espacios previamente inhabitados (Miotti, 2006; Miotti y Magrin 2012; Suárez 2011a, 2015a).

El reciente reconocimiento de las puntas Pay Paso y Tigre tienen una fuerte implicancia para comprender las adaptaciones tempranas ocurridas durante la transición Pleistoceno Holoceno. Los datos sugieren diversidad tecnológica durante el poblamiento del sureste de América del Sur, que comienza a reconocerse en diferentes diseños de puntas de proyectil y grupos humanos que circularon en la cuenca del Plata y en particular en la cuenca del Río Uruguay.

El río Uruguay medio en una extensión aproximada de 450 km entre los ríos Queguay (Uruguay) e Ijuí (Brasil) es una región donde hay una importante base cronológica que evidencia redundantes ocupaciones tempranas ligadas al poblamiento inicial del sureste del continente. Los grupos humanos luego de ingresar por la vertiente atlántica se dispersaron hacia el norte, alcanzando probablemente el estado de Santa Catarina (sur de Brasil), hacia el sur hay evidencia de ocupaciones tempranas en el río Negro medio y la costa Atlántica en el actual territorio de Uruguay. Hay que remarcar que el límite sur del territorio utilizado por los grupos Tigre y Pay Paso es la desembocadura del río Uruguay. En sitios tempranos de Pampa Argentina estos diseños de puntas de proyectil no se han recuperado o registrado hasta el presente. Sin embargo, el uso del espacio que realizaron estos grupos humanos hacia el norte indica la utilización y reconocimiento de amplios territorios ligados con ambientes fluviales que incluyen los actuales estados de Río Grande del Sur, Santa Catarina y Paraná en el sur de Brasil, donde se han recuperado puntas de proyectil Tigre y Pay Paso.



Figura 12. Vista general de componente temprano durante la campaña de excavación del sitio K87 Arroyo del Tigre en el año 2012.

Los sitios arqueológicos del Río Uruguay medio presentan redundancia de ocupaciones tempranas durante el poblamiento en diferentes periodos cronológicos, o sea durante el final del Pleistoceno, transición Pleistoceno al Holoceno y Holoceno temprano.

El inicio de la ocupación de esta región comienza con flujos humanos que reconocen las planicies del sur de Uruguay hace 14.000 años cal AP, los sitios de este periodo son muy escasos pero recientemente se viene presentando evidencia cronológica y arqueológica de estas efímeras ocupaciones (Suárez, 2014, 2016; Meneghin, 2015). Posteriormente, entre 12.800-10.065 años cal AP se reconoce una tradición bifacial con grupos humanos que manufacturan diferentes diseños de puntas de proyectil pedunculadas, aunque se registran también núcleos bifaciales, preformas y cuchillos. Hacia 12.800 años cal AP (ca. 10.800 años  $^{14}\text{C}$  AP) la tecnología asociada a las puntas cola de pescado está presente en las planicies de Uruguay y sur de Brasil, en este mismo periodo en las excavaciones arqueológicas del sitio Pay Paso se reconoce una tecnología orientada hacia la producción de hojas. Estos grupos humanos se adaptaron en vastos territorios de praderas con gramíneas y pasturas en el Cono Sur.



Figura 13. Excavación arqueológica realizada en el sitio K87 Arroyo del Tigre en septiembre de 2012.

En el Río Uruguay medio hace ca. 12.200-12.000 años cal AP, ocurre una reorganización tecnológica con innovaciones culturales como la aparición de las puntas Tigre y la tecnología asociada a las mismas. La restructuración tecnológica incluye cambios tecnológicos y morfológicos en las puntas de proyectil, destacándose la aparición de aletas, la disminución de la acanaladura como técnica para adelgazar la base, la forma de los lados del limbo, así como la forma de la base y lados del

pedúnculo. Entre los aspectos tecnológicos existe una reducción significativa en la acanaladura de la base, disminuyendo de 38.6% en las puntas cola de pescado a 4.7% en las puntas Tigre. Esto podría indicar una transición entre las dos tecnologías, donde se tiende a dejar de acanalar la base de las puntas. Si bien se observan cambios en la morfología del pedúnculo y la base, el tamaño del pedúnculo —largo y ancho— se mantiene constante sin mayores cambios en las puntas cola de pescado y Tigre. La punta ilustrada en la Figura 11 podría ser un ejemplo de esta transición tecnológica, donde los productores de puntas cola de pescado comienzan a experimentar realizando cambios y mutaciones en las aletas a las puntas, pero manteniendo la clásica forma del pedúnculo y lados del limbo. Esta punta tienen 94,2 mm de largo por 40 mm de ancho, y 7,5 mm de espesor; es importante remarcar que una de las aletas tiene un ángulo de 75° y sobresale 10 mm del pedúnculo donde se inicia el limbo, lo que es infrecuente en las puntas cola de pescado. Además, se observa que esta punta esboza un limbo triangular largo, pero manteniendo los lados convexos.

Las innovaciones morfológicas que se suceden en las puntas del Río Uruguay medio están asociadas al cambio en la forma de los lados del limbo, que pasan de ser convexos en las puntas cola de pescado a rectas en las puntas Tigre. Estos cambios e innovaciones pueden ser respuestas tecnológicas vinculadas a la reorganización del armamento de los cazadores al iniciarse el Holoceno. Esta innovación tecnológica no necesariamente implica un reemplazo cultural, representa el reacondicionamiento de las armas como respuesta a cambios en los parámetros climáticos, paleoambientales y faunísticos asociados con la expansión del bosque en galería por el Río Uruguay medio y a una fase climática más cálida y húmeda que comienza hace ca. 12.400-12.200 cal años AP, justo cuando aparecen las puntas Tigre.

El aprovisionamiento de recursos líticos para hacer artefactos indica que durante el poblamiento de esta región del continente los grupos humanos tenían una movilidad logística que incluía circuitos de cientos de kilómetros en busca de rocas específicas para confeccionar sus artefactos.

Existen dos casos de estudio bien documentados. El caso del ágata traslúcida en el norte de Uruguay, donde los grupos humanos se trasladaron desde los sitios residenciales del Río Uruguay medio hasta la *Región Arqueológica Catalanes Nacientes Arapey*, alcanzando rangos de movilidad de hasta 170 km. Las largas distancias que debieron viajar los cazadores-recolectores para obtener ágata traslúcida sugieren una movilidad logística (Binford, 1980; Shott 1986) relacionada con circuitos de movilidad planificados para acceder a recursos líticos específicos. Quizás la cualidad de ser traslúcida le dio al ágata un significado social o un valor simbólico que la hizo particularmente atractiva para manufacturar artefactos.

Por otro lado, Flegenheimer et al. (2003) señalan el transporte de caliza silicificada rojiza desde el centro-sur de Uruguay hasta Pampa Argentina por medio de intercambio entre grupos humanos que alcanzarían distancias de entre 400-500 km durante la Transición Pleistoceno Holoceno. Aunque también el acceso a este recurso por grupos humanos de Pampa, pudo haber ocurrido de forma directa. O sea, grupos humanos de Pampa pudieron haber accedido al recurso caliza silicificada rojiza de Uruguay durante procesos de agregación social, cuando diferentes bandas se pudieron reunir en el río Negro medio, donde existe la mayor densidad de puntas cola de pescado en Uruguay y pudieron acceder a los afloramientos regionales de caliza silicificada rojiza.

Existieron, por lo tanto, dos estrategias diferentes relacionadas con incursiones o viajes a largas distancias para el acceso a lugares específicos de aprovisionamiento de caliza silicificada rojiza y ágata traslúcida que estarían unidas a estrategias logísticas de movilidad e intercambio que ocurrieron durante el poblamiento del sureste de América del Sur.

El poblamiento de la cuenca del Plata y el Río Uruguay medio se inició con pequeños flujos humanos que lentamente exploraron y colonizaron esta región. Los grandes cursos fluviales, como el Río Uruguay, donde se puede obtener concentraciones significantes de recursos (líticos, fauna, madera, agua, etcétera), fueron las principales rutas de entrada, comunicación y dispersión de los primeros exploradores (en el sentido de Borrero, 1999) y poblaciones que se aventuraron hacia el interior del continente desde la costa Atlántica (Miotti, 2006; Miotti y Magnin 2012; Suárez 2011a). El ingreso por el denso sistema de ríos debió haber minimizado los riesgos de explorar una región del continente previamente desconocida e inhabitada. Las poblaciones debieron ser muy pequeñas y estar esparcidas a través de vastos territorios, generando bajos niveles de visibilidad en el registro arqueológico (Borrero, 1999). La tecnología cola de pescado representa uno de los procesos iniciales y más exitosos de exploración humana en el Cono Sur. Sin embargo, los datos recientemente obtenidos indican que las planicies de Uruguay estaban pobladas antes de la aparición del horizonte cola de pescado. Existieron poblaciones dispersas por vastos territorios hace 14.000 años cal BP, adaptadas a diferentes regiones geográficas del Cono Sur durante el final del Pleistoceno, como el centro-sur de Chile (Dillehay, 2008), Pampa en Argentina (Politis et al., 2014) y Uruguay (Suárez, 2014).

Por otro lado, las adaptaciones y tecnologías Tigre y Pay Paso tienen una más restringida distribución geográfica. Estos grupos humanos circularon por vastas regiones del norte y centro de Uruguay, así como por el sur de Brasil. Puntas Pay Paso por ejemplo se han reconocido a 800 km del sitio homónimo. Estos grupos explotaron y utilizaron amplios territorios que



alcanzan aproximadamente 600.000 km<sup>2</sup>, incluyendo el actual territorio de Uruguay y los estados de Río Grande del Sur y Santa Catarina del Sur de Brasil.

La explotación de ambientes con un amplio rango y variedad de recursos como se encuentra usualmente en los grandes ríos favoreció la exploración y colonización de esta región. Los cazadores-recolectores entre aproximadamente 12.800-9.500 años cal AP tenían una alta movilidad residencial caracterizada por traslados y movimientos frecuentes por las márgenes del Río Uruguay y sus tributarios, que eran utilizados como vía de comunicación y tránsito. Además, se observa una movilidad logística para acceder a recursos específicos, como se ha indicado en los viajes necesarios para acceder a recursos líticos.

Las diferentes adaptaciones tempranas observadas en diferentes tecnologías asociadas a la variación morfológica en las puntas responden a reorganizaciones sociales internas de los grupos humanos que debieron enfrentar los bruscos cambios climáticos, ecológicos y faunísticos ocurridos durante la transición Pleistoceno-Holoceno. Las innovaciones tecnológicas observadas en el cambio del diseño de las puntas de proyectil no significan un reemplazo cultural, pero sí transiciones tecnológicas causadas por cambios paleoambientales asociados con el avance de la floresta en galería por las márgenes de los ríos durante el inicio del Holoceno. El estilo de vida de los grupos humanos portadores de los diseños cola de pescado, Tigre y Pay Paso probablemente siguió siendo similar en cuanto a sus estrategias sociales, políticas y de movilidad.

La investigación sobre el poblamiento en la cuenca del Plata es un excelente laboratorio para investigar la inicial dispersión y colonización humana del sureste de América del Sur, sin embargo es necesario integrar nuevas regiones a la discusión, esto sin duda aportará información inédita que permitirá ampliar y discutir el esquema propuesto en este trabajo.

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# Climate, Catastrophe and Culture in the Ancient Americas: the Case of the Pacific Coast

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## Abstract

The Peruvian coast is an extreme environment of radical contrasts. Though tropical, the desert landscapes that dominate much of this coast are usually one of the driest deserts on earth. Dense human populations and complex social organizations are possible thanks to two factors: rivers that run down from the adjacent Andes mountains to fill irrigation canals, and one of the world's richest marine fisheries. Large magnitude earthquakes and sometimes tsunamis occasionally shatter this apparent tranquillity. At least as devastating are El Niño events that occur at irregular intervals and intensities. By warming the normally cool water of the Antarctic Humboldt Current, El Niño not only reduces marine biomass but also causes convective storms leading to torrential rainfall on the coastal plain. Rain in the desert is rarely a good thing. On the Peruvian coast, waters coalesce into raging, destructive floods that alter the landscape and destroy human infrastructure, while pooling on the countryside to rot crops and attract disease-bearing insects.

Since the arrival of humans over 14,000 years ago, El Niño frequency has varied along with population density and social complexity. Before 9,000 BP, El Niño was present but of unknown frequency. People lived in small groups that hunted, fished and gathered. Social complexity was low. From 9,000 to about 6,000 years ago, El Niño was absent or extremely rare. Through this period, human populations grew slightly and aggregated into villages, even building small-scale monumental architecture and developing or acquiring farming. From 6,000 to 3,000 BP, El Niño returned but with less frequency than in modern times. Populations grew more rapidly and people established major monumental centres that suggest a higher degree of social complexity. From 3,000 years ago until AD 1532, El Niño became much more frequent, populations grew rapidly along with site size and volume of monumental construction, and states and empires arose. The Spanish conquistadors arrived in AD 1532 and within a century, coastal population had plummeted to as little as 1% of the final Pre-Columbian numbers. Through time, then, growth in population and complexity paralleled increasing risk as defined by El Niño frequency. Only a fully anthropogenic event, the Spanish Conquest, was able to trigger a long-term demographic disaster. These broad-brush patterns require that we examine the nature of catastrophe more closely, both in the past and for the future.

The Peruvian coast has over 14,000 years of sites that demonstrate the above patterns. Some of these sites are feasible for inclusion on the UNESCO Tentative List because they fit some or all of the following criteria for Outstanding Universal Value (World Heritage Centre 2013, paragraph 77): 'bear a unique or at least exceptional testimony to a cultural tradition or to a civilization which is living or which has disappeared (criterion iii); be an outstanding example of a type of building, architectural or technological ensemble or landscape which illustrates (a) significant stage(s) in human history (criterion iv); and be an outstanding example of a traditional human settlement, land-use, or sea-use which is representative of a culture (or cultures), or human interaction with the environment especially when it has become vulnerable under the impact of irreversible change' (criterion v). They also concur with the narratives considered for the definition of Human Evolution Sites for consideration of the HEADS Programme: 'Sites important for the history of science, Sites related to human mobility, Colonization of new environments and dispersion, and Deposits useful for the reconstruction of palaeo-environments'. I close this chapter with a brief review of sites that fit these criteria and narratives.

## Introduction

The Pacific coast of Peru is subject to significant natural disasters that tend to recur frequently but without a predictable periodicity. Both climate and geology drive events that alter resources, change landscapes and affect human societies in this dynamic region. Here, I briefly review the natural forces that have impinged on culture and society since people first arrived in Peru over 14,000 years ago (Sandweiss et al., 2001, 2007; Sandweiss, 2014; Sandweiss and Quilter, 2012). As El Niño is the most patterned of these natural processes and therefore most likely to correlate with patterned





*Figure 1. Peruvian coastal desert looking south from the Los Morteros site, Salinas de Chao, north Coast of Peru.*



*Figure 2. Artisanal fishing fleet at Bayovar, north Coast of Peru.*



*Figure 3. Irrigated fields in the Supe Valley, north Central Coast of Peru, looking toward Caral.*

change in human behaviour, I go into some detail on our reconstruction of El Niño frequency over the span of human occupation in this region. I point to several correlations between El Niño and prehistoric cultural change. Finally, I review several Peruvian sites that might be considered for inclusion in the UNESCO Tentative List; one is directly related to the reconstruction of ancient El Niño behaviour.

## Natural forces

The Peruvian coast lies between the cold Humboldt or Peru Current flowing up from Antarctica and the Andes Mountains. As a result of these two barriers to rainfall, in a normal year the region is one of the driest deserts on earth (Figure 1). However, the same cold current that prevents rain is also a highly productive upwelling zone that is one of the world's richest fisheries (Figure 2).

At the same time, the Andes capture precipitation in the form of rain and snow, some of which flows into rivers that run down to the coast and fill irrigation canals (Figure 3). These two factors have provided the necessary resources for large coastal populations and the development of large, complex societies.

The Andes are located on a subducting plate margin (the oceanic Nazca Plate is sliding under the continental South American Plate), so the region experiences frequent seismic activity and volcanism. Earthquakes, volcanic eruptions and the tsunamis sometimes associated with seismic activity have a devastating impact not only on the people but also on the towns, cities and economic infrastructure, such as irrigation systems (for example, Giesecke and Silgado, 1981). However, because of the unusual shallow-angle subduction under northern and central Peru, active volcanism does not occur here as it does in Ecuador and in southern Peru, Bolivia, northern Chile and Argentina (Barazangi and Isacks, 1976). Consequently, this sector of the central Andes lacks catastrophic volcanic eruptions.

El Niño Southern Oscillation (ENSO) dominates present-day climatic variability on inter-annual timescales in the tropics and involves both the atmosphere and the ocean in the tropical Pacific (for example, Maasch, 2008). On the central Andean coast, El Niño warms near-shore waters, bringing torrential rainfall to the land and depressed biotic productivity to the adjacent

ocean. Frequency, intensity and duration of El Niño events generally follow a latitudinal gradient, decreasing toward the south. However, each event is different and rainfall can skip valleys or occur in different sectors of valleys, with variable consequences. In this largely unvegetated region, the rains often lead to destructive flooding as well as plagues of insects and diseases (see, for instance, Alcocer, 2001 [1580] for eyewitness accounts of the first large magnitude El Niño of the Colonial epoch, in AD 1578).

Seismic activity and El Niño flooding work synergistically to alter landscapes, affecting human settlements. Earthquakes produce abundant debris on the landscape; El Niño flooding mobilises this unconsolidated sediment, often resulting in coastal progradation (seaward expansion of the shoreline) and inland dune incursions that can cover fields and depress agricultural productivity (see Sandweiss et al., 2009; Sandweiss and Quilter, 2012).

### Prehistory of El Niño

In the wake of several large-scale El Niño events over the last 30 years, archaeologists, geologists and palaeoclimatologists have worked hard to reconstruct the prehistory of this climatic anomaly. Molluscs found in archaeological sites on the north and central coasts of Peru provided the first clues that El Niño frequency had varied significantly throughout the Holocene. In the aggregate, available archaeological and palaeoclimatic data support a major change in tropical Pacific climate at about 5800 cal yr BP (Rollins et al., 1986; Sandweiss et al., 1996, 2001, 2007), though it is unclear whether El Niño was absent or just extremely rare for several millennia prior to that date. Molluscan remains from Peru also suggest that between c. 5800 and 3000 cal yr BP, El Niño was present but less frequent than today. Modern, rapid recurrence intervals were apparently achieved only after that time (Sandweiss et al., 2001).

Archaeological and palaeontological deposits on the fossil beach and associated archaeological sites of the Ostra Complex, just north of the Santa River on the north-central Peruvian coast (9°S), date to about 5800 to 7150 cal yr BP (Rollins et al., 1986; Perrier et al., 1994; Sandweiss et al., 1996; Andrus et al., 2003) (see Figure 4 for the location of the Ostra sites and other places mentioned in the text). Research at Ostra beginning in 1980 led to the hypothesis that the Ostra sites reflect a time when El Niño did not function as it does today (Rollins et al., 1986; Sandweiss, 1986, 1996, 2003; Sandweiss et al., 1983, 1996, 1997, 1998a, 2001).

Situated on the shores of a now-dry embayment, the principal sites of the Ostra Complex are the Ostra Base Camp (OBC), located on the southern end of the fossil bay and the Ostra Collecting Station (OCS), located on a rocky knoll about halfway along the shore of the fossil bay (Figure 5). Both the sites and the fossil beach contain mollusc species no longer present in the area - in fact, they are now found more than 4 degrees of latitude to the north, near the Equator (Sandweiss et al., 1983). At Ostra, we found the same molluscs in living position in the former bay, indicating that the site's inhabitants were collecting the

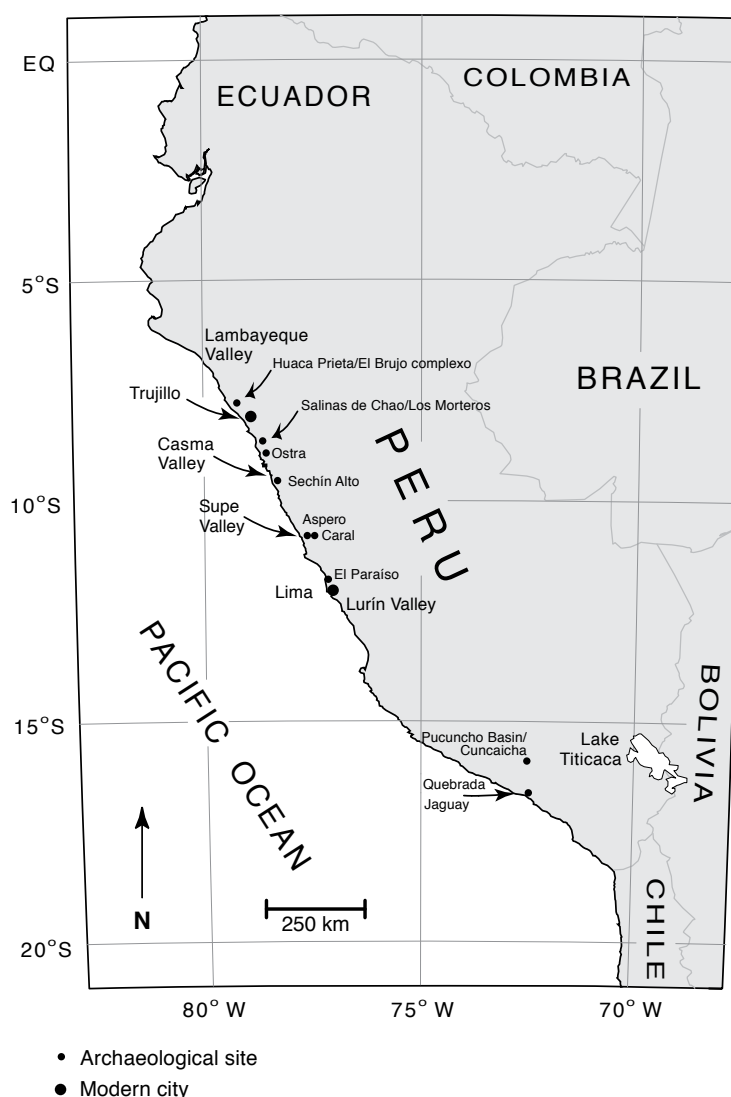


Figure 4. Map showing locations mentioned in the text.

shells from the adjacent beach rather than from distant shores. We refer to assemblages like those from the Ostra Complex as warm water molluscan assemblages; we use the term 'cool water assemblages' for the Peru Current-adapted species found at later sites (see Reitz and Sandweiss, 2001).

Just 20 km north of the Ostra Complex is the Salinas de Chao, a palaeoembayment and fossil shoreline with many associated sites. One of these sites, Los Morteros (8°40'S), dates between 5500 and 3600 cal BP and is an early example of monumental architecture (Cárdenas, 1979, 1995; Sandweiss et al., 1983, 2010; Perrier et al., 1994) (Figure 1). All of the molluscs in this site and those around it are from the cool water assemblage. Molluscan assemblages had clearly changed sometime in the centuries immediately following 5800 cal yr BP. Further north, near Talara in Peru, Richardson (1973, 1978) had observed a similar change from warm water mangrove molluscs to cool water species, also around 5800 cal yr BP. We expanded our research to include fish as well as molluscs and carried out additional work at one of the Talara sites, Siches (4°30'S). Ostra and Siches fish and mollusc assemblages were predominately warm water prior to 5800 cal BP (Sandweiss et al., 1996; Reitz and Sandweiss, 2001).

We considered several hypotheses to explain these data. After compiling all available data for the Mid-Holocene in the Pacific Basin, we concluded that for some time prior to 5800 years ago, the coast of Peru north of c. 10° S latitude was characterised by permanent warm water and that El Niño did not operate for some period before 5800 cal yr BP; after that time, we saw conditions as essentially the same as today (Rollins et al., 1986; Sandweiss et al., 1996, 2007).

Additional insight into the climatic conditions reflected by the pre-5800 cal yr BP, Mid-Holocene marine fauna in coastal sites north of 10°S came from Andrus's geochemical analyses of growth increments in fish otoliths (fish ear bones) from OBC and Siches (Andrus et al., 2002, 2003) and in a mollusc from OBC (Andrus et al., 2005). Delta <sup>18</sup>O of the otoliths showed that in the millennium preceding 5800 cal yr BP, average sea surface temperature (SST) was about 3-4 °C warmer than today, consistent with our interpretation of the marine fauna. However, the seasonal structure of SST showed a more complex picture. At Siches (4°30'S), the annual SST cycle in the Mid-Holocene paralleled that of today but was offset by 3-4 °C. In contrast, at OBC winters were about as cool as today but summers were significantly warmer (Andrus et al., 2002); the amplitude of seasonal temperature at OBC was apparently the same as the amplitude of normal to El Niño SST today, but occurred annually rather than inter-annually. This pattern explains the difference between molluscan and fish fauna assemblages at OBC. Molluscs are sessile and therefore controlled by maximum annual temperature; OBC contained only species that can survive in warm water. Fish are mobile, so during the cool summers, cool water fish could move north to the Ostra area while the warm water fish would be present during the warm summers. The OBC fish fauna was dominated by warm water species but included some cool water fish as well.

In the late 1990s, further consideration of the molluscan record in Mid-Holocene Peruvian coastal sites led to additional insight (Sandweiss et al., 2001). We noticed that sites immediately post-dating the postulated onset of El Niño at 5800 cal yr BP had molluscan assemblages dominated by two species that are extremely sensitive to warm water. The large purple mussel *Choromytilus chorus* has an LT-50 (the temperature at which 50% of the population dies in 24 hours) of 28°C, based on studies in Chile (Urban, 1994). Although we don't have LT-50 data for *Mesodesma donacium*, this wedge clam was fished commercially as far north as Lima (12°S) before the 1982-83 El Niño, after which its northern limit shifted south to Lomas (15°30'S). Following the 1997-98 El Niño, the Peruvian government was forced to ban fishing of *Mesodesma* anywhere in Peru. The abundant presence of these two species in coastal sites between Lima and Trujillo (8°S) during the Late Pre-ceramic and Initial Periods (c. 5800-3000 cal yr BP) would not have been possible with an El Niño recurrence interval as short as it is today. The disappearance of the two mollusc species from north-central and northern Peruvian sites after 3000 cal yr BP strongly suggests an increase in El Niño frequency at that time (Sandweiss et al., 2001), as the shorter recurrence interval for warm water events would not have permitted these species to recolonize the region.

Sandweiss (2003: Table 1) summarises the archaeological record of Terminal Pleistocene to Mid-Holocene climate change along the Peruvian coast. This broad review of excavation results from multiple projects supports the outlines of Holocene change detailed from our own work (Sandweiss et al., 1996, 2001, 2007), with clearly marked transitions in the behaviour of El Niño at c. 5800 and 3000 cal yr BP. Sandweiss et al. (2007) also summarises information from natural archives (flood deposits, soils, lake cores and marine cores) that support our reconstruction of the last 14,000 years of El Niño behaviour.

### Cultural records of the early to mid-Holocene associated with El Niño

As reviewed above, Peruvian coastal archaeological sites contain or are associated with a variety of records pertinent to reconstructing El Niño behaviour over the last 14,000 years. These include biogeography (for example, Reitz and Sandweiss, 2001; Sandweiss et al., 1996), growth increment analysis (for instance, Rollins et al., 1986, 1987) and biogeochemistry (for example, Andrus et al., 2002, 2005) of molluscs and fish, differential preservation of soft organic materials, stylistic connections





Figure 5. Looking across the Ostra Paleoembayment from the OCS site to the OBC site.

between distant regions sharing similar environments (Sandweiss, 1996), flood deposits (for instance, Keefer et al., 2003) and beach ridge morphology (for example, Sandweiss, 1986; Shafer et al., 2004).

Peruvian sites also demonstrate change through time in cultural attributes that correlate temporally with the changes we have identified in El Niño frequency in the Mid-Holocene (Sandweiss et al., 2001; Sandweiss, 2003; Richardson and Sandweiss, 2008). Major indicators of cultural change include settlement pattern (the distribution and function of sites across the landscape), construction style (size, form and function of monuments as well as dwellings), subsistence practices, long-distance exchange or contact, symbolic content of artefacts and structures, and burial patterns. In this section, I focus on large-scale changes in settlement pattern, construction style and subsistence. In terms of cultural chronology, the relevant periods are the Early Preceramic Period (c. 14,000-9000 cal yr BP), the Middle Preceramic Period (c. 9000-5800 cal yr BP), the Late Preceramic Period (c. 5800-4100 cal yr BP) and the Initial Period (c. 4100-2800 cal yr BP).

Prior to 5800 cal yr BP, there was no large-scale monumental architecture in coastal Peru and only a few small structures elsewhere, as at Nanchoc on the western slopes of the northern Peruvian Andes (Dillehay, 1992; Netherly and Dillehay, 1986) and the initial monumental phases of Huaca Prieta on the north coast of Peru (Dillehay et al., 2012a). With the exception of Huaca Prieta, coastal sites in the millennia preceding 5800 cal yr BP range from small fishing camps such as Early to Middle Preceramic Quebrada Jaguay (16°30'S, Sandweiss et al., 1998b) and Siches (4°30'S, for example, Richardson, 1973, 1978; Sandweiss et al., 1996) and Middle Preceramic Ostra Base Camp (8°55'S, for instance, Sandweiss, 1996; Sandweiss et al., 1996) to villages such as Paloma (12°30'S, for example, Benfer, 1990). Early and Middle Preceramic coastal sites had subsistence systems based on marine resources, wild plants and occasionally early domesticated plants (Sandweiss, 2014). Marine organisms recovered from sites north of 10°S are predominately warm water species, while to the south of 10°S, and especially south of 12°S, marine organisms are almost entirely cool water species (for example, Sandweiss et al., 1996; Reitz and Sandweiss, 2001; see above).

Human populations in Peru grew through time (for example, Rick, 1987; Wilson, 1988; Sandweiss and Quilter, 2012) and consequently created more and larger archaeological sites. Combined with the stabilisation of sea level during the Mid-Holocene, this demographic trend resulted in an increasing number of sites preserved for analysis. In the following paragraphs, I review data for the best known Late Preceramic and Initial Period coastal sites (see Sandweiss, 2003:Table 1; Moseley, 2001; Burger, 1992; Quilter, 2014 *inter alia* for other sites of this time). This is the critical period when sea level had stabilised, El Niño had returned, large scale monumental architecture first appeared and social complexity increased dramatically.



## Late Preceramic period

Coastal monuments first appear during the Late Preceramic Period, after the climatic transition at 5800 cal yr BP. Although Late Preceramic mounds are distributed between Lima (12°S) and the Lambayeque Valley (6°48'S), it is now clear that the first florescence of monument building in coastal Peru took place on the North Central Coast (aka Norte Chico) between about 10°S and 11°S. At Aspero (10°45'S) on the shore of the Supe Valley, Feldman (1980, 1985) excavated several small, early temple mounds, but only recovered materials from the last several construction phases. These phases date to c. 5000-4300 cal yr BP. However, Feldman also obtained one anomalously early date of c. 5650 cal yr BP on charcoal that may have been recycled from an earlier construction phase and may therefore indicate an onset of monument building as early as that date.

Subsistence at Aspero was based on fishing, farming and gathering. All of the marine species are typical, cool water Peru Current taxa. Among the molluscs, *Choromytilus chorus* and *Mesodesma donacium* were particularly important. The most important domesticated plants were cotton (*Gossypium barbadense*) for nets and textiles and gourd (*Lagenaria siceraria*) for floats and containers (Feldman, 1980), utilitarian species which Moseley (1975) calls industrial plants. Though present in Peru by the Late Preceramic Period (for example, Grobman et al., 2012; Perry et al., 2006), maize was not a dietary staple on the coast.

Though known for decades as Chupacigarro Grande (for instance, Kosok, 1965), the site now called Caral (10°45'S) (Figure 3) was not proven to be Late Preceramic in age until recently (Shady et al., 2001). A suite of radiocarbon dates, many on short-lived plants used in construction, place the site between about 4600-3900 cal yr BP (ibid.). Called the New World's first city, Caral is a complex settlement with six large mounds and residential areas with different kinds of architecture suggesting different social classes (ibid.; Shady, 2005; Shady and Leyva, 2003;). In contrast to Aspero, Los Morteros and other Late Preceramic monumental sites known before 2001, Caral is located about 25 km inland, up the same valley as Aspero. Work by Shady elsewhere in the Supe Valley, and more recently by Haas et al. (2004) in neighbouring valleys, has uncovered additional inland Late Preceramic centres with mounds.

Caral has been extensively excavated for almost two decades and R. Shady's multidisciplinary team has analysed many classes of subsistence remains (for example, Shady and Leyva, 2003; Shady, 2005). Despite the distance from the shore, the animal diet came almost entirely from the ocean. As elsewhere on the North Central Coast and Central Coast, *Choromytilus* and *Mesodesma* were dominant molluscan species, the most abundant fish were sardines (*Sardinops sagax sagax*) and anchoveta (*Engraulis ringens*), and the most common plants were cotton and gourd.

Caral and the surrounding, contemporary Supe Valley sites (Figure 3) also provide a clear example of the potential synergy between natural forces and cultural systems. Working with Peruvian archaeologist, Ruth Shady, (for example, Shady Solis, 2005; Shady et al., 2001), Michael Moseley and other colleagues, I was able to track a coastal disaster sequence beginning about 3,800 years ago (Sandweiss et al., 2009; Sandweiss and Quilter, 2012). Several sites had clear evidence of earthquake damage followed by reconstruction. In this largely unvegetated environment, earthquakes produce abundant debris on the landscape, just waiting for the torrential rains of El Niño to wash them down the valley slopes, into the river, and out to the shore. That this process happened about 3,800 cal BP is clear. A massive beach ridge formed along the shore and eventually blanketed about 100 km of coastline. Bays filled with sediment and sand began blowing inland. Because the Caral settlement system relied heavily on agriculture for cotton, gourds and increasingly for food, when sand covered the fields it created an economic crisis. In several sites, sand deposits were covered by a final construction level, less well made than earlier structures, and then the sites were abandoned.

In the Supe case, the temporal correlation between natural and cultural events is clear, frozen in time by human construction. Given the tight chronology, there is almost certainly correlation between the natural disasters and the human activities culminating in abandonment. Whether the disasters caused the abandonment is harder to know, though it is tempting to believe that they played a role in the regional cultural changes at the end of the Late Preceramic Period. What were those changes? First, as far as we know, only the monumental sites were abandoned; we do not know what happened to the population of the Supe and adjacent valleys after the large sites fell out of use. Second, monumental, preceramic or aceramic sites continued for several hundred years on the peripheries of the Supe Culture area, to the north at Salinas de Chao (Alva, 1986) and to the south at El Paraíso (Quilter, 1985), beyond the reach of the massive beach ridge that fed the invading sand sheets. Were these sites homes to different societies with different cultural dynamics? Were they successful for longer simply because they were safe from the sand and other disasters? Did they receive migrants fleeing the Supe area who enhanced their labour pools and contributed to their longer survival as monumental sites? These are all important topics for future research.

Los Morteros is a large mound on the fossil bay at Salinas de Chao (8°40'S). Radiocarbon dates on materials from shallow excavations date the final occupation of the structure to c. 5500-5100 cal yr BP (Cardenas, 1979, 1995); the structure itself is earlier, though how much earlier is unknown at this time (Sandweiss et al., 2010). Later ephemeral use of the mound surface

produced food remains that date as recently as 3600 cal BP. Molluscan remains from this site are typical cool water Peru Current species. Los Morteros is the northernmost Late Preceramic monumental structure on the Peruvian coast.

Near Lima, El Paraíso is a large aceramic site with dates falling at the end of the Late Preceramic Period and overlapping the Initial Period (c. 4100–3200 cal yr BP; Quilter, 1985; Quilter et al., 1991). The site covers about 58 ha and consists of six large mounds and at least five smaller structures. Though test excavations failed to find evidence for a large resident population, primary midden deposits did provide insight into diet (Quilter et al., 1991) and climate (Sandweiss et al., 1996). Like other Late Preceramic sites, molluscs and fish provided most of the animal food, while plant food was a combination of wild and domesticated taxa. Once again, the most important crops were cotton and gourd.

Although modest-sized permanent settlements such as Asia Unit 1 (12°30'S, Engel, 1963) have been found south of Lima, El Paraíso is the southernmost Late Preceramic monumental site known to date.

Debate continues about the temporal priority of shoreline vs. inland centres in the Late Preceramic Period (Haas and Creamer, 2006; cf. Sandweiss, 2006, 2009), but the weight of evidence currently available supports a sequence beginning on the coast with fishing/farming sites, with later population growth driving expansion inland to increase production of cotton and gourds to intensify the fishing industry (Sandweiss and Rademaker, 2006; Sandweiss, 2009). How complex Late Preceramic societies really were continues to be debated, but the recent work at Caral and the other North Central Coast monumental sites supports earlier arguments for social stratification, at least in the core region between about 12° and 8°S. The North Central Coast was the centre of Late Preceramic development, with the greatest number, size and complexity of monumental sites. In this pristine setting, supernatural sanctions (religion) must have played an important role in the consolidation of power in the hands of a nascent elite (Roscoe, 2008).

## Initial period

During the Initial Period, the size of monumental structures increased and the geographical ranges expanded south to the Lurín Valley just south of Lima (12°15'S) and north to the Lambayeque Valley (6°30'S). Like the majority of Late Preceramic monumental sites in the North Central Coast valleys, Initial Period monuments throughout the entire range tend to be located inland from the shore. Seafood was still important, but agriculture played an increasingly significant role in subsistence (see Burger, 1992; Moseley, 2001 for a review of Initial Period coastal sites). The suite of marine species exploited during the Initial Period is substantially similar

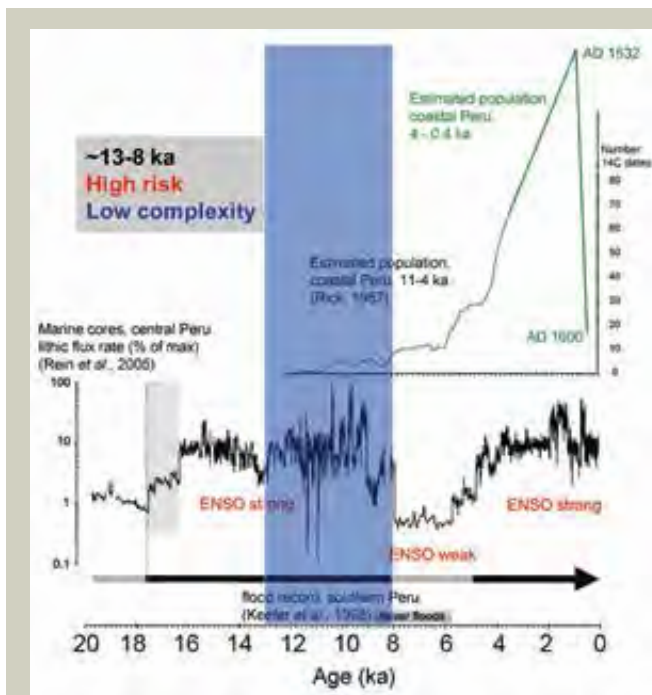


Figure 6. Population, risk, and complexity on the Peruvian coast, 13,000–8000 BP (years before present/AD 1950). Population curve drawn from Cook (1981), Moseley (2001), Rick (1987), and Wilson (1988) (see text). Risk is based on frequency/intensity of El Niño, from Rein et al. (2005) and Sandweiss et al. (2007). Complexity is based on the authors' experience and the general literature (e.g., Moseley 2001; Richardson 1994). Figure drafted by Kurt Rademaker. Adapted from Sandweiss and Quilter (2012).

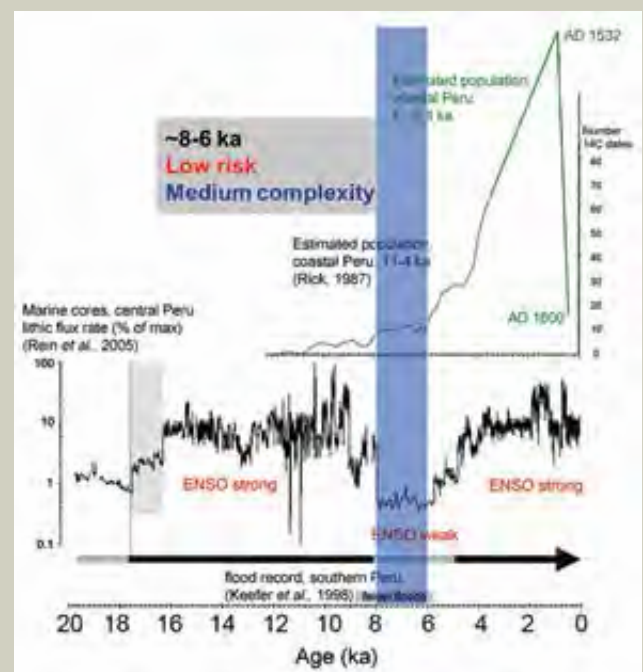


Figure 7. Population, risk, and complexity on the Peruvian coast, 8000–6000 BP. See figure 5.5 caption for sources. Figure drafted by Kurt Rademaker. Adapted from Sandweiss and Quilter (2012).

to that of the Late Preceramic Period, with *Choromytilus* and *Mesodesma* among the most important molluscs, and sardines and anchoveta dominating the fish (Sandweiss et al., 2001).

Monumental construction ceased or decreased greatly in the North Central Coast valleys after the Late Preceramic Period and the Casma Valley (9°30'S) became the focal point for Initial Period development. Among the many Casma sites of this time, Sechín Alto was the largest mound in the Americas for its epoch; like Pampa de las Llamas/Moxeke, Sechín Alto and associated sites demonstrate large-scale site planning (Pozorski and Pozorski, 1987). At Pampa de las Llamas/Moxeke, this plan extends across 2 km, uniting a temple mound (Moxeke) with a monumental storeroom (Pampa de las Llamas) along a central axis of symmetry (Pozorski and Pozorski, 1986, 1987).

A secondary focus of development occurred in the valleys around Lima (12°S), with sites such as Huaca la Florida (Patterson, 1985) and Garagay (Ravines et al., 1982) in the Rimac Valley and a series of mound sites in the Lurín Valley (Burger, 1992). Burger's work at three of the Lurín centres, Cardal (Burger and Salazar-Burger, 1991), Mina Perdida (Burger, 1992) and Manchay Bajo (Burger, 2003), showed that these mounds were built incrementally. Burger and Salazar-Burger (1991) argue that the Lurín mounds would not have required sufficient labour and central direction to justify attributing the sites to a complex society. This view contrasts with the Pozorskis' (1986, 1987) interpretation of the Casma Initial Period sites as evidence for an early state. Given differences in the size and complexity of sites in the two valleys, social complexity may well have been unevenly distributed along the coast at this time.

Regardless of the level of social complexity in the different valleys of the Peruvian coast, people living in many of the valleys between about 6°S and 12°S built mounds during the Initial Period, continuing the tradition begun in the Late Preceramic Period. At the end of the Initial Period, the 3,000 year sequence of coastal monument building came to a halt for at least several centuries at the same time that El Niño events increased in frequency (Sandweiss et al., 2001, 2007).

## Larger patterns in climate, catastrophe and culture on the Peruvian Coast

Over the time span of human occupation of coastal Peru, from about 14,000 years ago through the Spanish Conquest in AD 1532 and its immediate consequences, we see an intriguing pattern in the relation among demography, complexity

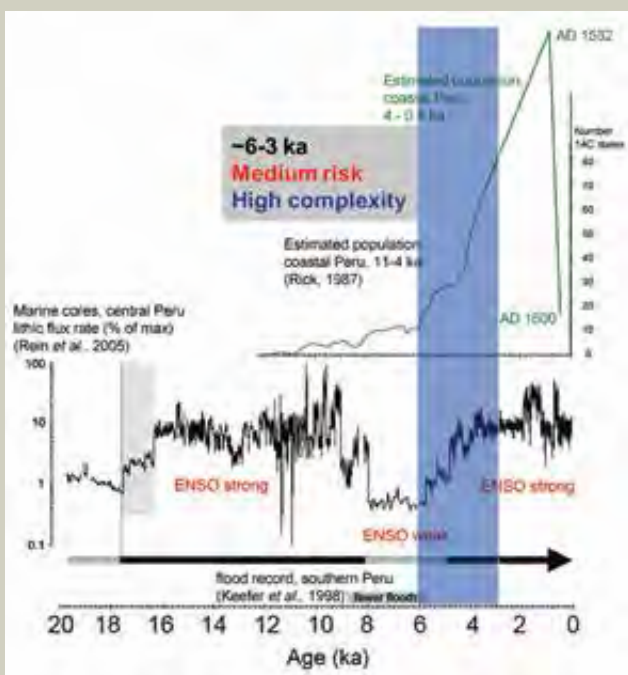


Figure 8. Population, risk, and complexity on the Peruvian coast, 6000–3000 BP. See figure 5.5 caption for sources. Figure drafted by Kurt Rademaker. Adapted from Sandweiss and Quilter (2012).

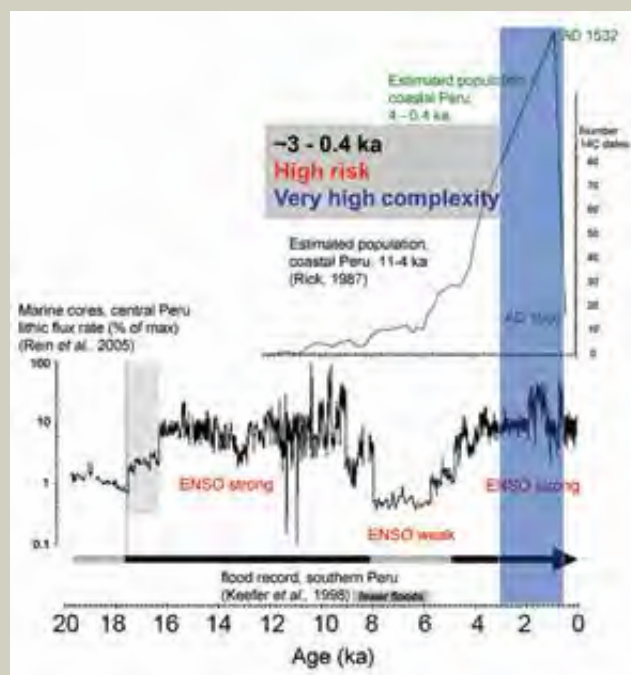


Figure 9. Population, risk, and complexity on the Peruvian coast, 3000 BP–present. See figure 5.5 caption for sources. Figure drafted by Kurt Rademaker. Adapted from Sandweiss and Quilter (2012).

and risk from disasters on the Peruvian coast. Through time, populations grew, though it is difficult to quantify prehistoric population levels. To substantiate our assertion of the direction and approximate rates of growth, Quilter and I (Sandweiss and Quilter, 2012) spliced and smoothed John Rick's (1987) radiocarbon date-based curve for the Preceramic Period (c. 13,000–3600 calendar years before present) with David Wilson's (1988) site survey-based curve for the coastal Santa Valley (~9° S) for the Initial Period through the Middle Horizon (c. 3,600 to 1,000 years ago, or 1600 BC to AD 1000).

For the final two prehistoric periods, the Late Intermediate Period time of the north coast Chimu Empire and the Late Horizon or Inca Empire (c. AD 1000–1532), Wilson's curve shows a population decline in the Santa Valley; however, he recognizes that continuity in the local ceramic tradition may mask the continued occupation of sites under Chimu and Inca domination. Considering ethnohistoric records relating to population at the time of the Spanish Conquest in AD 1532 (for example, Cook, 1981) and broader archaeological patterns (for instance, Moseley, 2001), Figures 6-9 show continued population growth through these final two prehistoric periods. The early historical record is very clear on the demographic disaster that followed the Spanish Conquest, with depopulation ratios of as much as 100:1 in less than a century for some coastal valleys (Cook, 1981).

The archaeological record shows a general increase in social complexity through time along the coast (for example, Moseley, 2001; Richardson, 1994). The earliest settlers were mobile or semi-sedentary hunter-fisher-gatherers (Sandweiss, 2014) who became sedentary shortly before 6,000 years ago, when they began to build large monuments. Despite fluctuation in monument building, such as the Supe case outlined earlier, the volume of construction and the nature of social and economic organization evidenced in the archaeological record and (for the latest period) in the ethnohistoric record show a general trend toward larger volumes and more complex arrangements.

The frequency of volcanism and tectonically driven earthquake and tsunami activity should not have fluctuated through the time of human occupation; these events do not have a regular recurrence interval but do recur at average rates through time that are independent of climate on a human timescale. In contrast, El Niño frequency did change throughout the period of human occupation of Peru (Keefer et al., 1998; Rein et al., 2005; Sandweiss et al., 2007) and we therefore use El Niño as our proxy for risk (Figures 6-9).

The following paragraphs summarise my colleagues' and my current understanding of the interplay between climate risk, population and social complexity for the Peruvian coast from first arrivals to the Spanish Conquest (Sandweiss et al., 2007; Sandweiss and Quilter, 2012):

From c. 13,000 to 8,000 years ago, El Niño occurred at an unknown frequency; we assess risk as high, but complexity and population were low (Figure 6). From c. 8000 to 6000 cal BP, few or no El Niño events took place, coastal waters were seasonally warmer than present in northern Peru and there was probably seasonal rainfall north of 10° S. At this time, population began to grow but remained low overall. Complexity increased as the first sedentary villages were founded. Risk was minimal (Figure 7).

From c. 6,000 to 3,000 years ago, El Niño events were strong but infrequent; coastal waters were cool along all of Peru. Complexity increased with the onset of large-scale monument building, evidence of different social classes at monumental centres and a diversifying economy. The rate of population growth increased notably (Figure 8).

From c. 3000 cal BP to present, El Niño variability fluctuated within the range of modern variability. Population grew rapidly until the Spanish Conquest in the early 1530s and then plunged precipitously. Complexity also increased, from state-level societies to large (ultimately pan-Andean) empires (Figure 9).

Though very broadly painted, this record shows that through the prehistoric era on the coast of Peru, increasing population and growing complexity were accompanied by ever greater risk from natural hazards. In stark contrast, the demographic collapse after the 1530s was not caused by natural disasters but instead resulted from human-induced disasters - warfare, economic and social disruption and disease (Cook, 1981; cf. Kiracofe and Marr, 2009). This pattern seems counterintuitive at first glance but may hold important lessons.



Figure 10. *Huaca Prieta, occupied from about 14,500 cal BP to about 2400 cal BP.*





Figure 11. Fish and mollusc remains at the Ostra Base Camp representing dramatically different climatic conditions between about 6250 and 7150 cal BP.

### Sites for Consideration for the Tentative List

The Peruvian coast has over 14,000 years of sites that offer unique and critically important information about ancient climate, catastrophe, culture and the correlations between them. Some of these sites are feasible for inclusion on the UNESCO Tentative List because they fit the following criteria for Outstanding Universal Value (World Heritage Centre n.d., paragraph 77, criterion iii): 'bear a unique or at least exceptional testimony to a cultural tradition or to a civilization which is living or which has disappeared; be an outstanding example of a type of building, architectural or technological ensemble or landscape which illustrates (a) significant stage(s) in human history (criterion iv); and be an outstanding example of a traditional human settlement, land-use, or sea-use which is representative of a culture (or cultures), or human interaction with the environment especially when it has become vulnerable under the impact of irreversible change (criterion v)'. They also concur with the narratives considered for the definition of Human Evolution Sites for consideration of the HEADS Programme: 'Sites important for the history of science, Sites related to human mobility, Colonization of new environments and dispersion, and Deposits useful for the reconstruction of palaeo-environments'. Below, I briefly review three sites or site complexes that fit one or more of these criteria.

Located on the modern shoreline of the Chicama Valley on the northern coast of Peru, Huaca Prieta (Figure 10), meets multiple criteria and narratives for Outstanding Universal Value. Junius Bird's (1963; Bird et al., 1985) excavations at the site in the 1940s constitute the first large-scale archaeological investigation of a preceramic site in Peru, so Huaca Prieta is a 'Site important for the history of science'. Bird's work also demonstrated links 600 km north to the coast of Ecuador before about 4000 BP, fulfilling the HEADS narrative of 'Sites related to human mobility'. Tom Dillehay's work at Huaca Prieta over the last decade has significantly added to the importance of the site and its feasibility for inscription on the Tentative List (Dillehay et al., 2012a, 2012b; Grobman et al., 2012 *inter alia*). First, Dillehay has demonstrated that the first occupation of the site dates to 14,500 BP, making it the earliest reliably dated site in Peru and one of the earliest in South America (Dillehay et al., 2012b). Therefore, Huaca Prieta fits the OUV criterion (iii) of being 'a unique or at least exceptional testimony to a cultural tradition or to a civilization which is living or which has disappeared'. Furthermore, faunal remains discovered in this early occupation



Figure 12. Quebrada Jaguay, an early fishing site dating from about 13,000 to about 8000 cal BP

demonstrate use of both marine and terrestrial resources. Therefore, Huaca Prieta fits the HEADS narrative of ‘Colonization of new environments and dispersion’. Plant micro- and macro-fossils and faunal remains offer information on past climate and environments as well as on past lifeways, so Huaca Prieta also fits the HEADS narrative of ‘Deposits useful for the reconstruction of palaeo-environments’ (see also Dennell, this volume).

Unlike most sites related to the peopling of the Americas, Huaca Prieta appears monumental. The site currently presents as a large, highly visible mound and the presence of this structure on top of the earliest deposits probably accounts for their preservation. Dillehay’s work has shown that monumental architecture, though initially small-scale, is as early as any found in South America (Dillehay et al., 2012a). Dillehay and his colleagues have also found evidence of the early adoption of domesticated plants, including maize (*Zea mays*) (Grobman et al., 2012). Finally, Huaca Prieta is in close proximity to monumental sites of later ages: 1) Huaca Cao Viejo (also known as El Brujo) belongs to the first millennium AD Moche culture and has been extensively excavated, revealing polychrome murals and the tomb of the Señora de Cao (for example, Mujica, 2007); 2) Huaca Cortada, also Moche, has a large looters’ trench but has not been scientifically excavated; and 3) Magdalena Vieja dates to the early Colonial Period (late 16<sup>th</sup> to early 17<sup>th</sup> centuries) and has been excavated scientifically (for example, Quilter, 2011). These sites together form a triangle with sides from 1 to 1.5 km, about 0.75 km<sup>2</sup>. For both of these reasons, Huaca Prieta fits the OUV criterion (iv) of ‘an outstanding example of a type of building, architectural or technological ensemble or landscape which illustrates (a) significant stage(s) in human history’.

Located just north of the Santa River along a palaeoshoreline (c. 8°50’ to 8°55’ S) (Figure 5), the sites of the Ostra Complex are critical in understanding the prehistory of El Niño. I reviewed these sites and their role in climate studies above. Our work at the Ostra Collecting Station and the Ostra Base Camp (Figure 11) led directly to the now well-accepted hypothesis that El Niño frequency has varied significantly through time (Sandweiss et al., 1996, 2001, 2007). Furthermore, at the time we first proposed a major change in Eastern Pacific climate dynamics in the Mid-Holocene (Rollins et al., 1986), the prevailing view of a climatically stable Holocene was just beginning to break down. The Ostra work thus contributed to the modern perspective that Holocene climate has been highly variable though not on the scale of Pleistocene fluctuations. Finally, the Ostra Base Camp produced proto-figurines related to Ecuadorian figurines from 700 km to the north but unlike anything known from Peru. At the time when the site was occupied, the coasts of northern Peru and southern Ecuador shared a similar warm water environment and the similarity of the figurines suggests a cultural connection (Sandweiss, 1996). For these reasons, the Ostra Complex fits the following OUV criterion (v) for inclusion on the Tentative List: ‘an outstanding example of a traditional human settlement, land-use or sea-use which is representative of a culture (or cultures), or human interaction with the environment especially when it has become vulnerable under the impact of irreversible change’. The Ostra complex also accords with the HEADS narratives of ‘Sites important for the history of science, Sites related to human mobility, and Deposits useful for the reconstruction of palaeo-environments’. Protection for the Ostra Complex is particularly urgent, as the major site (OBC) has been damaged by looting, irrigation and gravel mining, and it may not survive at all for much longer.

Located at 16°30’ S on the south coast of Peru, Quebrada Jaguay is one of the oldest fishing sites known in the New World (Sandweiss et al., 1998b; Sandweiss, 2003, 2014). Dating as old as 13,000 years ago during the Terminal Pleistocene, remains at the site show that the inhabitants were sophisticated maritime fishers and gatherers who targeted particular marine species, built rectangular houses, situated their camp for the efficient use of a wide variety of natural resources and either travelled to the adjacent highlands or maintained trade relations with people in the sierra. Quebrada Jaguay thus accords with the OUV



Figure 13. Pucuncho Basin, a high altitude wetland in the Andes of Arequipa Department in southern Peru, associated with Terminal Pleistocene occupations up to 12,500 years old. © Kurt Rademaker.

criterion (iii) of 'a unique or at least exceptional testimony to a cultural tradition or to a civilization which is living or which has disappeared'.

Rademaker et al. (2013) traced obsidian found at Quebrada Jaguay (Figure 12) to a specific source (Alca-1) near the Cotahuasi Valley of the highlands. In doing so, Rademaker identified six geochemically distinct sub-sources of Alca obsidian, the first time multiple sub-sources have been identified at an Andean obsidian deposit. He also found a series of early high-altitude sites in the Pucuncho Basin (Figure 13), about 150 km inland and uphill from coastal Quebrada Jaguay at elevations above 4000 MASL. Rademaker's excavations in one site, Cunchaicha Rock Shelter at 4488 MASL, have revealed the oldest high-altitude human occupation in the world. Basal dates are as old as 12,400 cal BP, during the Terminal Pleistocene (Rademaker, 2012; Rademaker et al., 2014; Sandweiss and Rademaker, 2013). Furthermore, Cunchaicha lies on the least-cost path from Quebrada Jaguay to the Alca-1 subsurface and has obsidian from Alca-1. These data suggest that Quebrada Jaguay and Cunchaicha were part of a multi-elevational, long-distance interaction sphere at the end of the Ice Age. For these reasons, Quebrada Jaguay and the Pucuncho Basin together fit the following OUV criterion (v) for inclusion on the Tentative List: 'an outstanding example of a traditional human settlement, land-use, or sea-use which is representative of a culture (or cultures), or human interaction with the environment especially when it has become vulnerable under the impact of irreversible change'. These linked sites and landscapes also fall under the HEADS narratives of 'Colonization of new environments and dispersion, Sites related to human mobility and Deposits useful for the reconstruction of palaeo-environments'. In this case, the sites/areas would be discontinuous but culturally linked.

## Conclusions

The Peruvian coast is a study in contrasts. Fertile valleys watered by streams from the adjacent Andes alternate with some of the starkest deserts on earth and contact with one of the world's richest fisheries. The region witnesses extreme environmental events - earthquakes, tsunamis and El Niño climate catastrophes - on a recurring if unpredictable schedule. Yet people settled this land over 14,000 years ago. Through time, populations grew and social complexity increased even as environmental risk also increased. This counter-intuitive pattern lends particular urgency to the study of coastal Peruvian prehistory, for surely it holds lessons for us in a time of burgeoning population and evermore variable climatic risk. If we are to harvest the lessons of antiquity in this core region, then we must preserve key sites such as those listed above.

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# The Outstanding Universal Value of the Monte Verde Site and a Comparative Analysis of the Authenticity and Integrity of the Site in a Regional Perspective

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## Introduction

Between 1976 and 1987, the author directed a large interdisciplinary research team to study the archaeological site of Monte Verde in south-central Chile (Figure 1). The site is an open air campsite on the banks of a small stream, surrounded by sandy knolls, small bogs and damp forests that have been there since at least 20,000 BP. The bog later developed in the stream basin, covering the abandoned site under a layer of peat. Because the lack of oxygen in the bog inhibited bacterial decay and because the constant saturation prevented drying for thousands of years, various types of organic materials that normally disappear from archaeological sites have been preserved. An interdisciplinary research team of more than sixty scientists studied the remains excavated from two areas at the site, called Monte Verde I and Monte Verde II. The results of this study were published in two large volumes by the Smithsonian Institution Press (Dillehay, 1989 and 1997) and more recently, in a single volume in the Spanish language (Dillehay, 2004).

A number of remarkable and unexpected finds were recovered at Monte Verde: not only stone tools and spear points (Figure 2), typical of several early South American sites, and animal bones of an extinct fauna, but also, a wide variety of plant remains and numerous wooden objects, hearths, the fallen remains of two tent-like structures (Figures 3 and 4), and human footprints (Figure 5). The organic remains indicate the importance of plants as well as animals in the inhabitants' diet. The existence of wood and wooden tools (Figure 6), more common at Monte Verde II than stone artefacts, provides an intriguing look at food items, technology and equipment rarely seen in late Ice Age archaeological records. All these remains indicate a variety of tasks, primarily food preparation and consumption, tool production and maintenance, and the construction and occupation of shelters.

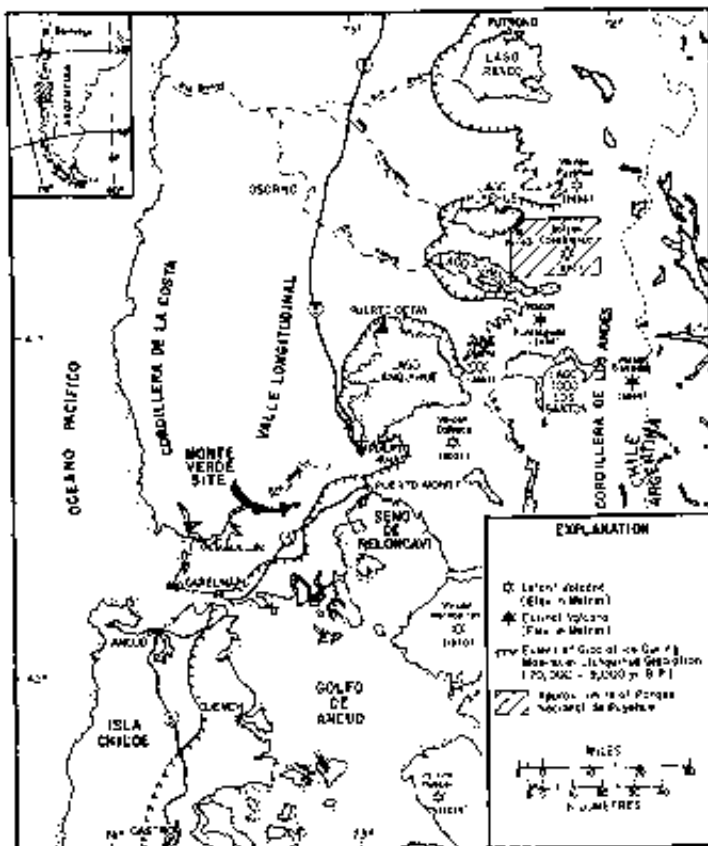


Figure 1. Location map of Monte Verde.

Monte Verde was the centre of considerable controversy for nearly 25 years, because in the 1970s it was in the wrong time and place to comfortably fit with the established understandings of when the continents were first settled, by Clovis hunters, about 11,200 years ago. Because of the hemisphere-wide significance of Monte Verde in reconstructing the Late Pleistocene human occupation of the New World, there was careful scrutiny of the Monte Verde data and interpretations. In 1997, the National Geographic Society sponsored a blue-ribbon panel of 12 archaeologists to visit the site and to study the excavated materials in order to confirm the validity of the Monte Verde II levels. The site was confirmed as being a legitimate pre-Clovis settlement and the results of this visit were published in 1997 in the Society's popular magazine, as well as in *Science* (Meltzer, 1997) and *American Antiquity* (Meltzer et al., 1997). The interdisciplinary research at Monte Verde and other early sites broke the foundations of what archaeologists had understood about how the Americas were populated, leading to the idea and eventual acceptance of a pre-Clovis occupation in the Americas (Meltzer, 2009). The implications have been massive: by helping to break down the Clovis barrier, the conservative





Figure 2. Projectile points of the Monte Verde II site.

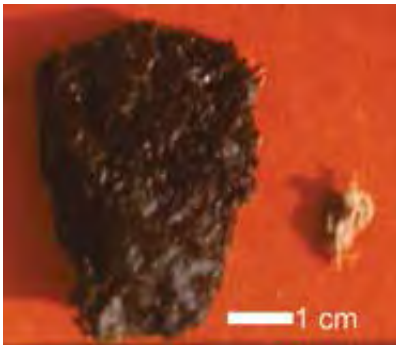


Figure 3. Preserved plant remains from Monte Verde II (various species of marine algae are on the left; a wild potato skin is on the right).



Figure 4. Wishbone-shaped structure in Monte Verde II.

Clovis school has had to reconsider its theory about the arrival of people in America (Pitblado, 2011). Although some minor controversy continues today, many more pre-Clovis sites have now been identified and are being much more seriously considered than they were before Monte Verde was discovered.

There are five reasons why Monte Verde is unique and valuable as an archaeological site.

Monte Verde is currently one of the earliest Late Pleistocene sites in all of the Americas, and it has been the most extensively worked from an interdisciplinary perspective.

It is the archaeological site that was pioneering in breaking the Clovis-first paradigm of the earliest peopling of the Americas, a paradigm that had dominated American archaeology for more than sixty years.

What makes the site important is not only related to the above two points, but Monte Verde is the only Late Pleistocene wet site that has been excavated to date in the New World. Not only are organic food and non-food remains well-preserved in the site, but two hut-like structures are present as well. These remains reveal a broad-spectrum diet of hunters and gatherers who were well-adapted to the cool temperate rainforest of the region.

Monte Verde also is significant because it has high archaeological integrity, meaning the site is geologically intact and has been subjected to very little disturbance that might have compromised its scientific validity.

In summary, it is the chronology, wide array of artefactual and ecofactual materials present, conservation and integrity, and historical paradigm-breaking role of Monte Verde that makes it unique and valuable to world cultural heritage.

Presented below are more facts about the cultural materials found at Monte Verde and the site's wider role in interpretative models of the first peopling of the Americas and in programmes of public education and outreach about early Americans.

### Life at Monte Verde as perceived through the material record

As mentioned earlier, Monte Verde II, dated about 12,500 BP radiocarbon years, exhibits the remains of a long tent-like structure made of wooden poles and animal hides. Several pieces of cordage and string made of reed wrapped around the poles and stakes holding them in place were recovered among the architectural remains. These data suggest that the people planned a lengthy stay. The tent's dirt floor was embedded with hundreds of microscopic flecks of hide tissue, suggesting that it was covered with animal skins. On the floor of the tent were brazier pits lined with clay and surrounded by stone tools and the remains of edible seeds, nuts and berries. Outside the tent were two large communal hearths, a store of firewood, wooden mortars and grinding stones and three human footprints near one of the large hearths. All of these remains indicate tasks, primarily food preparation and consumption, tool production and maintenance, and the construction of shelters.

The remains of a wide variety of local and non-local edible plants and a few bones of palaeo-llama (*Paleollama llama* sp.) also were recovered from the hearths, living floors and small pits. The presence of exotic foods, including ten varieties of seaweed and other items at the site shows that distant coastal and Andean mountain habitats provided important resources to the Monte Verde economy. Three different stone tool technologies existed at the site, including bifacial tools, unifacial implements and waste debris, and grinding stones. Also present were tools made of animal bones and wood, especially hardwoods that grow locally.

The second structure was wishbone-shaped in ground plan and made of wooden uprights set into a foundation of sand and gravel. Parts of gomphotheres (*Cuvieronius* sp.) carcasses were butchered, hides were prepared, and stone and wood tools were manufactured in and around the structure. Eighteen probable medicinal plants were found inside the structure. These activities suggest a public non-living area. This also seems to have been a place used for healing the sick. Eighteen probable medicinal plants were found in this structure - the same species the Huilliche people, who live in the area today, use to treat various diseases. Most of these medicinal plants were from the coast or across the Andean mountains from the Patagonian plains of western Argentina.

In addition to medicinal herbs, the remains of a wide variety of edible plants were recovered from the hearths, living floors and small pits inside the structures, along with the remains of mastodon, palaeo-llama, small animals (for example, rodents, birds, amphibians) and freshwater molluscs. Aquatic plants from the freshwater marshes and lagoons of the flood plain and from brackish marshes of the river delta provided the greatest variety and, along with meat and wild potatoes, the bulk of the Monte Verdeans' diet. Most of these ecological zones are located far away in the basin of the Maullin River to the north and along the Pacific shoreline or in the Andean mountains.

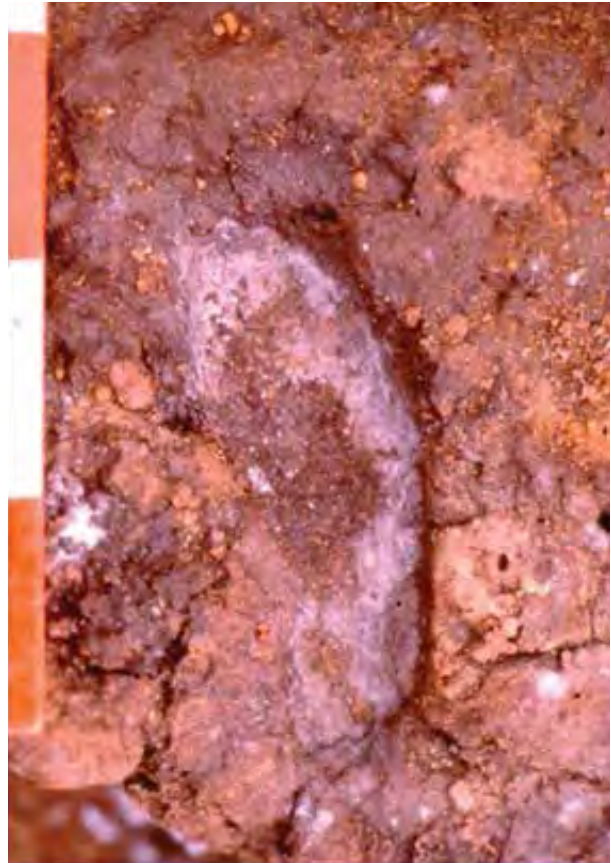


Figure 5. Human footprint from Monte Verde I.



Figure 6. Wooden artefacts from Monte Verde II.

The distinct living structures, features and concentrations of specific materials at the site suggest that the occupation was continuous and that portions of the site were used more intensively than others, particularly the long tent-like structure. Different kinds of artefacts give evidence of a wide variety of activities. A long sequence of radiocarbon dates on different organic materials from the site, place the Monte Verde II occupation at about 12,500 BP – more than a thousand years before Clovis.

Exploiting this wide range of resources from various environmental zones undoubtedly called for sophisticated knowledge and perhaps a division of labour. This also is suggested by the separation of the living from non-living areas at the site and by the association of distinct activity areas and living spaces with different tool types and food remains. The many different artefacts give evidence of a wide variety of living activities. There is also evidence for specific family or social unit tasks, special purpose activities, and spatial separation between domestic and non-domestic tasks. The internal division and size of the long tent suggest that a moderately large group of people had a mixed hunting and gathering economy focused on many different ecological zones in the area. All this evidence reveals a more complex social and economic organization than previously expected of early New World cultures.

In the deepest levels of Monte Verde, separated from the later 12,500 year settlement and buried in a different area of the site, we found a possible earlier occupation, Monte Verde I, with twenty-six stone tools and three burned clay features. Six of these are valid stone tools. Radiocarbon dates placed this possible occupation around 33,000 years ago. We hesitate to accept this older level without more evidence and without sites of comparable age elsewhere in the New World. Not enough archaeological and geological data were recovered from this area of the site to warrant a more detailed understanding. Until this site has been restudied and re-dated by radiocarbon assays and other dating techniques, this area of the site remains nothing but a possible human locale.

In addition to the Monte Verde site, two radiocarbon dates were obtained from the Chinchihuapi site, located 500 m upstream from Monte Verde. Excavations at the site in 1983 and 1985 yielded two unifacial flakes, one heavily modified spheroid and three pieces of burned and modified wood. A single piece of burned and cut wood was dated at 12,500 years ago, as well as an unburned sliver of wood, which dated at 11,800 BP. More archaeological work also needs to be done at this site.

In summary, there is no question that the younger Monte Verde II occupation represents a human settlement practising a generalized economy throughout most of the year. The archaeological evidence suggests that the settlement was formed by a group of exploratory or incipient colonizers who lived along the banks of the small stream. Although few contemporary sites have been found in the Americas, it is probable that the Monte Verdeans were part of a low-density colonizing population adapted to a cool, temperate wetland-and-forest environment in times of advanced deglaciation. In the end, Monte Verde II has made us question the accepted theory that all Ice Age people were nomadic big-game hunters, since the settlement was probably occupied throughout the year by at least a portion of its inhabitants, and they gathered a wide variety of plant and animal foods.

## Placing Monte Verde within a hemispherical setting

Much rethinking about the peopling of the Americas has taken place in recent years as a result of the acceptance of Monte Verde and other early sites, new discoveries across the Americas and in palaeoanthropology. Besides Monte Verde, several archaeological sites in both North America and South America have recently documented very early traces of human occupation (Adovasio, 2002; Adovasio and Pedler, 2010; Bryan, 1973; Dillehay, 2000; Dillehay et al., 2012; Dixon, 1999; Leon Canales, 2007; Meltzer, 2004). A few localities in the United States also have yielded convincing evidence of sites ancestral to the widely documented 11,200 year old Clovis culture, which is best known for its fluted bifacial projectile point and big-game hunting tradition. Meadowcroft Shelter in Pennsylvania, Cactus Hill in Virginia, Paisley Cave in Oregon, the Gault and Buttermilk Creek sites in Texas and a few others suggest that groups of generalized hunters and gatherers may have lived in these areas possibly as far back as 16,000 to 13,000 years ago (for example, Collins, 2002). These possibilities are supportive of the 12,500 year occupation at Monte Verde II in South America, because if people first came into the Americas across the Bering land bridge, we would expect earlier dates in North America. It also is likely that multiple early migrations took place and people moved along the edge of the ice sheets from Siberia to Chile (Dixon, 1999; Dillehay, 2000) and from northern Europe into eastern North America (Stanford and Bradley, 2013). Although remote possibilities, there also is discussion of possible influences from Africa and even Australia. For instance, some palaeoanthropologists believe that the oldest skeletal material from Brazil more strongly affiliates with ancient Africans and Australians than with modern Asians and Native Americans. This may suggest the presence of non-Mongoloid as well as Mongoloid populations in the Americas (for example, Neves et al., 2005; Steele and Powell, 2002; c.f. Perez, 2011). There also are new databases provided by genetic studies over the past several years (for instance, Schurr, 2004) that have added to our insights into the peopling process.

### Climates, environments and human adaptations

Taken together, these early finds from across the Americas reflect early human adaptations to a wide variety of changing environments and climates of the late Ice Age. What we know about these adaptations largely depends on the quality and preservation of the archaeological and palaeocological records at sites (for example, Ackert et al., 2008; Borrero, 2003, 2007; García, 2003; Heusser, 2003). The preservation of organic remains is a key factor that allows a reconstruction of the local climate and environment of each site. This reconstruction especially depends on the specific species of floral and faunal remains preserved in sites, which make the Monte Verde site particularly important because all types of organisms are present, including animal bones and soft tissue, plants remains, diatoms, insects, pollen and so forth. The presence of this wide diversity of organisms at Monte Verde has allowed a more precise interpretation of the type of climate and environment that the Monte Verde people adapted to. Based on the data recovered from the site, we know that the climate at the time of its occupation was slightly warmer and wetter within a cool temperature rainforest, similar to that of south-central Chile today.

From a wider perspective, major changes in vegetation communities have taken place over the past 18,000 to 10,000 years. During the period from 13,000 to 10,000 years ago, for instance, when most American environments were likely inhabited by humans, temperatures were generally warmer in the summer and cooler in the winter, and rainfall was increasing. Patchy heterogeneous biotic zones were shifting to broadly homogenous mosaics with new and different mixtures of plant and animal species. In contrast to many interior regions, the coastal areas displayed a combination of higher and more reliable and greater ecological diversity. These features may have been particularly desirable as cold and arid conditions reduced ecological productivity over much of the extreme northern and southern latitudes of the Americas, but even in some of these areas human occupation may have intermittently concentrated in short-lived warming episodes. In the high Andean mountains, for example, this is indicated by the pulsing of occupation at several caves and rockshelters and the abandonment of some areas (Dillehay, 2000). This also may have been the case at Monte Verde. The cool temperate rainforest of south-central Chile was subject to intermittent periods of cold and cool climates, accompanied by vegetation changes that facilitated or possibly even inhibited human adaptation to the area, particularly in the Andean mountains east of Monte Verde where glaciers existed until about 16,000 years ago.

Regional geological evidence shows that although glacial moraines came within 5–6 km of the Monte Verde site, they never covered the site or inhibited human movement to and from it. As determined by palaeoecological studies at Monte Verde and other sites across the Americas, a major factor determining expansive ice sheets in some regions, changing sea levels, mammal extinction, regional biotic restructuring and the movement of Late Pleistocene fauna, flora and people was climatic change. Although glacial ice sheets greatly affected the routes available to early migrants in the higher latitudes of North America and the southern Andes, they had little to no effect on the middle and lower sections of North America, all of Central America and most of South America. During the terminal Pleistocene, sea levels were 70 or more metres lower than at present, and the Pacific and Atlantic shorelines were considerably farther out than their present position. As the continental ice sheets melted and retreated, the oceans rose and inundated most of the continental shelves. Most early archaeological sites along old shorelines have thus been destroyed or inundated by water. Widespread extinctions also accompanied these changes, particularly the loss of more than 30 genera of large mammals. It is not known whether climatic change, human overkill or both led to the extinction of some species (c.f. Martin and Klein, 1984; Grayson and Meltzer, 2003). (Two megafaunal species were present at Monte Verde in the form of bone, hide and soft tissue remains. Presently not known is why they became extinct in the area, although it is likely due to both factors, that is, human overkill and changing climates).

Taken together, the palaeoecological and archaeological evidence is still a long way from accurately transforming palaeoclimatic data into statements about economic resource productivity, availability and reliability during the Late Pleistocene period, which would be of value to archaeologists in reconstructing past human lifeways (Flegenheimer et al., 2006; Lavallée, 2000; Lavallée et al., 1999; Gnecco and Aceituno, 2006; Massone, 2005; Miotti and Salemne, 2004; Vialou, 2005). On both a regional and local level, climatic shifts must have greatly influenced human land and resource use patterns, resulting in differential patterns of archaeological site location, abandonment and occupation, and artefact content and structure (Kelley, 1995). Yet climatic factors, such as ice sheets, rainfall and aridity, are only one among several (for example, technology, social alliances, perceived alternatives by people) influencing decisions to occupy or abandon parts of a landscape and how the archaeological record of each landscape is studied and preserved.

To conclude this section, it is my belief that the first migrants into the Americas adapted to many different environments quickly, creating a mosaic of contemporary different types of hunters and gatherers (such as big-game hunters, general foragers, coastal foragers) immediately after they entered new environments. A key issue is not just the rate of migration and adaptations but rapid social change and a steep “learning curve” across newly encountered environments, that is, adaptation of technological, socioeconomic and cognitive processes over several generations (c.f., Dillehay, 1997, 2000, 2004; Meltzer, 2004). As the early archaeological records of South America and parts of the eastern United States suggest, this was not a single unitary process, but many. While hunter and gatherer groups were settling into one new environment, others were



probably just moving into neighbouring areas for the first time. Others probably stayed for longer periods in more productive environments. All of these processes must have begun sometime before 13,000 years ago in order to produce the types of technological and economic diversity reflected in the archaeological record (Bryan, 1973). The record left behind by these processes is characterized by variable site sizes, locations, functions, occupations, artefact assemblages and internal structures that collectively reflect different human adaptations to different environments, of which Monte Verde represents only one case of these processes.

## The peopling process

From a hemispherical perspective, there is archaeological evidence that by 13,000 to 11,000 years ago people had colonized most broad environments in the Americas, such as deciduous forests, coasts, tropical rain forests, cold steppe and shrub grasslands, and deserts. With the exception of eastern Beringia (Alaska and Yukon Territory) in the far north-west, firm evidence for early colonization of the northern boreal forests and tundra of Canada is still lacking, although promising evidence comes from Bluefish Caves where modified bones suggest early human habitation around 20,000 to 15,000 years ago. Another series of early sites is found in the Nenana Valley of Alaska that date between 11,500 and 11,000 years ago. Thus, it appears that by at least 11,500 years ago, people with similar tool technologies moved from western to eastern Beringia and thus became some of the first people to have entered the New World. It is not known whether these people migrated farther south through ice-free corridors or followed the Pacific coastline. Further, the lithic industries from these areas appear to have little resemblance to Clovis stone tools. By 11,200 years ago, there is widespread evidence of the Clovis culture throughout the middle sections of North America and in parts of northern Mexico. Clovis and other fluted-point traditions are widely distributed in the eastern United States and Canada at the Vail, Bull Brook, Shoop, Shawnee-Minisink, Debert and other sites. In west-central North America, along the eastern slopes of the Rockies and on the southern plains, Clovis and Folsom sites are common. Studies in the Plains and Southwest deserts reveal parallel or sequential point traditions associated with hunting economies, especially big-game in open terrain. These also include Clovis followed by several regional point styles such as Folsom, Midland, Goshen and Plainview. Clovis is much less frequent in the far western United States where stemmed points are associated with varying hunting and gathering economies (Dixon, 1999; Meltzer, 2009).

Although generally perceived as a big-game hunting tradition, not all Clovis and other fluted point sites support this notion. Better preserved than plants, faunal remains suggest that any idea of a single Late Pleistocene economy is unrealistic. For instance, at Meadowcroft Shelter and other early woodland sites in eastern North America, both Holocene and Late Pleistocene faunae are dominated by small and medium-sized animals, perhaps reflecting greater environmental stability in the eastern woodlands and earlier extinction of mega-fauna. If so, then human populations may also have been better able to maintain themselves in these mixed woodland habitats than elsewhere. In fact, Meltzer has proposed that rather than being specialized big-game hunters, Clovis and later fluted point makers were generalized foragers, particularly in the eastern woodlands and southern areas where the environment was more diversified than northern latitudes. The rather uniform forest cover in the eastern United States would have been conducive to generalized foraging populations. These groups probably foraged over the landscape, repeatedly moving their campsites as resources in their immediate area were depleted. Generally, these sites are small in size, represent short-term occupations and contain expedient lithic assemblages designed for generalized economies that exploited a wide range of plant and animal food types. In the eastern United States, formal, curated tools tend to be infrequent at such sites, as is the use of high-quality stone material, unless it outcrops locally.

In contrast to North America, the fluted point tradition played a minor and late role in the peopling of South America. Instead, a wide variety of unstemmed and stemmed point and unifacial industries associated with broad spectrum economies are found in many regions from at least 12,500 to 11,000 years ago. In the Andes and in the eastern tropical lowlands, many caves and rockshelters were occupied intermittently from at least 11,800 to 11,000 years ago, especially in eastern and central Brazil and in extreme southern Patagonia. It is not known whether this pulsing of rockshelter occupations is simply an artefact of climatic change or simply human patterns of social and economic change. Strong similarities in the dates of occupation pulses as far apart as 1,000 km, however, implicate climatic processes operating on subcontinental scales. The surviving evidence of recently discovered human occupation of the Amazon basin and other forested areas may be no more than a small sample of the populations that once concentrated there and elsewhere.

The current evidence from South America is clear: early technological and economic developments show cultural diversity at the outset of human entry and the establishment of ever increasingly distinct regional economic combinations on the coast and in highland Andean valleys. Although the current evidence is still too scanty to discern the specifics of these developments in all environments, two general transitions can be inferred. The first was a change in adaptive strategies and organizational abilities during and at the end of the Pleistocene period. This transition signifies the rapidly increasing ability of people to recognize the environmental potentials that existed in coastal wetlands, desert oases, intermontane valleys, lowland river valleys and

high altitude puna grasslands, to communicate these potentials to others and to take advantage of them and to develop the social organization required to exploit resources in a wider variety of compressed environments. Second, early people probably learned many hunting and gathering techniques, and on occasion employed them to domesticate some plants (for instance, squash, chili peppers, *Chenopodium*) and to begin a semi-sedentary or sub-territorial lifestyle in some areas by at least 10,000 to 9,000 years ago. With the exception of only two sites in South America - Taima-Taima in Venezuela and Tagua-Tagua in Chile - there is no hard evidence to show that hunting was the mainstay of the earliest known South Americans (Lavallée, 2000). Instead, most early South Americans employed a generalized, or proto-Archaic, economy (Dillehay, 2000) that was associated with expedient tool technologies and territorialism.

Another dimension of Late Pleistocene subsistence throughout the Americas remains difficult to investigate though the evidence of older sites suggests that marine foods also were exploited. Changes in sea level and occupation hiatuses at several coastal sites in Chile (Huentelafquen, Quebrada de Las Conchas) and Peru (Quebrada Tacahuay, Quebrada Jaguay, Quebrada de los Burros) during the 11,000 to 10,000 year period mean that earlier marine-oriented sites may exist on submerged continental shelves (for example, DeFrance and Alvarez, 2004; Dillehay et al., 2008; Jackson et al., 2007; Keefer et al., 1998; Sandweiss et al., 1998). Freshwater and brackish fish also were taken in northern Peruvian Paijan sites dated around 10,500 years ago and in several early sites along rivers in eastern Brazil (Chauchat et al., 2003; Dillehay et al., 2003; Dillehay, 2000). Similar evidence is being retrieved from several sites along the submerged shelves of Florida and the state of Washington in the United States.

In my opinion, these patterns may help to explain the rise of later complex societies in some areas of South America where we know that large nomadic hunter-gatherer bands eventually settled down to establish productive food economies and dynamic social systems by 10,000 to 9,000 years ago (Dillehay, 2000). Not known are the conditioning factors that brought about these changes in regional settings. The archaeological evidence for a broad-spectrum economy is weak in some areas. Only in the past twenty years we have come to realise how widespread this type of economy was in the Late Pleistocene of the eastern woodlands of the United States and especially along the Pacific coast, lowland tropical forests and northern Andean regions of South America (Stohtert et al., 2003; Balter, 2007). This is probably a result of better recovery techniques (for instance, flotation studies) to find new foods, which have opened archaeologists' minds to the idea that not all early people were big-game hunters. Examples of 'new' foods are the thousands of snails recovered from Paijan sites on the north coast of Peru; the variety of seeds, nuts, soft leafy plants, tubers and seaweeds recovered from residential floors at Monte Verde; and the abundant remains of palm nuts and other plant types found at several caves and rockshelters in Brazil dating between 11,600 and 10,000 BP. Despite these new foods, other groups developed economic practices that relied on a specific species, for instance, hunting high quantities of camelids (guanaco) or a few other species on the high puna or tundra of the Andes. This evidence from South America jointly confirms a Late Pleistocene human past somewhat distinct from that of North America.

### Monte Verde and public outreach

Today, Monte Verde is preserved and protected by Chilean law, which in 2008 declared the site as a national historical monument. I am currently working with the same interdisciplinary research team that excavated the site in the late 1970s and 1980s to build a site museum where the artefacts will be permanently housed and where the site will be duplicated in life-size form to reconstruct the activities carried out by the Monte Verdeans nearly 12,500 years ago.

We also have established dialogues with indigenous groups in southern Chile (Mapuche, Huilliche, Chilota) to listen to their ideas about Monte Verde and about the meaning of the site to them. The idea is not to treat the site as a dead or past history, but also as a past lived everyday in the present. Indigenous people in the forested region where Monte Verde is located still exploit the same kinds of economic resources (except for the extinct animals) that were hunted and gathered 12,500 years ago. To these people, sites like Monte Verde are not dead or inert, but live in their cultural memory and in their everyday practices. To them, their ancestors still live and walk about in sites. As a result of the indigenous interest in Monte Verde and other archaeological sites, we have shared the scientific information that we have collected from the site with them. We also have sought their interpretations of the site and their opinions of our interpretations of it.

Although we have always shared our experiences at Monte Verde with the public and with indigenous communities, the increased dialogue and communication that we have had with them has significantly enhanced our understanding of Native American concerns, of the archaeological record in general and of our relations with indigenous communities. I will explain briefly:

Only a few years ago, there was a broad notion within the discipline of archaeology and bio-anthropology that to acknowledge the interests of indigenous people would compromise the integrity of science. The scientific position was that close relations

with indigenous groups and their concerns might limit archaeological fieldwork and require the return of excavated materials to local communities. Many archaeologists believed that science was objective, neutral and for the benefit of all, while the religious and political claims of indigenous people were sectarian, subjective and for the benefit of few.

However, as the years have passed more and more archaeologists have changed their ideas and have begun to work much closer with indigenous groups. Increasingly, indigenous voices are being heard, in dialogue with archaeologists.

As part of the sweeping changes in the discipline, we have obtained scholarships for Huilliche and Mapuche students to study anthropology at the Universidad Austral de Chile in order to establish an indigenous-regulated archaeology that makes more use of their concepts of time, space and the material world in the excavation of sites and in the interpretation of archaeological remains. From the perspective of these students, 'the scientific objective measuring and recording of sites is combined with their living past.' As a result of these changes, our practice of doing archaeology has changed considerably in the past few years, especially where we are excavating on or near indigenous lands. We have formed partnerships with indigenous communities to study the past from the perspective of the 'past still living.' This new perspective has opened up the possibility of other kinds of archaeological practices, 'archaeologies' done by and for the Huilliche and Mapuche. Our research at Monte Verde and the dialogues we have established with indigenous peoples has given a more meaningful historical context to the site.

In recent years, the research team also has begun to play an important role in developing cultural heritage and ecological tourism at Monte Verde, which involves looking at the site from a local, regional, national and international perspective. The new focus on heritage tourism already is realizing positive impacts that include building community pride among local indigenous groups, enhancing the community's sense of identity, contributing to community stability, providing employment opportunities and ensuring that not only Monte Verde but other cultural and historic sites are preserved and maintained. An outgrowth of this is the development of long-term public support for protection of resources by engendering appreciation and understanding of the value of other cultural resources, providing the exchange of information necessary for the successful adaptation of visitors to the site environment and developing support for policies and programmes that incorporate the protection/preservation of resources as a fundamental part of their management and use.

To conclude, the contribution that Monte Verde has made to Chilean culture and history was recognized by Chile's use of the site as the official emblem, or Sello Bicentenario, to symbolise the country's bicentennial, which the nation celebrated in 2010. This is an honour that we are proud of.

## Epilogue

The old models for understanding worldwide changes taking place in human societies from the Late Pleistocene and to the middle Holocene periods have been altered significantly in the light of new archaeological evidence and new ways of thinking about these changes. For instance, recent studies have shown that not all Pleistocene peoples were highly mobile, big-game hunters but also territorial foragers subsisting on a wide variety of local foods. It also is becoming clear that plant and animal domestication, sedentism, crop production, social complexity, population growth, environmental stress and new technologies such as pottery do not constitute a coherent package of changes which drove each other progressively forward in the manner once envisioned by Lewis Henry Morgan and Gordon Childe. The new global picture is becoming a highly regional one of fluid, multi-velocity, even reversible changes. We now see similar kinds of innovations that took place independently at different places and times across the globe. Processes we once thought of as 'switches' and 'triggers' often unfolded at a gradual pace stretching over centuries or millennia. People tried new food producing strategies and then rejected some or all of them and returned to a foraging strategy, or they aggregated in or disaggregated from sedentary communities. We like to think that the evidence from and the research at Monte Verde has helped to change this thinking and to set a new course toward interpreting the human past.

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## Primeras evidencias arqueológicas y la ecología de paleopaisajes en Patagonia

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### Resumen

A diferencia de las ciencias que llevan mucho más años de desarrollo o abordan problemas relativamente simples y constantes, la arqueología, como disciplina histórica y centrada en un agente tan flexible e impredecible como el ser humano, genera un conocimiento muy dinámico, en cambio permanente. Ningún sitio, por famoso que sea, resiste el paso del tiempo. Las técnicas con que se estudió ya están superadas y la importancia de las ideas que generó reside, muchas veces precisamente, en su posterior revisión.

La siguiente discusión, por ende, pretende ir más allá de los sitios clásicos para considerarlos meros hitos simbólicos y puertas de entrada para discutir procesos tan interesantes y sujetos a frecuentes cambios en el conocimiento, como son los referidos al poblamiento y dispersión de los seres humanos por el continente americano.

Por su mismo carácter de llamativos, estos sitios suelen ser los primeros en estudiarse (con técnicas en gran parte obsoletas) y estar muy alterados por lo que hoy se privilegia: la investigación de muchos sitios menores en los alrededores, procurando documentar una amplia gama de actividades en grupos muy móviles, las que están reflejadas en diversos contextos. La mera cantidad de sitios que se excava actualmente, la complejidad de sus análisis, la velocidad con que cambian sus interpretaciones y valoración, y la multiplicidad y dispersión de medios informativos, obstaculizan su conocimiento y aceptación masiva.

Dado que la arqueología patagónica ha florecido en los últimos años a la par del desarrollo de este nuevo paradigma, es claro que todos los sitios (e incluso los hallazgos aislados) son igual de importantes.

Ya que la UNESCO quiere precisamente destacar las narrativas que hacen un sitio interesante más allá de su atractivo evidente, y dado que estas narrativas exceden cualquier sitio en particular, esta revisión toca además contextos menores, desconocidos para el gran público y que han sido estudiados con enfoques interdisciplinarios modernos.

Ya que casi todos los contextos arqueológicos tempranos en Patagonia corresponden a ambientes esteparios al este de los Andes, también discutimos sitios que son evidencia del poblamiento inicial en el litoral Pacífico o en ciertos espacios marginales, pese a ser posteriores a la transición Pleistoceno/Holoceno, ya que el proceso de dispersión humana por la Tierra —foco del programa HEADS— no termina entonces.

### Patagonia y el problema de los primeros americanos

Aunque corresponde al extremo meridional del continente americano y en consecuencia al territorio más distante de la supuesta vía de entrada inicial<sup>1</sup> —o tal vez por eso mismo...— Patagonia (fig. 1) ha jugado un rol central en las discusiones sobre el poblamiento inicial del "Nuevo Mundo".

Recién se había zanjado la polémica de Clovis o la coexistencia del hombre con megafauna pleistocena extinta en Norteamérica, cuando, en 1936, Junius Bird excavó la que pasó a llamarse "Cueva Fell", cerca del Estrecho de Magallanes. Con los limitados conocimientos entonces disponibles, bastó la presencia de huesos de animales extintos con puntas bifaciales semejantes a las del paleoindio norteamericano para relacionar ambos fenómenos y suponer que eran más o menos contemporáneos, cosa que vino a ratificar el ulterior desarrollo de la datación radiocarbónica. Ese temprano descubrimiento despertó una serie de preguntas que siguen resonando hasta el día de hoy: si las primeras evidencias humanas al sur de los

<sup>1</sup> Sea terrestre o costero, el arribo por Beringia cuenta con un respaldo empírico muy superior al de otras hipotéticas rutas, aunque hay una minoría que las defiende.

hielos revelan la llegada del ser humano a América un poco antes, ¿cómo avanzaron tan rápido? ¿O no es más bien una invitación a considerar que pudieron llegar mucho antes?

Cuarenta años más tarde, otro descubrimiento austral vino a revolucionar el pensamiento y las discusiones sobre el poblamiento inicial de América. Otro arqueólogo norteamericano descubrió e investigó el sitio abierto de Monte Verde, defendiendo con muy buenos argumentos no sólo una antigüedad mayor de lo aceptado por la mayoría, sino que abriendo los ojos hacia el estudio de sistemas basados en gran medida en una dieta vegetal y una tecnología de la madera y –sobre todo– a una gran diversidad, más allá de los cazadores de grandes presas en espacios abiertos semidesérticos estudiados (¿o susceptibles de estudiar con las técnicas entonces disponibles?) tradicionalmente. Aunque convencionalmente esta área no se considera parte de Patagonia, no hay dudas al menos que se encuentra en sus límites, muy próxima a ella.

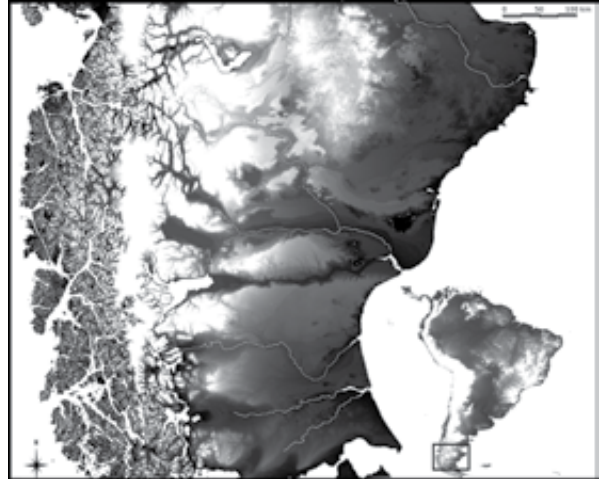


Figura 1. Mapa de Patagonia.

Que documentar otros contextos alrededor de un sitio “clásico” es considerado hoy un criterio fundamental para su evaluación explica los recientes esfuerzos por descubrir y excavar sitios aledaños a Monte Verde, que es lo que se está haciendo en los mismos momentos en que se escribe esto (Pino et al., 2013, reexcavaciones en MV con especial énfasis en sitios aledaños como Chinchihuapi). Lejos de ser “marginal”, esta información no sólo ayuda a entender el sitio tradicional sino que aporta información adicional, contribuyendo a entender el sistema de vida de un grupo humano, que siempre abarca mucho más que un sitio (sobre todo si se trata de poblaciones cazadoras-recolectoras, por lo general más móviles que los agricultores).

### Los sitios “clásicos” y famosos como faro para guiar la búsqueda de sitios alrededor

Los estudios en Cueva Fell (figura 2) fueron excepcionales ya que, de hecho, desde un principio la investigación se centró en varios sitios y Bird (1988, p. 212) incluso creyó encontrar en Cerro Sota los cuerpos de los mismos individuos que habían vivido en Cueva Fell. En su intento por excavar y relacionar varios sitios vecinos, se vislumbra un interés por entender la vida de los seres humanos, más allá de un sitio en particular.



Figura 2. Vista Cueva Fell.

Este esfuerzo —típico de la arqueología moderna— se ha expandido a todo el campo volcánico, donde hoy se reconocen una veintena de contextos excavados (figura 3; Borrero y Charlín, 2010). Aunque la mayoría de ellos siguen siendo cuevas u otros reparos rocosos, y testimonian ocupaciones mucho más recientes, varios yacimientos finipleistocénicos han entregado valiosa información acerca del contexto medioambiental y en especial de otros mamíferos que convivían (y competían) con el ser humano, en una compleja interrelación que ha sido detectada también en sitios donde hay claras evidencias antrópicas, como Cueva Fell o Pali Aike (Martin y Borrero, 2010).

Los niveles inferiores de Cueva Fell han sido datados en  $11.000 \pm 170$  AP (I-3988) y revelan un énfasis inusual en el uso de puntas “cola de pescado”, orientadas a la caza del guanaco (*Lama guanicoe*). Pese a que lo más llamativo<sup>2</sup> son los restos de fauna extinta, y aunque parece lo más probable que se haya consumido al menos (aunque no cazado) milodón (*Myodon darwini*), las evidencias de ello son muy discutibles, al igual que en el sitio de Pali Aike, localizado a unos 20 km.

2 Y antes del desarrollo de la datación radiocarbónica lo único disponible para definir una ocupación fini-pleistocena.

Las evidencias más tempranas halladas al oeste, en la región de Última Esperanza (figura 4) capitaneada por la famosa Cueva del Milodón (figura 5) hablan de un sistema de vida algo distinto.

Si bien las puntas cola de pescado son semejantes y suelen agruparse en un mismo sistema (Massone y Prieto, 2004), el énfasis estuvo puesto en esta área en la caza del caballo americano (*Hippidion saldiasi*), que también se encuentra como presa en los sitios de la región volcánica discutida antes, pero en proporción mucho menor. Al igual que allí, la relación con el tan famoso milodón es, por decir lo menos, poco clara (Borrero et al., 1991). Aunque es indiscutible que los seres humanos llegaron a la zona cuando este gran endentado todavía era relativamente común, no hay evidencias claras de su consumo. En Alero Dos Herraduras, los restos de milodón se encuentran embebidos en cenizas volcánicas producto de la erupción del Volcán Reclus, hacia el 10300 AP, fenómeno que pudo ser decisivo en la declinación y eventual extinción de este animal. El registro fini-pleistoceno de esta zona se asemeja también al de la zona de Fell y Pali Aike en que la gran mayoría de los refugios rocosos (ej., Cueva Lago Sofía 4; Alero Chico) entregan evidencias de animales como grandes felinos (*Panthera onca*, *Smilodon* sp.) u osos (*Arctotherium* sp.), que competían por alimento y espacio vital con los humanos, quienes rara vez podían ocupar las cuevas que aquellos usaban como madriguera.

Otro ejemplo de un sitio "clásico" que en la perspectiva que da el tiempo se valora sobre todo por su rol en llamar la atención sobre el registro circundante, es la cueva 2 de Los Toldos en la altiplanicie central de Santa Cruz. En un radio de unos 250 km de este sitio, se conocen hoy una gran cantidad de yacimientos fini-pleistocénicos u holoceno tempranos, incluyendo localidades tan importantes como Piedra Museo (Miotti, 2004) o La María (Paunero, 2009).<sup>3</sup>

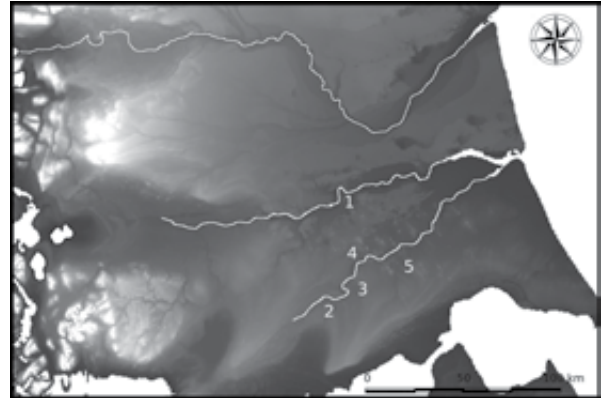


Figura 3 Mapa Campo Volcánico Pali Aike (Cueva Fell y alrededores)  
1. Río Gallegos (Las Buitreras, Abrigo de los Pescadores)  
2. Río Chico (Fell, Laguna Sota y varios otros) 3. Don Ariel  
4. Markatch Aike 5. Pali Aike, Cueva de los Chingus  
(Barberena, 2008, p. 267).

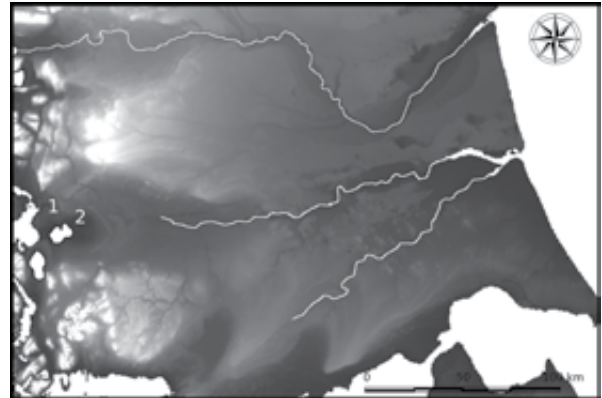


Figura 4. Mapa Última Esperanza (Cueva del Milodón y alrededores) 1. Lago Sofía (varios) 2. Cerro Benítez (Cueva del Milodón, Cueva del Medio, Dos Herraduras, Cueva Chica, Cueva de la Ventana y varios otros).



Figura 5. Vista Cueva del Milodón.

3 Muchos de estos sitios son de hecho tanto o más llamativos que las cuevas del Cañadón de Los Toldos, pero son menos conocidas que las que se excavaron primero, cuando la arqueología era relativamente rara y todos se informaban por unos pocos medios (véase Mena, 2002).



Excavada inicialmente por Menghin (1952), Los Toldos pasó a representar para la Patagonia argentina una proyección del paleoindio norteamericano, parecido a lo que había sido Fell más al sur y en territorio chileno. Los trabajos posteriores de Cardich —aunque realizados en otro sitio del mismo cañadón (Los Toldos 3)— agregaron además el dato sensacional de la fecha más antigua de Patagonia. A pesar de que su calidad ha sido muy discutida, hoy hay varias fechas procedentes de algunos de estos sitios menos conocidos que permiten afirmar que este sector fue poblado por primera vez por el hombre hace unos 13.000 años o quizás 14.000 años (ca. 15.500 cal BP; Prates et al., 2013). En otras palabras, la fecha puede no estar tan errada, pero fue dada a conocer en razón de su sensacionalismo, pese a su falta de rigor. Nuevamente hicieron falta trabajos serios en sitios menos publicitados para aceptarla.

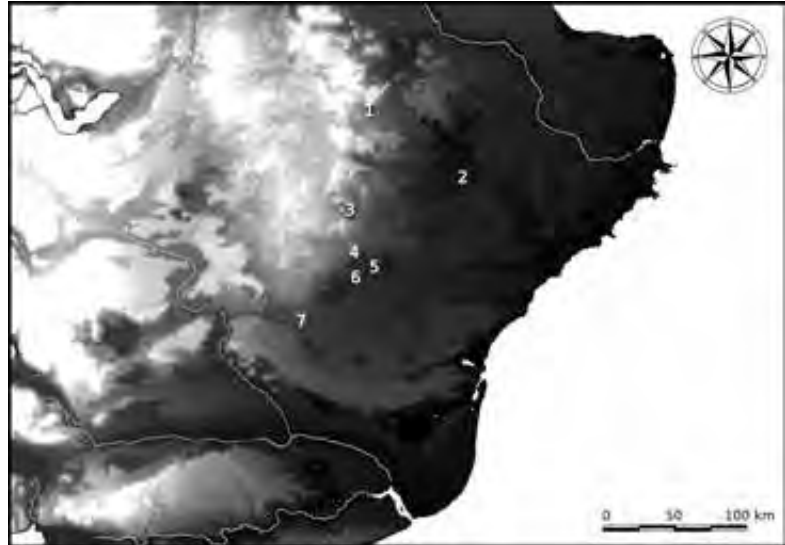


Figura 6. Mapa Meseta Central de Santa Cruz (Cuevas de Los Toldos y alrededores): 1 Los Toldos (varios); 2 Piedra Museo (varios); 3 Cerro Tres Tetas; 4 Tunel; 5 El Ceibo; 6 La María (Casa del Minero y varios otros); 7 La Gruta.

Uno de estos sitios es Alero El Puesto 1 (AEP1; conocido muchas veces como “Piedra Museo”, aunque hoy que se han excavado tantos sitios en esa localidad es conveniente llamarlo por su nombre particular), donde se han reconocido dos bloques cronológicos, ofreciendo una de las evidencias más convincentes de que efectivamente hubo una primera oleada poblacional (que quizás no llegó al pie de las estribaciones andinas al oeste) con una estrategia de caza oportunista y grandes artefactos unimarginales previos al desarrollo y difusión de las puntas “cola de pescado”.

## Ecología de paleopaisajes en la transición Pleistoceno/Holoceno

Hoy existe bastante evidencia de que ya había seres humanos en Patagonia hace unos 12 mil años y —aunque hemos aprendido que nunca detectamos “lo primero” y no podemos descartar futuros hallazgos más antiguos— es poco probable que los primeros ocupantes hayan llegado hace 20 mil o más años. Estos primeros exploradores (¿correspondientes tal vez al bloque temprano reconocido en AEP1?) debieron ser grupos relativamente pequeños por lo que —para ser genéticamente viables— no deben haber avanzado rápidamente ni separarse mucho de sus grupos de origen. Es muy probable que sus efímeras huellas se encuentren profundamente enterradas (y difíciles de detectar en un territorio poco alterado por obras que implican excavación), sobre todo si —como los grupos paleoindios norteamericanos— rara vez ocuparon cuevas. Es también posible que las evidencias más antiguas se hallen bajo el mar, puesto que cuando gran parte del agua líquida que hoy llega al océano estaba apresada en los casquetes glaciares continentales, la costa Atlántica se extendía varias decenas de kilómetros hacia el este. Particularmente intrigante es el que no se hayan encontrado sus restos esqueléticos, problema común a todo el continente americano, donde excepcionalmente se han encontrado a partir del 9000 AP.<sup>4</sup>

Es entonces también cuando se observa una tendencia más o menos sostenida<sup>5</sup> hacia un clima más templado y húmedo, que alcanza su culmine hace unos 5 mil años. Aunque no se pudo generalizar a este enorme territorio y los estudios en marcha revelan que cada zona tuvo sus particularidades, ésto puede relacionarse con una fase de colonización efectiva o estabilización. Antes, en lo que podemos llamar una fase exploratoria o de colonización inicial, el paisaje experimentó cambios importantes.

4 Los restos de Baño Nuevo (Reyes et al., 2012), siendo los más antiguos documentados a la fecha en Patagonia (Borrero, 2008), no reflejan un evento poblacional exploratorio y deben representar individuos separados por varias generaciones de los primeros pobladores del continente. No sabemos si esta ausencia se debe a prácticas funerarias destructivas o a que simplemente no se ha buscado en los lugares adecuados.

5 Sin duda hay variaciones menores aunque significativas a la escala de un actor humano.

Si bien es cierto que en lo general el relieve fundamental se mantuvo inalterado (ej. la cordillera de los Andes ya estaba plenamente emergida y constituía —como ahora— un verdadero “biombo climático”) y los glaciares ya se habían retirado hacia el oeste, hubo lagos donde hoy no existen, los existentes estaban mucho más altos y muchos de los que hoy drenan al Pacífico, lo hacían hacia el Atlántico. Así como debió haber caudalosos ríos actuando como “barreras relativas” u obstáculos a la movilidad, no existían otros tan importantes como el Estrecho de Magallanes, que era otro gran lago separado de los mares por lenguas de hielo y morrenas transitables (Sugden et al., 2005 y artículos varios en el mismo volumen). Cuando los seres humanos ingresaron por primera vez a Patagonia, éste era un territorio muy inestable y muy diferente del actual. Aparte de que existían —como hemos visto— algunos animales que se extinguieron durante este largo periodo de inestabilidad y cambio post máximo glacial (ej. milodón, paleolamas, oso chico, tigre dientes de sable, una subespecie del jaguar, caballo americano<sup>6</sup>) había especies que hoy se encuentran en otras latitudes (el *Rhea americana*, vicuña) y de que el paisaje era diferente del actual, con un clima predominantemente frío y una vegetación dominada por estepas incluso donde hoy existe bosque deceduo, hay factores más locales que es necesario considerar. Así, por ejemplo, la erupción explosiva del volcán Reclus en Última Esperanza (Moreno et al., 2012) o la sequía registrada en el Campo Volcánico Pali Aike hace 9.300 años (Zolitschka et al., 2013) definen un contexto especial para entender el proceso de extinción de la megafauna y en general el “escenario” activo en que vivieron (y ayudaron a construir...) los primeros humanos en la zona.

### Procesos de colonización post-Pleistocénicos

Si bien el poblamiento de Patagonia se inició en las estepas orientales y quizás en la costa atlántica, en este momento de grandes transformaciones hace unos 12 o 13 mil años hubo algunas zonas que se poblaron mucho más tarde.<sup>7</sup> Es el caso, por ejemplo, de los archipiélagos y canales de la Patagonia occidental.<sup>8</sup>

Aunque los recursos costeros en el Atlántico o el Estrecho fueron explotados oportunistamente desde temprano<sup>9</sup> (si bien aumenta en intensidad en los últimos milenios; Castro y Moreno, 1998, Barberena, 2008) la evidencia disponible revela que ya había poblaciones canoeras hace unos 6.500 años en el canal Beagle (Orquera y Piana, 1984), la zona del mar de Otway (Legoupil, 1997) y el Estrecho de Magallanes (Morello et al., 2012) que aparentemente se desarrollaron poco antes. A pesar de que los descubrimientos en el extremo norte de los canales patagónicos son un poco más recientes (Ocampo y Rivas, 2004; Gaete et al., 2003), es inevitable sospechar de la simple hipótesis de una rápida migración de sur a norte, que es lo que suele postularse con base en la información disponible (Legoupil y Fontugne, 1997). Sea donde sea que surgió la adaptación canoera, es claramente posterior a la colonización pedestre de Patagonia oriental y no puede relacionarse de ningún modo con una presunta “ruta costera” de poblamiento, que tiene un respaldo creciente (ej. Dixon, 1999). Algunos extremos de este mundo insular fueron ocupados por primera vez por el ser humano aun más tarde. La isla de los Estados, las Wollaston y el archipiélago de Cabo de Hornos, por ejemplo, debieron ser pobladas recién hacia el 2000 AP (Legoupil, 1993).

### Reflexiones finales

El hecho de que en Patagonia —a diferencia de en la mayoría del continente— hayan sobrevivido cazadores-recolectores hasta hace relativamente poco tiempo, constituye una bendición y una maldición a la vez. Aunque sin duda es un privilegio poder tener acceso a crónicas, fotos y hasta películas de grupos con una tecnología y economía que ofrecen información útil para entender los sistemas prehistóricos, existe también el riesgo de las comparaciones directas y la proyección acrítica, como si los pueblos históricos documentados por los ojos “occidentales” fueran fósiles vivientes, congelados en el tiempo.

En ausencia de diseños cerámicos o textilera, a los arqueólogos no nos queda más que rescatar y analizar piedras, huesos, conchas o excepcionalmente un pedacito de cuero o cestería que nos hablan de la esfera más estrecha de la economía o la ecología: la subsistencia. Cuando nos enfocamos en los primeros pobladores, muchas veces no tenemos ni el arte rupestre. Es tentador, por ende, rellenar los vacíos con analogías etnográfica simplistas y esencialistas.

6 Aunque sea un desvío un poco fuera de lugar, creemos importante aclarar que en estas latitudes nunca hubo mastodonte, ni menos mamut.

7 Y algunas que no se poblaron (ej. las Islas Malvinas) ni talvez se pueblen jamás (ej. los Campos de Hielo). De igual modo, es engañoso generalizar acerca de cuándo se pobló América, porque es muy diferente Beringia al norte de los hielos, las actuales praderas de Estados Unidos, el altiplano o las islas del Caribe...

8 Así como de los bosques montanos, que representan un desafío tal a la investigación arqueológica, que ni siquiera es prudente aventurar nada.

9 No podemos descartar que la intensidad de este uso costero haya variado también de norte a sur, aunque su detección y estudio está muy afectada por la ingresión marina del Holoceno medio.

El desafío es ir más allá de comparaciones anecdóticas de elementos y buscar principios generales a un nivel estructural. Desgraciadamente, esos mismos principios generales son lo que quisiéramos detectar a través de las observaciones. En un sistema tan complejo e impredecible como aquel que es blanco de nuestro interés (seres humanos flexibles y no optimizadores en un ambiente cambiante y espacialmente diverso del que forman parte...) debemos necesariamente navegar lo mejor que podamos en un laberinto donde deducciones e inducciones se retroalimentan.

Una recomendación que siempre será útil, sin embargo, es procurar huir del fenómeno aislado, prestar atención a la mayor cantidad y variedad posible de datos y procurar una mirada integradora. Muchas veces el elemento más modesto resulta clave cuando se ve en esta perspectiva, como ejemplifica en la misma arqueología patagónica los excrementos de milodón que guardó Bird y que luego sirvieron para datar el sitio del mismo nombre y estudiar la dieta de este animal y la vegetación circundante. Lo mismo pasa con los sitios menores y menos llamativos.

La ciencia consiste en buscar patrones y hasta "leyes" detrás de la descripción. Aunque ambas se complementan, la biología ha pasado de la historia natural a la ecología evolutiva. Nos ha costado mucho mirar más allá del sitio. El desafío es saber volver a verlo como símbolo de un proceso y una historia que lo rebasa y le da sentido.

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# Spatial Demarcation of Archaeological Population Cores in Southern Patagonia

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## Abstract

The archaeological record of southern Patagonia between the Atlantic and the Pacific coasts can be characterized as spatially discontinuous. This discontinuity cannot be explained as a result of differential sampling efforts or differences in archaeological visibility. The distribution of rock art, stable isotopic values on human bones and maritime items is used to demarcate two different core populational areas used during the last 4,000 radiocarbon years. The distribution of tools made on known lithic sources offers independent evidence supporting that demarcation. The core zones are separated by one ample zone, where archaeological evidence is minimal or even non-existent for long stretches. The eastern population is concentrated on the Pali Aike Volcanic Field, while the western population is located along a relatively narrow longitudinal band that goes from the south of the Argentino Lake to Última Esperanza. This recorded Late Holocene distinction probably is a result of the divergent populational history of southern Patagonia.

## Introduction

The southern tip of South America is configured like a relatively narrow peninsula (Morello, 1984). It originally included the island of Tierra del Fuego, which at the beginning of the Holocene was cut off by the post-glacial rising sea level (McCulloch et al., 2005).

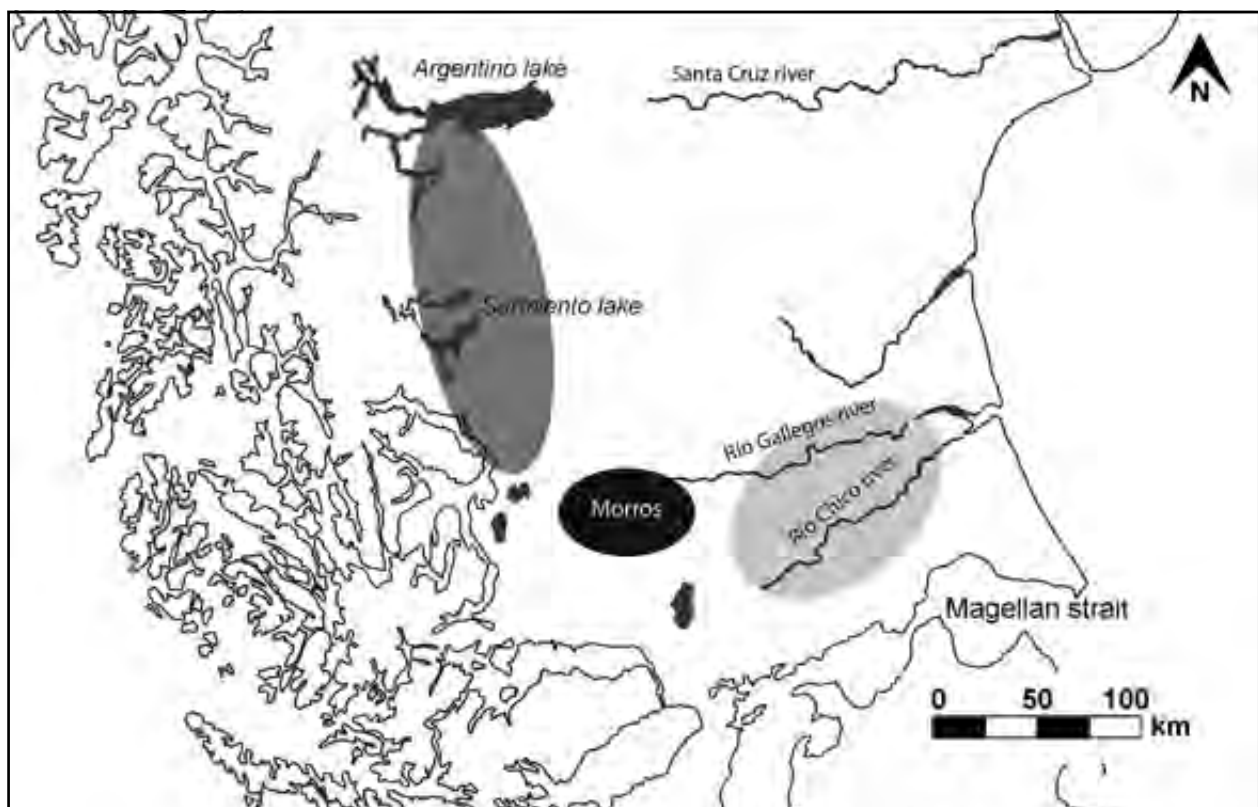


Figure 1. Map. Light grey marks the Pali Aike Volcanic Field, black marks the region of the 'morros' and dark grey the longitudinal band near the Cordillera that goes from the south coast of Argentino Lake to Última Esperanza.

The earliest archaeological record in the southern extreme of the continent is not abundant. Two groups of sites are located in the Pali Aike Volcanic Field and in an area near the Cordillera in Última Esperanza, in the west. Between these two clusters of sites is an extended plain of more than 150 km dotted by a few buttes, locally known as 'morros'. This plain is largely devoid of archaeological manifestations. The archaeology from those two areas attests to the clear presence of humans approximately during the period 11,000-10,000 BP. These early inhabitants were characterised by their use of projectile points known as fishtail or Fell Cave and other lithic tools. They were found in close association with hearths and the bones of extinct horse (*Hippidion saldiasi*), *Mylodon* sp. and camelids, particularly guanaco (*Lama guanicoe*) (Nami, 1987; Bird, 1988; Prieto, 1991; Martin, 2013). Cut marks on some of the bones are proof of their exploitation, but it is not always clear how they were acquired by humans (Martin, 2013).

Moving forward in time several thousand years, the archaeological record of the late Holocene of the same regions again displays two widely separated groups of sites. One difference with the previous period is that now the frequency of sites is higher in both regions. Accordingly, their distribution covers much wider areas. While the Pali-Aike sites were still restricted to the volcanic field (Charlin, 2005), the findings at Última Esperanza were extended to the North to include the Cordón Baguales, the south coast of Argentino lake and parts of the eastern steppes. Importantly, the separation between both regions still exists and it is at least 100 km wide, marking the existence of a significant piece of land where archaeological manifestations are scarce and even absent for long stretches.

Thus, the archaeological record of southern Patagonia between the Atlantic and the Pacific coasts can be characterised as spatially discontinuous on a regional scale. The importance of this discontinuity was such that the idea that the distribution of the historical Aonikenk was restricted to the eastern region was entertained (Gómez Otero, 1991).

The environmental and geographic characteristics of the areas where the two clusters of sites are located are quite distinctive. Pali Aike is a volcanic region where more than 400 volcanic apparatus are identified (D'Orazio et al., 2000). Precipitation is around 200-250 mm/year and the vegetation is mostly steppe with patches of shrubs. The archaeological record is relatively abundant in caves, lava tubes and craters, both in stratigraphy and on the surface (Martin et al., 2011). The western region, closer to the Cordillera, is more varied, including plateaus, pampas, the mountains of the Cordón Baguales and smaller hill systems. The archaeological record is less abundant than in Pali Aike. Precipitation is higher than in the eastern steppes, reaching 350-500 mm/year. The vegetation is characterised by the extensive presence of forest. Farther west the maze of the archipelagos is characterised by much higher precipitation, in the order of >5000 mmm/year (Endlicher and Santana, 1988).

The archaeological record in this maritime zone is sparse (Legoupil and Sellier, 2004; Maire et al., 2009).

It may be the case that the richness of the archaeological record of Pali Aike is a result of its higher archaeological visibility. Effectively, at Última Esperanza most of the findings are in caves and the forests of the hill systems make it difficult to find sites. In spite of this, moderate field efforts produced some evidence of the presence of prehistoric humans at Cancha Carrera (Pallo and Borrero, 2015), the eastern end of Baguales (Borrazzo, 2008).



Figure 2. South America with the region of the buttes indicated by a rectangle. Transformed from Borrero et al. 2011.

### The region of the buttes

The northern hinterland up to the middle basin of the Gallegos River, an area near the ecotone between the western forests and the eastern steppes, is characterised by the presence of four buttes that interrupt a basically flat landscape.

On the basis of the decline in the abundance of archaeological remains, it can be sustained that the zone of the 'morros' presented extremely low population densities in prehistoric times. It can be seen as a relatively unused area, perhaps not used residentially. It may well be that we are just dealing with an area away from one or more core areas of intensive human use. It is an area of mesic steppe that even when exposed to seasonal changes in the availability of resources, possess a relatively high carrying capacity (Mazzoni and Vázquez, 2010). The resources are the same that are present both east and east of the buttes region.

The originally known archaeological record of the intermediate zone includes:

1. A concentration of lithic tools near Laguna Condor (Gómez Otero, 1991).
2. Funerary assemblages located above each of the four buttes (Ortiz Troncoso, 1973; Bate, 1982; Prieto, 1984). The number and frequency of rare offerings in these burials is higher than usual in the region. Red ochre-embedded silex bifaces were found associated with a multiple burial at Morro Philippi (H. Roehr, pers. comm.; Ortiz Troncoso, 1973). The silex is not local, is very rare in the region and has only been found at Bahía Santiago 2 on the coast (Prieto, 1993–1994) and Mala Cueva on Pali Aike (Martin and San Roman, 2010). A decorated/carved lignite pendant was found with the human skeletal remains at Morro Chico (Prieto, 1984).
3. Concentrations of surface findings at places with soil erosion at Estancia Rincón de los Morros (Molinari, 2000) and at Little Hill (Carballo Marina et al., 2008).

In sum, only four funerary and three surface loci were known in the region of the 'morros'.

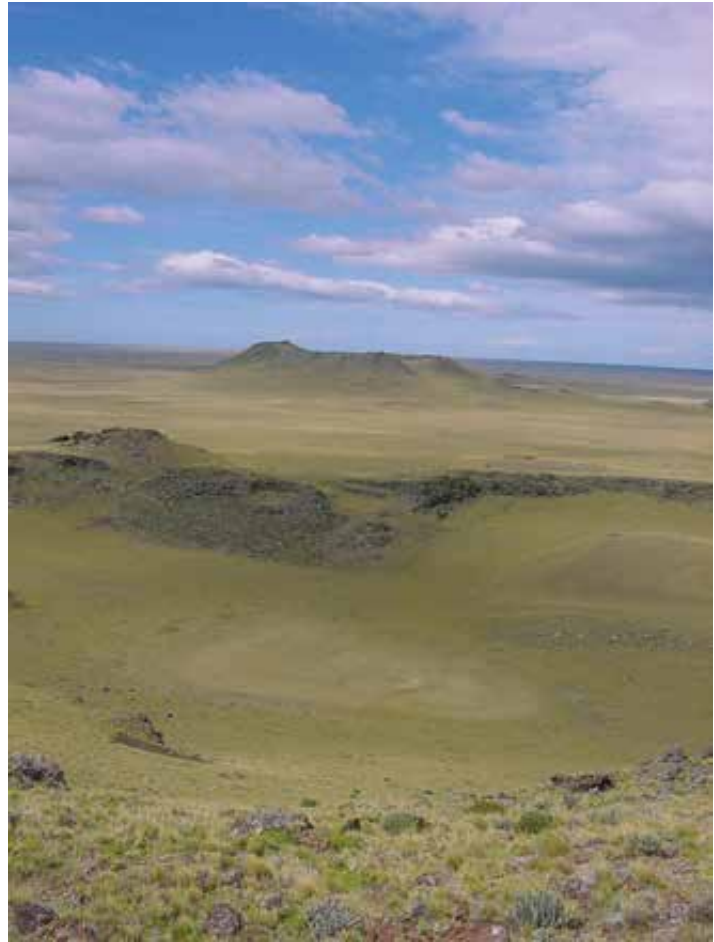


Figure 2. Pali Aike Volcanic Field.

## New results

Intense field efforts were made searching for archaeological manifestations in the area separating both clusters of sites. Using a regional taphonomical approach, searches took advantage of exposures like natural cuts produced by wind, streams or recent anthropic activities and places with high visibility in general. Locations with severe erosion were specifically selected (Mazzoni and Vázquez, 2010, p. 362). Systematic random transects were implemented at those places, which were complemented with intensive searches at selected places. In spite of all these efforts, the archaeological record of the intermediate zone continues to be small. Thus, it appears that these discontinuities cannot be explained as a result of differential sampling efforts or differences in archaeological visibility.

Our search at estancias Stag River, Santa Ana, Glencross, Morro Chico and Rincón de los Morros, clearly showed a highly discontinuous distribution of archaeological materials, with many empty quarters and few focal clusters of artefacts. In fact, most of the area displays no archaeological evidence at all. This results not only from our own work, but also from the results of other archaeologists (Gómez Otero, 1991) and amateurs, especially the latter, who failed to find tools after decades of search. Again, even when our work produced a few new discoveries (Charlin et al., 2011), none were substantial. Only limited concentrations at Puesto Aserradero and isolated findings were added west of the most eastern previously known findings - those of Laguna Córdor and morro Philippi -. The absence of an archaeological record at Stag River and extensive sectors of Estancias Santa Ana and Glencross, as well as in the area near Río Turbio implies the existence of ample areas where no archaeological evidence was ever recovered.

Our work at places which are still characterised by the presence of patches of *Nothofagus* forests produced archaeological assemblages and isolated findings at Puesto Aserradero (Estancia Santa Ana). These assemblages located N and NW of the intermediate zone are characterised by a completely different technology from that observed both at Laguna Córdor and Pali Aike. In contrast, the occupations at Laguna Córdor are better explained as a result of logistical exploitation from Pali Aike in the east. The distribution of rock sources selected for tools confirms this (Charlin, 2009a; Charlin, et al., 2011). Additionally, from these places access to forest resources like huemul (*Hippocamelus bisulcus*) or wood was possible. It is clear that both localities were part of different annual foraging ranges.

As already mentioned, the concentration of archaeological remains at Laguna C ndor, morro Philippi and areas nearby at Estancia Glencross suggest a redundantly visited place, perhaps under a logistic mode of exploitation. Effectively, relatively abundant artefacts were recovered at eroded places on the NW coast of Laguna C ndor and at the north slope of morro Philippi. The available radiocarbon dates indicate that they reflect late historic occupations, probably during Aonikenk times (Martinic, 1995). At that time, the settlement of cacique Mulato was located at the Zurdo basin, some 30 km from Laguna Condor before moving to the middle Coyle River (Childs, 1936; Martinic et al., 1995). An alternative to logistic exploitation is circulation, but the distribution of lithics and technological studies do not support this interpretation.



Figure 3. The Guillermo River, near Cancha Carrera.

### Regional lines of evidence

The point now is to evaluate to what extent both core areas can be considered independent. In order to discuss this we have developed a number of independent lines of evidence.

The importance of maritime protein in the diet varies with the distance to the coast. There is an abundance of coastal items including molluscs and sea mammals in sites near the eastern mouth of the straits of Magellan (Borrero and Barberena, 2006). The distribution of molluscs, seal and whale bones is ubiquitous in Pali Aike (Borrero and Barberena, 2006), while it is only restricted to the western part of the  ltima Esperanza region (Laming-Emperaire, 1972). It is clear that there was a degree of interaction between Pali Aike and the coastal zone (Barberena, 2008). In the case of  ltima Esperanza, the Pacific Ocean is clearly the origin of these items, whose presence was only detected within a narrow coastal band. This situation led to the so-called Dual Hypothesis (Borrero et al., 2006), in which human circulation in  ltima Esperanza is marginal both in relation with the lands east of the mountains and with the western archipelagos (Legoupil, 2000). In contrast, there is a gradual decrease in the abundance of marine remains as one moves from the coasts of the Strait of Magellan toward the hinterland (Borrero and Barberena, 2006).

Stable isotopes on human bones also present a clear-cut spatial pattern. They indicate mixed diets in both the coast and the hinterland (Barberena, 2002). This pattern changes approximately 30 km from the strait, where stable isotopes on human bones uniformly display a fully terrestrial diet (Barberena, 2002; Borrero et al., 2001, 2009). Again, the evidence for the Atlantic coast indicates a more widespread utilisation of marine resources. The consumption of maritime resources is recorded to some extent in Pali Aike, where practically every site displays some evidence of interaction with the ocean. In many cases the marine items appear as burial goods, but there is at least one important exception. The archaeological site of Orejas de Burro 1 can be considered as a place where the transport of marine mollusc, some 20 km inland, for consumption occurred (L'Heureux, 2008).

Rock art is one of the many markers that can be used to map the distribution of archaeological human populations (Charlin and Borrero, 2012). There is a general similarity of the rock art recorded at both the western and the eastern extremes of the study region, but there are specific trends in the ratio of certain types of motifs. Figurative motifs - anthropomorphs and zoomorphs - are more abundant in Lago Argentino, near the Cordillera. Dots and dotted geometric figures predominate in  ltima Esperanza, also near the Cordillera. In contrast, lines and lineal geometric figures are the most important motifs in Pali Aike (Charlin and Borrero, 2012).

Information about the provenance of rocks used for artefacts is also available (Charlin, 2009a). Green obsidian is abundant at Morro Domeyko (Prieto, 1993–1994) and Morro Chico (Stern and Prieto, 1991). This obsidian is completely foreign to the steppe regions and can only be obtained in the channels area, at least 120 km to the west (Morello et al., 2004). Other



obsidians also show distinct patterns (Franco, 2008; Charlin, 2009b). The distribution of other lithic raw materials used for the manufacture of different tools, their exploitation intensity and the technological strategies in general are also different mainly between Lago Argentino and the Pali Aike region (Franco, 2008; Charlin, 2007). In Lago Argentino the dacite is both the most abundant and the most exploited rock for the manufacture of artefacts, while several types of fine grained dark rocks are usually selected at Pali Aike despite being relatively scarce (Charlin, 2007, 2009a, 2009b).



Figure 4. 'Morros' Philippi and Domeyko.

Lithic technology also presents some differences (Pallo and Charlin, 2010). The same types of small and medium triangular stemmed projectile points -

which functioned within different weapon systems (Ratto, 1994) - were used in both regions (Franco et al., 2005; Cirigliano, 2011), although differences in the selection of rocks are known (de Azevedo et al., 2014, p. 204). There are also important differences in the lithic assemblages from these regions (Franco, 2002; Franco et al., 2004; Charlin, 2009a; Charlin et al., 2011). A trend of reduction in artefact diversity is observed from the coasts of the straits of Magellan toward the hinterland (Charlin and Cardillo, 2010: 94).

There are also important differences in settlement patterns. Both the size and intensity of occupations are larger at sites in Pali Aike (Barberena, 2008). It is possible that the pattern of occupation near the Cordillera was affected by seasonality (Borrero et al., 2006; Borrazzo, 2008; Pallo and Borrero, 2015).

## Conclusions

Summing up, there are a number of markers indicating relatively independent archaeological concentrations that we interpret as evidence of the existence of two populations: one occupying Pali Aike, with regular connections with the maritime zone and the other near the Cordillera, more focused on terrestrial resources (Borrero and Charlin, 2010; Charlin et al., 2011). It is clear that both regions display quite distinct archaeological signatures and constitute non-overlapping spatial units. The main difference between both populations is derived from their location. One is near the Cordillera ecotone, offering access to resources like grey obsidian, huemul or wood, while the other is on the eastern steppe, with better access to ocean resources. The concept of relative isolation, in which no strict barrier exists, makes sense in this discussion (Broodbank, 2008). Different patterns of stable isotopes from human bones, lithic artefacts and settlement patterns suggest that there are also different non-overlapping extended annual ranges. The area near the Cordillera appears to be less connected with the coast than the area of Pali Aike, where the presence of different kinds of maritime items and the degree of reduction of some lithic raw materials from the coast point to a more typical relationship with the coastal area (Borrero and Barberena, 2006; Charlin, 2007, 2009a).

Finally, the existence of extensive intermediate zones where archaeological remains are not abundant is significant. The '*morros*' probably were significant natural landmarks for humans. We know that they were selected for burials and that these burials were often accompanied by offerings, which included art productions. However, the region where these '*morros*' are located presents limited evidence of subsistence oriented occupations. These occupations can be better explained as a result of logistical exploitation. The archaeological evidences indicate that this intervening space appears to have interacted more with Pali Aike and correspondingly with the sea. Moreover, all the available chronological evidence indicates that the process of utilisation of the region of the '*morros*' took place very late during the Holocene, more probably during historic times (Borrero et al., 2011; Charlin et al., 2011). The evidence is not strong, but it can be the case that these populational cores are the result of divergent evolution that started within a relatively homogeneous colonizing population at the end of the Pleistocene.

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# The Mitochondrial Genome and the Origin of Native Americans: Structuring Variability in South America's Initial Settlements, Moving Forward Toward Integrated Research Approaches

**Nelson J. R. Fagundes**

*Departamento de Genética – Instituto de Biociências – Universidade Federal do Rio Grande do Sul – Porto Alegre, Brazil*

## Abstract

The mitochondrial DNA (mtDNA) is perhaps the most widely studied genetic marker in human populations. Due to its fast mutation rate and lack of recombination, it provides a straightforward way of identifying different genetic lineages and their associated geographic distributions. In the case of Native Americans, the five founding lineages originally identified based on the sequence of mtDNA 'control region' – a short and hyper variable segment of less than 1,000 base pairs – have been recently expanded into more than ten lineages thanks to the increased resolution provided by complete mtDNA genome sequencing. 'Pan-American' lineages, that is, those occurring all over the Americas, seem to have undergone a strong and fast expansion, possibly around 15 thousand years ago (kya), which is usually associated with a fast migration southwards following the Pacific coast. Nonetheless, there is a general lack of strong genetic structure between North and South America, which is illustrated by the fact that most founding lineages entering the Americas through Beringia eventually reached South America. In this sense, mtDNA studies tend to make inferences on migration routes based on haplotype frequency in different geographic regions. However, inferring such a process from mtDNA alone is problematic. Sampling issues aside, because all mtDNA genome is non-recombining, it gives us a single genealogy, which in turn tells us a single history. Because a single genealogy can be highly influenced by stochastic processes, the major problem is that this specific history may not be representative of the true population history we are trying to reconstruct. To overcome these issues, it is important to use multilocus (or genomic) approaches to study the peopling of the Americas and, more specifically, the peopling of South America. Large genetic datasets, such as those composed by microsatellites (STRs) or single nucleotide polymorphisms (SNPs) genotypes in many individuals across a wide geographic area are good alternatives to mtDNA in understanding the evolutionary history of human populations. On a broad geographic scale, these approaches are helping us to understand the strength of genetic exchange between Native Siberian and Native American populations suggesting that a 'single wave' model is too simplistic to explain the Peopling of the Americas properly. This general conclusion seems to be robust across different analytical frameworks, including model-free analyses or approaches based on explicit evolutionary scenarios. In conclusion, those of us interested in the peopling of the Americas have learned important lessons from mtDNA in the last decades. However, a necessary next step is using multilocus analyses to refine our understanding about migration routes and population structure, more specifically in South America.

Mitochondrial DNA (mtDNA) is probably the most studied molecular genetic marker in animals, including humans. Since the initial descriptions of how and when all living human populations shared a common ancestor in the past (Cann et al., 1987; Vigilant et al., 1991), mtDNA in general, and its control region (mtDNA-CR) in particular became the genetic markers of choice for other studies. Of course, there are many reasons for this. MtDNA is relatively easy to characterize as it is present in several copies in every cell type having mitochondria, and it is thus much easier to extract and amplify mtDNA than nuclear markers. It lacks recombination, which is difficult to model and complicates several evolutionary/population genetic analyses. In addition, as only women can transmit it to the offspring, it has a smaller effective population size compared to autosomes (one quarter, to be precise), which makes it easier to detect genetic structure among populations. Finally, it has a fast evolutionary rate, which results in the accumulation of new substitutions in a short amount of time. This feature, coupled with methods based on the molecular clock (for instance, the assumption that the DNA molecule accumulates difference linearly in time), is extremely useful for dating recent events (in evolutionary time) such as those associated with human evolution (see Witas and Zawicki, 2004; Pakendorf and Stoneking, 2005).

This history of success also translates into another advantage. MtDNA datasets are usually large and, therefore, it is relatively easy to compare many individuals (and sometimes many populations) in a single analysis. For example, in September 2014, using the taxonomy browser in the Genbank ([www.ncbi.nlm.nih.gov/taxonomy/](http://www.ncbi.nlm.nih.gov/taxonomy/)) and 'mitochondrion' as the keyword resulted

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in about 35,000 matches. Moreover, there is a growing systematic effort to name related mtDNA sequences into haplogroups (Hg) or sub-Hg ([www.phylotree.org](http://www.phylotree.org); van Oven and Kayser, 2009), which allows the discovery of shared/private patterns among populations and the comparison of mtDNA haplogroup frequencies in space.

### MtDNA and the peopling of the Americas

Schurr (2004) provides an excellent review of the initial studies of mtDNA variation in Native Americans. In summary, five major Hgs, termed A-D and X, were identified and strongly suggested a close affinity with Central Asian/Siberian populations. Each of these Hgs would have contributed to a single 'founding type' for the Native American gene pool. The earlier studies witnessed a hot debate concerning the timing and number of different 'migration waves' from Asia to the Americas. The timing of these migration waves were usually inferred based on the coalescence time of each Hg (for instance, the time when all different haplotypes find a common ancestor). For example, Bonatto and Salzano (1997) suggested that HgA-D all show an excess of low-frequency haplotypes, which is typical of populations which underwent demographic expansion. Under these circumstances, the coalescence time is connected to the expansion time. The close similarity of the coalescence times for these four Hgs made these authors suggest a single wave for the peopling of the Americas after a period of population growth in Beringia. This explanation would fit well with the dates obtained (>25 thousand years ago [kya]), which were much older than those reported for archaeological sites in the Americas (Goebel et al., 2008). On the other hand, the origin of HgX was harder to pinpoint, as this was a rare Hg, later shown to be absent from extant South American indigenous populations (Dornelles et al., 2005). Some authors took the more recent coalescence time estimates as evidence of a second migration, perhaps even from a different route (Brown et al., 1998), even though these estimates could be due to the small sample size for this haplogroup. Another lesson from the older studies was that the different Hgs were unevenly distributed across the continent. HgX was not restricted to North America, but Hg frequency could also change among regions (see Figure 2 in Schurr, 2004), possibly indicating the importance of regional movements or different demographic histories among regions.

The development of faster and cheaper DNA sequencing devices in the early 2000s allowed researchers to move from the mtDNA-CR perspective to the full mtDNA genome perspective (for example, Ingman et al., 2000). The full mtDNA genome has ~16,000 base pairs (bp), compared to the ~1,000 bp of the mtDNA-CR. However, as important as the availability of more DNA sequences to refine the picture of mtDNA Hg classification was the estimation of a more accurate calibration of the evolutionary rate for the mtDNA, which is essential in molecular clock analyses. Because the mtDNA-CR evolves faster, it is more difficult to control for multiple-hits when comparing the human sequence with the chimpanzee. In other words, it is very hard to know precisely how many mutations have occurred since these two species diverged ~6,500 kya and, of course, this affects how well the molecular clock would work. The remaining of the mtDNA genome, which codes for proteins or contain genes for rRNA and tRNA (therefore usually called the 'mtDNA coding region'), evolves a little slower and therefore allows for better resolution and better dating.

New studies based on complete mtDNA sequences initially confirmed some of the findings of the earlier studies, such as the importance of Beringia in the development of specific Native American mutation motifs, but also reserved several new results (Tamm et al., 2007; Achilli et al., 2008; Fagundes et al., 2008; Mulligan et al., 2008). For instance, they suggested that coalescence times were actually more recent than previously thought, between 15-20 kya and, therefore, that the population expansion previously associated to the standstill in Beringia was actually better reconciled with an expansion into the New World following the Last Glacial Maximum (LGM) around 16-18 kya. Also, new founding types were proposed and the rapid expansion suggested that the initial settlers followed a Pacific route, as by that time there would be glaciers into the continent blocking any passage to the south. Finally, it was also clear that while HgX could have taken part of the same 'wave' together with the other four major Hgs, some other sub-Hgs with more restricted distribution, especially in northern North America, such as HgD2a, would have arrived later, reflecting new migrations affecting these regions only.

Continued research on complete mtDNA genomes has revealed a growing number of founding types, which now sums almost 20 of them (Saint Pierre et al., 2012; Achilli et al., 2013). Arguably, several of these (see Achilli et al., 2013) may have distributions restricted to North America (but see below) and especially those restricted to Arctic populations may represent secondary waves from north-east Asia into the Americas after the major expansion occurring after the LGM. In addition, as long as more populations are being studied, the geographic distribution of mtDNA Hgs allows different interpretations of the mtDNA data. For example, Perego and colleagues (2009) and Hooshiar Kashani and colleagues (2012) claim that the geographic distribution of haplotypes C4c and X2a suggest a secondary entry route onto the continent possibly through an inland ice-free corridor. In this case, two, rather than a single major 'wave' from Beringia, would have affected mtDNA variation at the continental level.

## MtDNA and the peopling of South America

When we turn our focus to South America, much of the job is to understand what happened in North America, as all genetic data available so far suggests that Beringia was the only entry door for the earliest Native Americans. Brown and colleagues (1998) suggested a putative 'western Eurasian' link with the Americas based on the presence of mtDNA HgX, but the sub-Hgs present in Native Americans, west Asians and Europeans are actually quite different. In agreement, the recent ancient genome from a 24 kya skeleton from central Siberia showing mixed affinities with both western Eurasians and Native Americans suggest some population replacement (with gene flow) in central Siberia, not alternative entry routes for the Americas (Raghavan et al., 2014).

An excellent review of models for the peopling of South America was recently presented by Rothhammer and Dillehay (2009). In short, they proposed some sort of genetic continuity from the north (for instance, coming from the Panama Strait), with a major entry route following the Pacific coast, with secondary migration waves flowing east of the Andes to the Amazon, Chaco, Patagonia and the Brazilian Plateau. Indeed, we should not forget that the oldest archaeological site in the Americas, Monte Verde, lies in southern Chile (Dillehay, 1997) and the evidence from mtDNA does suggest an extremely strong and fast demographic expansion, which can be reconciled with the Pacific route (for example, Fagundes et al., 2008). Another interesting feature is that the number of rare founder sub-Hgs is much lower in South America than in North America (Achilli et al., 2013). This is expected as a migrating population loses genetic variation as it moves on geographically, creating the known pattern for humans of loss of diversity as one moves out of Africa (for example, Ramachandran et al., 2005).

Though mtDNA studies based on several complete genomes from Native South Americans are lacking, two studies focused on mtDNA haplotypes found in southern South America (Bodner et al., 2012; Saint Pierre et al., 2012) suggest some interesting features. Firstly, they suggest that some sub-Hgs found (so far) only in South America are old enough to play the role of a founding type. According to this idea, sub-Hgs D1g, D1j and B2I could be present in low frequencies in the expansion wave and then expanded (in frequency) locally in South America, but were subsequently lost by genetic drift in Central and North America. This is an exciting finding, as it suggests that new founder types could be found locally in South America given that enough sampling effort is taken in characterizing these sub-Hgs. Secondly, they suggest that at least in southern South America, the Andes do not act as a barrier to gene flow. At first sight, this is in contrast to the scenario proposed by Rothhammer and Dillehay (2009). However, it is well known that some Patagonian populations such as the Mapuches crossed the Andes frequently (see Bodner et al., 2012 and references therein) and it is hard to know if the pattern for the southernmost part of the continent would be representative of the overall picture.

Interestingly, another well-known continental pattern in South America is also related to the Andes. Tarazona-Santos and colleagues (2001), based on Y-chromosome data, suggested that populations in the Andes (or in western South America) would have higher connectivity and larger population sizes, while populations from lowland (or eastern) South America would have smaller population sizes and would be more



*Figure 1. Major patterns of mtDNA variation in South America. The dark blue square represents the standing genetic variation in North America, and the thick blue arrow represents the major ancient (~15 kya) migration through the Pacific coast associated with some loss of genetic variation, as indicated by the color gradient in light blue. Two additional blue arrows in Northern South America (identified with a question mark) represent two putative alternative ancient migration routes. The major east/west difference in genetic variation is represented as follows: Populations from Western South America (Andes) are generally characterized by larger population sizes, higher connectivity due to gene flow and low values of genetic structure. This is represented by the large circles in shades of red, and the thick bidirectional arrows. Populations from Eastern South America (Amazon, Chaco and so on) generally have smaller population sizes, low connectivity and consequently higher genetic structure. This is represented by the small circles in different tones, and bidirectional arrows with broken lines. Putative connections between East and West 'components' are represented by bidirectional arrows. A black unidirectional arrow in Northern South America represents possible migration movements towards Central America, as may be the case for the Chibchan language group.*



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isolated. This pattern would result in more genetic diversity and less genetic structure in the Andes, and in less genetic diversity and more genetic structure in the lowlands. Fuselli and collaborators (2003) corroborated this general pattern using low resolution mtDNA data.

In a different study including protein genetic markers, Fagundes and collaborators (2002) focused on a sample containing many populations from the Amazon region and suggested that genetic drift was stronger than migration to create patterns of genetic structure, in agreement with the scenario suggested above (Tarazona Santos et al., 2001; Fuselli et al., 2003). They also suggested that language, rather than geography, was the best proxy of the genetic relatedness among populations (Fagundes et al., 2002). Other mtDNA patterns usually reported involve high/low frequency of specific Hgs, such as high frequency of HgC in Brazil or high frequency of HgB in the Andes (see Figure 2 in Schurr, 2004) but these data are usually based on low resolution mtDNA. Clearly, more complete mtDNA genomes from all around South America would be important to critically evaluate the relevance of the scenarios proposed by Tarazona-Santos and colleagues (2001) and by Rothhammer and Dillehay (2009). The major patterns of mtDNA variation in South America are summarised in Figure 1.

### Limitations of the mtDNA as a molecular marker

Despite all we have learned from mtDNA studies, there are at least two major drawbacks of maintaining it as some sort of 'gold standard' for molecular anthropological studies worldwide. The use of the coding region of mtDNA in studies of complete genomes should have allowed a more reliable clock estimate compared to mtDNA-CR studies and a common choice was based on the estimate for the coding region of  $1.26 \times 10^{-8}$  substitutions/site/year from Mishmar and collaborators (2003). However, there are several technical issues related to mtDNA evolutionary rate calibration. Thus, the first and more technical concern is related to the tricky exercise of calibrating this.

Bromham and Penny (2003) and Kumar (2005) present two useful reviews for those unfamiliar with the molecular clock history and basics. In short, the idea of using a molecular clock is that if one has some 'calibration' for the clock rate, then it is possible to estimate any event affecting clades or populations. This 'calibration' can be provided by fossils or biogeographic data, as is common practice in phylogenetic studies. However, for recent human evolution, one usually has to rely on a direct estimate of the molecular clock obtained from previous studies (probably based on fossil data). This leads to an overestimation of coalescence time due to the 'time-dependency' effect, which occurs when estimation and calibration operate in very different time periods (Ho and Larson, 2006; Ho et al., 2011). In addition, rate variation among lineages and among mtDNA sites is also challenging for having a perfect molecular clock (Endicott and Ho, 2008).

More recently, Soares and colleagues (2009) suggested a method for correcting the effects of the ongoing purifying selection on standing variation which is one of the major causes in the overestimation of coalescence times (Kivisild et al., 2006), suggesting different rates for different mtDNA partitions. Using their method, these authors estimated the expansion of a Native American major founder Hgs ~15 kya, which is slightly later than the original estimates (see above). Although most recent studies do use this corrected evolutionary rate, it is important to keep in mind that even this 'best rate' cannot account for some of the complexities of mtDNA evolution and, therefore, associating specific mtDNA Hgs to a specific points in time is far from a trivial task.

The second limitation of the mtDNA as a marker, however, is more theoretical/philosophical and less technical. This also means that this limitation might be harder to overcome. To try to illustrate it in a didactical way, I will take an example from the arts. *Rashomon* is a classic film by the Japanese director Akira Kurosawa. In the movie, we are shown different versions of the same story told by different characters. Naturally, in the end the spectators are left with the feeling that no single story could be trusted as a single 'truth'. How does the *Rashomon* film connect with the concerns of population genetics and molecular anthropology? In some sense, mtDNA has been the sole 'story teller' molecular anthropologists are relying upon. It has several advantages, as previously mentioned, but it is still a single story teller. What about other stories? What about other genes?

Coalescent theory has revolutionised the field of population genetics since the 1980s (Kingman, 1982; Hudson, 1983; Tajima, 1983) by providing a way of describing the genealogy of a sample of genes taken from a population of size  $N$  (for a recent review, see Wakeley, 2008). Importantly for us, coalescent theory showed explicitly that the genealogy of any gene is highly stochastic and thus, that the genealogies of two independent genes taken from the same population can be different. More or less like *Rashomon* in molecular genetic terms, it means that the story of a single gene may not be representative of the history of the populations where it was drawn. In other words, relying on a well resolved and accurately dated mtDNA genealogy might be misleading as it may be very different from other genealogies which are also conditioned in the same demographic history. Rather than interpreting 'THE' mtDNA genealogy, we should interpret a set of genealogies derived from our samples.

Rather than asking if 'THE' mtDNA genealogy corroborates or refutes a given hypothesis, we should ask if a set of genealogies corroborates or refutes our hypothesis. For molecular anthropologists, this is a major change in thinking.

### MtDNA and multiple loci studies in testing hypothesis about the peopling of the Americas

Among the classical hypotheses proposed to explain the Peopling of the Americas, it is important to understand how much support they receive from genetic data (mtDNA and multiple loci studies), as well as some of the limitations of these studies. In the following paragraphs, I will present the tripartite hypothesis of Greenberg and colleagues (1986), the dual component hypothesis based on morphology (for example, Neves and Pucciarelli, 1991; Neves and Hubbe, 2005) and the recurrent gene flow model of Gonzales-José and colleagues (2008).

The first major multidisciplinary hypothesis for the origin of Native Americans is the tripartite hypothesis of Greenberg et al. (1986), who proposed three distinct migration waves corresponding to the three linguistic phyla identified by J. Greenberg, namely, Amerind, Na-Dene and Eskimo-Aleut, with Amerind being the first wave and Eskimo-Aleut the last. In this model, we would expect a strong genetic structure associated with the linguistic phyla and, ideally, expansion or divergence dates associated with the corresponding phylum would be congruent with the order predicted in the original hypothesis. A second major (continental-level) hypothesis that could be tested with genetic data was proposed, among others, by Neves and Hubbe (2005), based on craniofacial morphology. According to these authors, there is a major shift in craniofacial shape in the Americas, where the early skeletons are much more robust and without many derived traits (so-called Palaeo-American), while extant populations and more recent skeletons (later than ~7 kya) have many derived features associated with a so-called 'Mongoloid' phenotype. In this hypothesis, the first Palaeo-American populations would have been replaced by more recent settlers or at least admixed with them causing the change in morphology. In this hypothesis, we would expect evidence of two distinct waves or, at least, a temporal structure between recent and old samples if the old settlers were completely replaced. More recently, Gonzalez-José et al. (2008) proposed a different interpretation of the morphological data suggesting, upon review of mtDNA and Y-chromosome studies, that the morphological transition could have occurred due to recurrent gene flow between Asia and Americas in the Arctic following a major initial Pleistocene colonization. In this case, we would predict evidence of gene flow between the two continents and only a subtle temporal structure comparing recent and old samples. Importantly, the hypothesis of Greenberg et al. (1986) is impossible to test with only South American samples, as the second and third migration waves only affected North America. However, the dual component hypothesis could be tested with only South American samples, as the morphological change would have occurred at the whole continent level. Indeed, a more recent analysis of craniofacial morphology lends support to the gene flow hypothesis (De Azevedo et al., 2011).

Current interpretation of mtDNA data suggests that, except for northern North America, one or two major migrations would explain well the observed level of variation (see above). On the other hand, the pattern for northern North America could be interpreted as evidence of recurrent gene flow from Asia. Another possible interpretation could be that these data support, at least in part, the three wave scenario of Greenberg et al. (1986) - even though a strong genetic distinction between Na-Dene and 'Amerind' (sensu Greenberg) populations is not very clear (for instance, Bonatto and Salzano, 1997; Achilli et al., 2013). On the other hand, there is not much evidence for a marked temporal structure in the continent (for example, Raff et al., 2011), lending little support to scenarios involving population replacement, such as those suggesting that more earlier 'Palaeoindian' populations were replaced by more recent 'Mongoloid' settlers on a continent-wide scale. Indeed, a recent study found mtDNA HgD1, typical of modern Native Americans, in an ancient Palaeoamerican skeleton from Mexico dating between 13-12 kya (Chatters et al., 2014) suggesting genetic continuity between 'Palaeoamerican' and 'Mongoloid' populations.

It should be no surprise that based on mtDNA alone it is difficult to distinguish rigorously among the different hypotheses that have been proposed to explain the big questions about the peopling of the Americas. MtDNA is just a single story teller. What about studies based on multiple markers? Hey (2005) and Kitchen and colleagues (2008) presented some results suggesting that gene flow with Asia could be important for explaining the patterns of genetic diversity in Native American populations, but neither study tested if gene flow provided a better fit to the data compared to a model of no gene-flow. On the other hand, Wang and colleagues (2007) suggested a single major colonization from Siberia but, again, did not test explicitly for the hypothesis of gene flow between the two continents. In an attempt to address this issue in a more formal way, Ray and colleagues (2010) used part of the Wang et al. dataset (401 out of 678 STR markers) to test hypotheses using an ABC framework (see Bertorelle et al., 2010; Csillery et al., 2010 for detailed reviews of this method).

Roughly speaking, the ABC framework is based on running many (millions) simulations based on coalescent theory for any arbitrary demographic model, which should be defined in advance. For example, one can choose to simulate a 'single wave' scenario for the peopling of the Americas by defining two populations (for example, pop1, representing Asia and pop2,

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representing the Americas) and forcing a major migration from pop1 to an empty pop2 by 15 kya. Following each demographic simulation, genetic data mimicking the observed data is generated and summary statistics for this data are recorded. Thus, if the real dataset contains 401 STR loci, exactly 401 STR loci are generated after each simulation and the same set of observed summary statistics calculated for the real data are recorded for the simulated dataset, such as the average number of alleles, average heterozygosity and so forth. The important point here is that the level of genetic diversity in the simulated data would be conditioned on the demographic story (thanks to coalescent theory). The last step is comparing the summary statistics generated from the simulations with the same summary statistics calculated on the real dataset. Simulated scenarios close to the true demographic history should generate summary statistics very close to that obtained from the real dataset. When different scenarios are simulated, the scenario better supported by the data will be the one resulting in simulated summary statistics closer to the observed than the real data. The ABC framework is an interesting alternative for comparing different scenarios explicitly when likelihood methods cannot be used.

Ray and colleagues (2010) tested three hypotheses: a single wave hypothesis, a two-wave hypothesis and the recurrent gene flow hypothesis. However, because the dataset contained only one Na-Dene speaking population and no Eskimo-Aleut population, no formal test of the Greenberg hypothesis could be done. The authors also decided to test hypotheses considering North and South America together or considering each subcontinent separately. This was important because if the two-wave scenario were better for North America only, for example, it could be better interpreted as reflecting the distinctiveness of the Na-Dene population, rather than something related to a morphological transition that occurred in both continents. The results clearly supported (with a relative posterior probability of  $\sim 1.00$ ) the recurrent gene flow hypothesis for both North and South America. This result corroborates the importance of recent migration between Asia and the Americas, and suggests that gene flow with Asia was an important evolutionary factor even for South American populations, in general good agreement with the model proposed by Gonzales-José et al. (2008).

Another important study is that of Reich and colleagues (2012), who typed  $\sim 365,000$  genetic markers in 17 Siberian and 52 Native American individuals from the three major linguistic phyla. These authors used a different approach compared to the one described before (Ray et al., 2010), in that no alternative scenarios were formally contrasted. Instead, they generated a population tree allowing for genetic admixture among populations. Their results also suggest that a single migration wave scenario would be too simplistic to account for Native American genetic diversity. They suggested three independent streams of Asian gene flow. While native South Americans would derive their ancestry from a single stream, Na-Dene and Eskimo-Aleut populations would be admixed between the first stream and subsequent ones. This sounds much like the original Greenberg et al. (1986) hypothesis, except that the subsequent migration waves would have admixed with the 'First Americans' as they reached the New World. It would be quite ironical if the Greenberg hypothesis, which has been strongly criticised by linguists (for example, Matisoff, 1990), shows to be accurate in terms of genetic ancestry (Amorim et al., 2013).

It is not easy to compare the results from the studies by Ray et al. (2010) and Reich et al. (2012). Except for the obvious convergence that a single wave does not adequately explain genetic diversity of Native Americans, the differences in methods and datasets makes other comparisons problematic. For example, based on the Reich et al. (2012) dataset, would a recurrent gene flow model perform better than a single wave model for South America? Would the scenario proposed by Reich and colleagues for the whole continent be better supported than the recurrent gene flow model of Ray and colleagues? If having multiple genetic story tellers alleviates the issues of relying on too much on mtDNA results, it clearly adds a new layer of complexity for our analysis and data interpretation.

Concerning South America, the study by Ray et al. (2010) suggests we would need to recognize the impact of recurrent gene flow with Asia as a possible player in the microevolutionary change of South American populations. Other major patterns can be also distinguished based on multiple loci studies. For example, Wang et al. (2007) corroborate the West vs. East pattern also found for the Y-chromosome (Tarazona-Santos et al., 2001) and mtDNA (Fuselli et al., 2003). However, genomic data also suggest that even this major pattern is not absolute, as the case of the Inga, in Colombia, whose genome seems to be admixed between Amazonian and Andean groups (Reich et al., 2012). Also, the connection of Chibchan-speaking groups in South and Central America (Wang et al., 2007; Reich et al., 2012) is important to show that even though South America is usually considered the endpoint of a migration process moving southwards, there were important back migrations from South to Central America.

### Moving forward

MtDNA will probably maintain its role as a major molecular tool for generating and testing anthropological hypothesis. The fact that it is much easier to find good quality mtDNA in old samples is also a major technical advantage of this marker. However, rigorous hypothesis testing based on mtDNA alone is difficult because it represents a realisation of the genealogical process

and a single genealogy may be compatible with several different historical scenarios. On the other hand, the recent trend of genomic studies will also bring new challenges for how we analyse, interpret and frame our anthropological hypotheses in ways that can be suited for testing using genetic markers.

Nevertheless, anthropologists interested in using genetic markers must keep in mind that population genetics models are simplifications of the real demographic processes and, as such, might be unable to fulfil the level of detail and precision that would be important for anthropologists. An instructive example is the very concept of 'effective population size', which is the size of an ideal population that behaves as an observed real population. Anthropologists might be interested in census population size (for instance, how many individuals are/were there?), but, in this case, population genetics models might be unable to answer this question satisfactorily. On the other hand, population genetics models are useful when they can predict results or when they can integrate results in a coherent and synthetic manner. Given all we have learned from population genetics models applied to the peopling of the Americas, I think that the new era of genomics will show major advances in refining our understanding of the peopling of the New World, in general, and of South America, in particular.

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# Molecular Approaches to Colonization and Population History in the North American Arctic

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## Introduction

Scholarly interest in the Arctic has a long and diverse history. From research into the ecological diversity of the extreme environment of the Arctic to human biological and cultural adaptations to those same ecological conditions, the reasons for academic interest in the Arctic are manifold. With respect to the UNESCO World Heritage thematic programme of Human Evolution: Adaptations Dispersals and Social Developments, our interest in the North American Arctic has four major elements: 1) via Beringia, the former land bridge linking North America and Asia, it represents the entry point for dispersal of human populations to the Western hemisphere, 2) the region of the North American Arctic has seen three major dispersals of colonizing populations within the last 15,000 – 20,000 years, and, therefore, 3) serves as a geographic model for the population dynamics of human colonization and dispersal that may be relevant to similar human dispersals in other parts of the world, and at other temporal depths. Finally, 4) the recency of human dispersal and adaptation in the North American Arctic provides an opportunity to more clearly assess the merger of the archaeological and genetic records as ways of unveiling past human activity. By assaying both the archaeological record of human occupation of high latitudes and the signature of human demographic history recorded in the genetic variation carried by both modern and ancient populations of the region, we can more directly identify the strengths and weaknesses of both records, and begin to merge them into a powerful, coherent approach to the study of the past.

The archaeological record of the North American Arctic has been accumulating for several decades and its broad outlines are well known to archaeologists and prehistorians (for example, Morrison and Pilon, 1994, and papers therein). The genetic record is of much more recent vintage, with information on modern molecular variation in Arctic populations having been accumulating for only a decade or so. As a result, it is more fragmentary and less well known than the archaeological record. Accordingly, a few words on the basic tenants of human evolutionary genetics are warranted. It has long been recognized that the demographic history of human populations is archived in the patterns of genetic variation exhibited by individual populations. With the advent of molecular genetic techniques, based on our ability to detect individual base differences in DNA sequences, the resolution of the genetic record, the observed pattern of sequence variation between individuals, has increased dramatically, as has our ability to read the history of a population in its genome. This has made it possible to estimate population sizes of earlier populations, date the divergence of populations from an ancestral population and begin to evaluate alternative histories based on both the archaeological and genetic records. Most recently, this has been facilitated by our ability to also assess molecular variation in prehistoric populations through the analysis of ancient DNA (aDNA) (see Tackney et al., 2014 for a review of aDNA studies in the Arctic).

Each individual possesses two genomes. The nuclear genome is very large, containing ~3 billion bases organized into 23 pairs of chromosomes. This genome, as the name implies, is found in the nucleus of a cell and each member of a pair of chromosomes is contributed by either the father or mother. Thus, the nuclear genome is biparentally inherited. The second genome each individual possesses is the mitochondrial genome. This genome is located not in the nucleus of the cell, but in multiple organelles in each cell's cytoplasm. The mitochondrial genome is a single, circular molecule of DNA approximately 16,500 bases in length and each of the many mitochondria in each cell may contain from tens to hundreds of these molecules. Thus, while the nuclear genome is very much larger than the mitochondrial genome and, hence, harbours much more variation overall, there are many more copies of the mitochondrial genome, a fact which has led to its intense study in ancient samples, where the likelihood of recovery of mitochondrial DNA (mtDNA) is much higher than nuclear DNA (nDNA) due to the initial higher copy number.

Unlike the biparentally inherited nuclear genome, mtDNA is inherited solely from the mother. Thus, tracking changes in mtDNA lineages is the equivalent of tracking maternal lineages through time. Many such maternal lineages have now been identified in populations around the world, although only a few are known from the indigenous populations of the Americas. The ancestral mtDNA lineage is termed L3 and is known primarily from Africa. It gave rise to two daughter forms, M and N lineages, which were carried out of Africa during the initial human dispersal and each subsequently gave rise to the large number of lineages known worldwide today. Although at least 15 founding mtDNA lineages have been identified in Native American populations (Perego et al., 2010), all belong to five larger groupings known as haplogroups. The individual lineages known in the Americas belong to haplogroups A, B, C, D and X. Arctic populations have an even more reduced

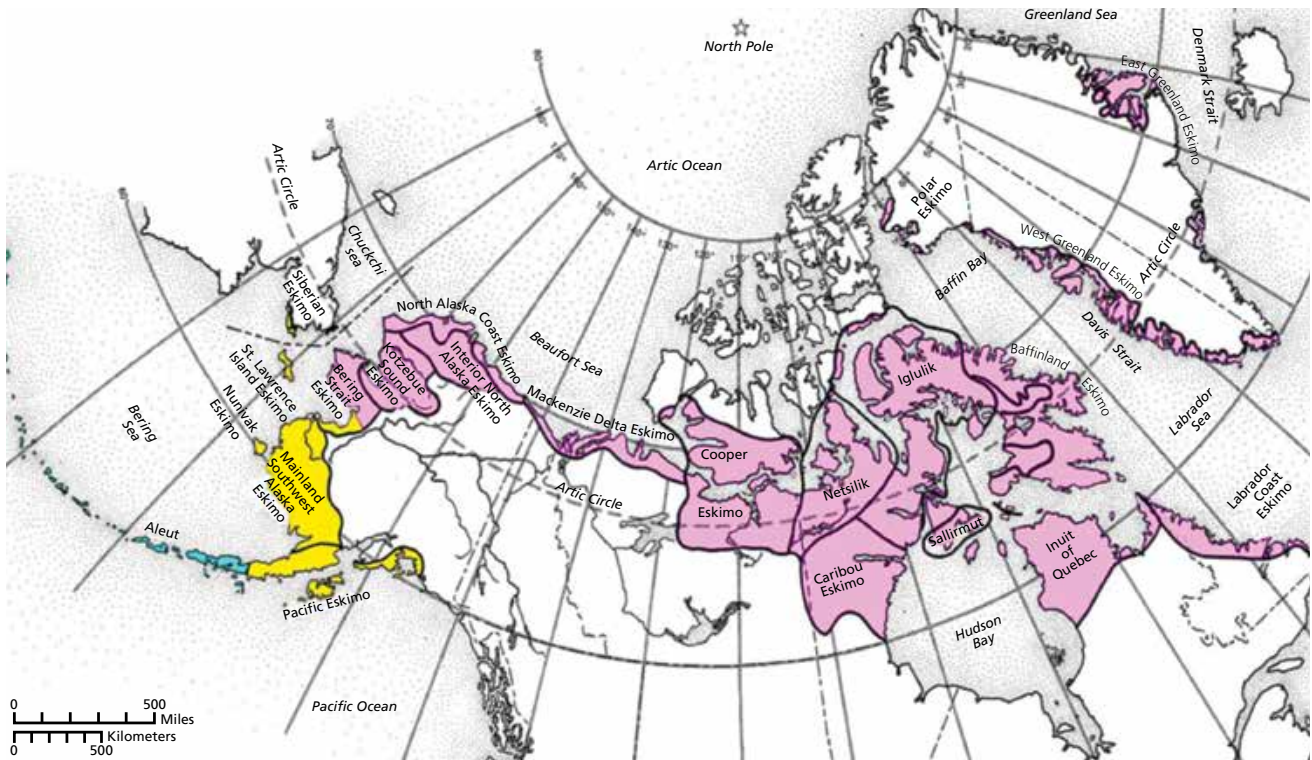


Figure 1. Geographic location of three regional arctic population studies reviewed in text.

number of mtDNA lineages, exhibiting lineages in only haplogroups A and D. Lineages of the other three Native American haplogroups are unknown in the Arctic, except as they can be accounted for by recent migration to the region.

## Regional Studies

With this brief primer of molecular genetics, it is now possible to begin to evaluate our state of knowledge of the genetic record of Arctic populations against the backdrop of the archaeological record to attempt to provide a greater resolution to our understanding of the prehistory of Arctic colonization and dispersal. Three regional studies will serve as examples of how molecular and archaeological data can be jointly employed to provide a clearer picture of prehistoric population dynamics and testing of hypotheses regarding population history. The three regional studies, where the archaeological record is augmented with both modern and ancient genetic studies are the Aleutian Islands, the Eastern Canadian Arctic and the Alaskan North Slope (Figure 1). In each area, the questions of interest, originally derived from the archaeological or osteological records, relate to colonization and population replacement in prehistory. For example, in the Aleutian case, Hrdlička (1945) hypothesised on the basis of perceived changes in cranial morphology that a population replacement occurred in the region approximately 1,000 years ago, despite archaeological continuity. In the Eastern Canadian Arctic, the archaeological record indicated a population replacement of Palaeo-Eskimo groups by Thule whalers, also approximately 800-1,000 years ago (McCartney, 1977; McCullough, 1989; Maxwell, 1985), while the morphological characteristic of the two groups did not appear to differ. In both cases, modern and ancient DNA studies are employed to test these contrasting hypotheses of human population dispersal and replacement. The Alaskan North Slope provides an opportunity to track the story of one of these replacement hypotheses back in time to attempt to examine the source of the migrants and therefore provides additional detail and resolution to our understanding to this period of Arctic history in North America.

## The Aleutian Islands

Archaeological evidence indicates that the eastern Aleutians were first inhabited 9,000 - 8,000 years ago, that the archipelago was settled from east to west and that the region is characterised by near archaeological continuity since

colonization. Nevertheless, based on an observed shift in cranial morphology from dolico-cranic to meso-cranic<sup>1</sup>, Hrdlička (1945) postulated a migration of the immediate ancestors of modern Aleuts (Neo-Aleuts) into the archipelago approximately 1,000 years ago, replacing an earlier resident population (Palaeo-Aleuts). We reasoned that if such a migration occurred, the earlier and later populations would likely differ genetically.

Accordingly, we undertook an ancient DNA study of the original human skeletal material recovered by Hrdlička (1945) and used in formulating his replacement hypothesis. The samples used in the aDNA analysis (Hayes, 2002; Hayes et al., 2003, 2005; Smith et al., 2009) came from the burial caves on Kagamil and Shiprock Island and Chuluka midden in Nikolski on the island of Umnak. AMS <sup>14</sup>C dating of each sample indicated an age range of >3500 – 750 BP (Coltrain et al., 2006), spanning the time period of the replacement event proposed by Hrdlička (1945). A total of 80 individuals from the three sites were studied, with two-thirds of those that yielded analysable DNA (n=61) characterised by mtDNAhaplogroup D and one-third by mtDNAhaplogroup A (Table 1A). These lineage frequencies were indistinguishable from the mtDNA lineage variation found in modern Aleut populations (Rubicz et al., 2003; Zlojutro et al., 2009), nor was there any significant difference between the lineage frequencies between Palaeo- and Neo-Aleuts, leading to an initial inference of no evidence for a migration or replacement event (Hayes, 2002; Hayes et al., 2003, 2005). Rather the results seemed to confirm the archaeological record of population continuity.

**Table 1. mtDNA lineage frequencies in prehistoric Aleutians and Eastern Canadian Arctic**

<b>The Aleutians - According to Smith et al., 2009</b>			
Sites	N	%A	%D
Kagamil	32	25	75
Ship Rock	12	17	83
Chaluka	36	48	52
<b>Total</b>	80	34	66
<b>Hrdlička's Morphological Groups</b>			
Paleo-Aleut	42	53	47
Neo-Aleut	38	19	81
<b>Total</b>	80	36	64
<b>Temporal Groups</b>			
Pre-1000 AD	11	73	27
Post-1000 AD	52	23	77
<b>Total</b>	63	32	68
<b>The Eastern Canadian Arctic - After Hayes 2002</b>			
Dorset	3	0	100
Thule	20	100	0
Sadlermiut	19	56	44

Closer examination of both the archaeological, radiometric and genetic data however, revealed additional information. The oldest samples came from the Chaluka midden site and all had been classified by Hrdlička as Palaeo-Aleuts. The majority of individuals recovered from Shiprock and Kagamil caves dated later in time (<1000 years old) and were classified by Hrdlička as Neo-Aleuts. Samples dating to after 1,000 BP at Chaluka were a mixture of Palaeo- and Neo-Aleuts as described by Hrdlička. This would seem to contradict Hrdlička's (1945) postulate of Neo-Aleuts as a replacement population, since both morphologically defined groups existed together at Chaluka for several hundred years. There is heterogeneity in lineage frequencies among the three sites and between Hrdlička's morphological groupings, but they proved to be statistically non-significant. However, when we examined the mtDNA lineage distribution in the pre- and post-1,000 year old material,

1 Dolico-cranic: a skull with a breadth c. 75% of the length; brachy-cranic, a skull with a breadth c. 80-85% of the length; meso-cranic, a skull with a breadth/length ratio intermediate between dolico-cranic and brachy-cranic.



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significant differences emerged. The samples predating 1,000 years BP (all from Chaluka) were predominantly mtDNA lineage A, with only a quarter lineage D. In the post-1,000 year old cohort, the frequencies were reversed, with only a quarter lineage A. These lineage frequency differences were much more substantial and statistically significant than any observed in any other grouping of the samples. Using the computer simulation program of population dynamics, *Nsitu* (Cabana et al., 2008), we could eliminate continuity and change via stochastic drift as an explanation of the observed temporal pattern in lineage frequencies (Smith et al., 2009). The data did support the arrival of some new individuals at ~1,000 years ago that differed from the earlier population of the Aleutians, although it did not appear to be an actual replacement event. In this regard, Hrdlička (1945) was at least partly correct.

In an effort to determine the source of the new genetic information and new migrants to the eastern portion of the chain, we undertook additional aDNA studies on human skeletal material from various sites on the Alaska Peninsula (Raff et al., 2010). The results indicated that more mitochondrial diversity existed on the peninsula than in the archipelago in prehistory, at least so far as our samples were adequate to judge. Two individuals from the Brooks River region (Dumond, 1981), both predating European contact by several hundred years, were found to be mtDNA lineage B. While common further south in both North and South America, this lineage had not been reported before in prehistoric Arctic or subarctic populations (Raff et al., 2010), confirming a genetically complex prehistory of the region than earlier studies on modern populations had indicated.

### The Eastern Canadian Arctic

The Thule expansion across Arctic North America is one of the most well-known and dramatic migration/replacement events in prehistory. The archaeological record indicates that Thule whalers dispersed across the North American high Arctic from somewhere in north-west Alaska or coastal Chukotka around 800 – 1000 BP, reaching and colonizing western Greenland in a span of 200 years or less (Friesen and Arnold, 2008). The Thule, immediate ancestors of modern Inuit/Īñupiat peoples, supplanted an earlier population in the eastern Arctic, the Palaeo-Eskimo groups known by various archaeological traditions depending on time and place. Despite what seems a clear archaeological record of migration and replacement, some argued that the Thule might have been a local innovation from a Palaeo-Eskimo source population in the east, while others suggested that the Palaeo-Eskimo population, always small and dispersed, had disappeared centuries before the Thule arrival (for example, Park, 2000). Still another archaeologically derived hypothesis was that some of the Palaeo-Eskimo populations did not originate in the west and disperse east in an earlier migration, but rather originated from American Indian populations living south of the Arctic in the middle Holocene (for example, Birket-Smith, 1929). Again, we attempted to test these various hypotheses with molecular genetic data.

With the support of local native communities and the Canadian Museum of Civilization, we obtained skeletal samples from the only three Dorset (Palaeo-Eskimo) remains then available. All came from the region of northern Hudson Bay and Southampton Island. We also secured access to prehistoric (that is, pre-contact) Thule samples from two archaeological sites on the north-west coast of Hudson Bay, Silimiut and Kamarvik (McCartney, 1977). The aDNA results provided strong support for the archaeologically inferred Thule migration and replacement (Table 1B). All of the Thule were found to be mtDNA lineage A, while two of the three Dorset samples were mtDNA lineage D (Hayes, 2002; Hayes et al., 2003, 2005). The third Dorset sample could clearly be shown to not be any of the other known Native American lineages, but the key sequence to confirm lineage D proved impossible to characterise (Hayes, 2002). Nevertheless, the differences in mtDNA lineage frequency strongly suggested separate origins for the Palaeo- and Neo-Eskimo groups and a plausible replacement interpretation.

This inference was given added weight with the analysis of another group of samples from Sadlermiut on Southampton Island. This population was known historically and became extinct in the early twentieth century due to contagious disease introduced by European sailors. The Sadlermiut were known to differ in many cultural traditions from modern Inuit, spoke a language unintelligible to modern Inuit, and lacked many of the components of the modern Inuit tool kit. Indeed, some early ethnographers suggested this population was a remnant Palaeo-Eskimo (Dorset) population that escaped replacement upon arrival of the Thule. The genetic analyses of this population seemed to confirm this suggestion, since the population was composed of nearly equal frequencies of mtDNA lineages A and D, as might be expected in an admixed population (Table 1B). However, recent genomic analyses of a series of Palaeo- and Neo-Eskimo individuals, in addition to ten Sadlermiut samples, clearly demonstrated that the lineage of haplogroup D present in the Sadlermiut (D4b1a2a; formerly a lineage of haplogroup D3) was not shared with any of the Palaeo-Eskimo samples (Raghavan et al., 2014). Indeed, the new genomic data indicated the Sadlermiut were more closely aligned genetically with Neo-Eskimo (Thule) populations rather than Palaeo-Eskimo (Dorset) populations. Thus, the earlier inference of the Sadlermiut being the result of admixture between Dorset and Thule populations is no longer supported (Raghavan et al., 2014).

The results of these analyses confirmed the archaeological inference that the modern Inuit are directly descended from the Thule migrants and that the Palaeo-Eskimo are genetically distinct from the Thule, and could not have given rise to them. Moreover, while it initially appeared that the Sadlermiut were an admixed population of both Dorset and Thule ancestry (Hayes et al., 2003, 2005), higher resolution genomic data from the same populations demonstrates this is most unlikely (Raghavan et al., 2014). At least some of these conclusions were confirmed by Gilbert et al. (2008) who obtained the full mtDNA genome sequence of a Palaeo-Eskimo from western Greenland (dated to >3500 BP). This individual of the Palaeo-Eskimo Saqqaq archaeological tradition was mtDNA lineage D2, the haplogroup D lineage found at high frequency in modern Aleut populations, and at moderate frequency in early Aleutian populations, but not present in the intervening geographic area of the Arctic. This would seem to confirm the west to east migration and dispersal of Palaeo-Eskimo groups rather than an origin in eastern subarctic Indian populations. But the absence of molecular data to inform the archaeology of the central Arctic and northern Alaska was problematic.

### A geographic gap - The Alaskan North Slope

These and other genetic studies of North American Arctic populations (for example, Helgason et al., 2006; Raff et al., 2010) clearly demonstrate that while prehistoric populations were occasionally genetically more variable than contemporary populations, modern Arctic populations are nearly monomorphic for mitochondrial lineage A2, reflecting substantial reduction in genetic variation among Arctic populations. Lineage A2 has two sublineages, A2a and A2b, which have distinct geographic distributions. A2a has higher frequencies in the western North American Arctic, where it is nearly fixed among Aleut populations, while A2b is typically higher in frequency in the eastern Arctic. Inuit/Eskimo populations also occasionally have a minor frequency of mtDNA lineage D4b1a2a (generally <3%), while this lineage is absent in Aleuts, where lineage D2 predominates, as it does among the Palaeo-Eskimo samples analysed to date. The origin of these regional patterns is not clear. All appear to be related to the early dispersal of Aleut and Palaeo-Eskimo groups, and later Thule populations, from the north or north-west coast of Alaska – an area for which molecular genetic data is lacking.

Consequently, with M. G. Hayes of Northwestern University and Anne Jensen of the Ukpiaġvik Iñupiat Corporation, we initiated ancient and modern DNA studies of the Iñupiat populations of the North Slope of Alaska. Hayes is assaying molecular genetic variation in all of the Iñupiat communities on the Arctic slope of Alaska, while our group at Utah has collected samples from Anne Jensen's archaeological excavations at the Nuvuk village site at the tip of Pt. Barrow, AK. Nuvuk was an Iñupiat village that appears to have been continuously inhabited for well over a thousand years; through the Classic Thule period until nearly the middle of the twentieth century. With the support and encouragement of the local Iñupiat community, the ancient burials that are now eroding into the Arctic Ocean due to increased erosion from storms caused by global climate change, are being identified, carefully excavated and studied prior to re-interment safely inland. This large collection provides an invaluable comparative base for other ancient and modern genetic studies of the region, and not only broadens the geographic coverage of such genetic samples, but covers a critical time period, as well. Most of the burials recovered for molecular sampling date between the tenth and fourteenth centuries.

This large project is not yet complete, but a few early inferences can be made. Based on analyses completed to date, the ancient mtDNA lineages match those found among the modern population of the region. The constellation of mtDNA lineages is consistent with the region being the source for both the Palaeo-Eskimo and the Thule migrations and colonizations of the North American high Arctic, with both A2 lineages being present in frequencies consistent with the known geographic clines in these lineages, and the presence of both mtDNA D lineages, not typical in other Arctic regions, where one or the other is present, but not both. As additional population analyses are completed on this project, we expect to provide additional clarification to the origin of dispersing populations in the American Arctic, and more clearly understand the population dynamics of colonizing populations in this challenging environment that will be useful in reformulating our views on continental colonizations at earlier points in time.

### Lessons learned

Several important insights have been obtained by using molecular genetic methods to test archaeological hypotheses. Reduced genetic variability is often the result of a restriction in population size, a bottleneck, at some time in the past. The fairly dramatic reduction in the number of mtDNA lineages in the North American Arctic might suggest a population bottleneck at founding, that is, at colonization, that could indicate a general pattern of bottleneck and genetic variation loss in other colonization contexts. However, Marchani et al. (2007), examining the reduction of mtDNA variability in the American Arctic relative to the greater diversity found in potential source populations in north-east Siberia found that a dramatic founder effect was not

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a requirement for lineage loss. The effects of a bottleneck on genetic variation are measured by the Severity Index (SI), which is the ratio of the duration of the bottleneck to the effective population size during the bottleneck. Marchani et al. (2007) found that the SI for early Thule populations ranged between 0.10 – 0.44 under realistic demographic parameters that were consistent with ethnographic and archaeological evidence. This is only a mild to moderate bottleneck, indicating that extreme population reduction is not necessary for lineage loss in migrating colonizing populations. Indeed, the loss of mtDNA lineage variation was consistent with effective population sizes of ~250, perhaps more. Census size would be substantially larger, indicating that fairly large populations may have been involved in both the migration and colonization of the Arctic, but nevertheless associated with a reduction in genetic variation. While this is counter-intuitive from a genetic perspective, it is consistent with the archaeological evidence of much larger effective sizes among the prehistoric Thule whalers than among the less economically specialized Palaeo-Eskimo populations that preceded them.

This lesson is echoed in a recent study of aDNA analyses conducted in the Americas. O'Rourke et al. (2000) reviewed the then limited set of aDNA studies in the Americas and found that 1) there was little evidence of reduced genetic variation in the ancient samples, measured by nucleotide diversity, compared to modern population genetic samples and 2) the strong geographic structure to mtDNA lineage variation was present even in the earliest aDNA samples studied. This implied that the geographic structure of modern indigenous populations of the Americas is of considerable antiquity. But this early review was based on only six aDNA studies published to that time and the oldest samples were barely 1,500 – 2,000 years in age. Raff et al. (2011) updated this analysis by examining over 60 aDNA studies conducted in the Americas over the previous decade and concluded that the geographic structure in mtDNA lineages is even stronger than suspected (Figure 2) and that there is little evidence to indicate that the ancient samples are any less variable at the DNA sequence level than modern samples. Indeed, it may be that earlier populations were slightly more genetically variable than modern populations and that apparent loss of variability may have less to do with founding populations at colonization than with loss of variation as a result of demographic collapse at contact. Moreover, an Analysis of Variance of the lineage frequencies in these aDNA studies indicated that while there was no discernable temporal effect on genetic variation at the continental level (nor any temporal x regional interaction), the geographic effects on lineage distribution was highly significant ( $F=10.286$ ;  $p<0.001$ ; Raff et al., 2011). These general trends will not hold for every population (for example, some regions exhibit lineage diversity increases over time, others diversity loss and still others show no change over time), but the general patterns of regional structure are well established and of long standing. In the present context, it is worth noting the placement of the Arctic populations at some distance from other regional populations of the Americas in Figure 2, and the similarity in the lineage distributions between the ancient and modern Arctic populations examined. These observations highlight the separate and later entry of colonizing populations into the North American Arctic compared to the Native American populations living at lower latitudes. Finally, it is worth emphasizing that the temporal frame covered by Raff *et al.*'s (2011) review is over 4,000 years, substantially extending the origin of the geographic structure of mtDNA lineage variation in the Americas.

These lessons are not unique or specific to the Arctic. Much debate has occurred as to the importance of small founding populations at the initial colonization of the Western Hemisphere by populations migrating through or along the Beringian land bridge (Goebel et al., 2008; Perego et al., 2010; O'Rourke and Raff, 2010; O'Rourke, 2011; Hoffecker et al., 2014). In the traditional view of American colonization, very small founding populations moved south between receding ice sheets to rapidly colonize the two continents. Almost by definition this model of colonization would require founding bottlenecks that would result in a substantial reduction of genetic variation. At first blush, the data reviewed above would seem to be consistent with this interpretation. But all of the data presented here is based on mtDNA, a single, uniparentally inherited genome that is particularly susceptible to intergenerational sampling error, genetic drift and hence, loss of lineages over time, even in moderately sized populations. A better measure of changes in effective population size and genetic variation comes from the nuclear genome. Unfortunately, we have only a very limited amount of nuclear genomic data on indigenous American populations at present. But this, too, is changing. Genomic screens by Wang et al. (2007) and Reich et al. (2012) indicate that there is only minimal reduction in genetic variation among Native American populations (for example, <7% in Wang, et al., 2007), drawing into question the assumption of small populations at founding. Perhaps this should come as no surprise, since Ward et al. (1991) suggested early on that there was little evidence of a bottleneck in even mitochondrial DNA sequence data even if some lineages had been lost. Thus, the lessons learned by studying the latest long-range migration and colonization event in the North American Arctic may well provide a foundation for how we view the original colonization of the Americas and the population dynamics associated with that momentous event.

### Conclusions

The use of newer, higher resolution genetic data, in conjunction with the constantly growing archaeological record, is a powerful inferential approach to the past. It facilitates both the refining of hypotheses of prehistoric population dynamics, and their more effective and efficient test, as well. Indeed, there is little reason to stop at the use of human molecular data.

Understanding the population dynamics of human prey species and resource items via similar molecular genetic analyses can tell us much about their human consumers (for example, Broughton et al., 2012). Not only can archaeo-faunal and archaeo-botanical materials tell us much about their human consumers, obligate human pathogens are also accessible via aDNA analyses and serve as effective proxies for human movement in the past. For example, genomic variation in a number of obligate human pathogens, including JC virus (Sugimoto, et al., 1997) and *H. pylori* (Ghose et al., 2002; Moodley et al., 2009), would seem to only be consistent with two or more independent colonization events, rather than the single one often favoured by modern geneticists (but see Reich et al., 2014 for an alternative genetic view). In the case of *H. pylori*, the existing genomic variation is consistent with a founding greater than 12,000 years ago and with no bottleneck (Ghose et al., 2002). How this translates to the population dynamics of the human host at introduction remains to be fully elucidated, but raises questions with respect to the standard view of American colonization.

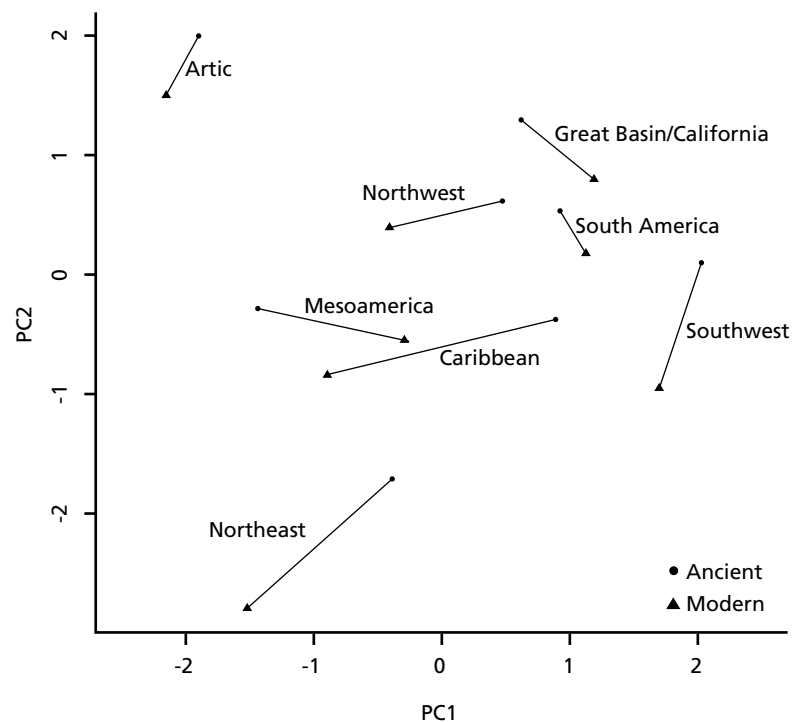


Figure 2. Plot of first two principal components of modern and ancient mtDNA lineage frequencies in the Americas. Filled circles represent plot of modern population mtDNA diversity while filled triangles reflect the position of the same diversity observed in ancient samples. Source: Raff, et al., 2011.

It has not been possible here to review another important area of research that also impacts the reconstruction of prehistory using molecular and chemical approaches. Isotopic analyses of human remains, as well as archaeo-faunal and archaeo-botanical material, is an important adjunct especially for aDNA analyses (Coltrain et al., 2004). Inferences are stronger and more robust with a combined aDNA/isotopic analysis that either provides alone. Incorporating faunal and botanical analyses can also clarify questions of dietary composition, local adaptive strategies and in specific contexts, aid in refining AMS  $^{14}\text{C}$  dating (for example, calibrating the marine reservoir effect, Coltrain et al., 2006).

As useful as I think such combined molecular and archaeological approaches are for both regional history and continental level colonization models, all such inferences are based on an oversimplification of the relevant environments in which early populations lived. Palaeo-environments and palaeoclimates were not uniform, but temporally and spatially heterogeneous (Hoffecker et al., 2014). As newer methods of palaeoecological reconstruction provide increasing resolution to our view of early landscapes and human environments, the integration of these environmental reconstructions with the archaeological and genomic records of humans and their resource bases, and their pathogens, will lead to a true science of the past.

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# Human Skeletal Evidence for the Peopling of North America: A Palaeoanthropological and Historical Perspective

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## Introduction

In addition to his pioneering observations on altitude sickness, geology and history in Peru and Mexico, the Jesuit priest, José de Acosta (1539-1600), was the first to formally assert that Native Americans must have derived from Asian populations (Burgaleta, 1999). In his book, *Historia natural y moral de las Indias (Natural and Moral History of the Indies)*, published in Seville in 1590, de Acosta marshalled biological and cultural observations made on Native Americans during his fifteen years in the New World to support his assertion and even suggested a land crossing across what would now be considered the Bering Strait land bridge (de Acosta, 2002). The Asian ancestry of Native Americans was firmly established in the literature by the beginning of the twentieth century and is evident in influential works on human biology, based largely on anatomical features of living and skeletal populations, throughout the century (for example, Deniker, 1909; Hrdlička, 1925; Hooton, 1932; Eickstedt, 1934; Coon, 1965; Stewart, 1960, 1973; Laughlin and Harper, 1979). Analysis of dental morphology, particularly the presence of shovel-shaping of the incisors (Hrdlička, 1920), has been emphasised in this context (Scott and Turner, 1997). The Asian-Native American connection has been further solidified by increasingly greater genetic knowledge based on autosomal, mitochondrial and Y-chromosome DNA (Crawford, 1998; Goebel et al., 2008; O'Rourke and Raff, 2010; Reich et al., 2012; Raghavan et al., 2014), including human DNA extracted from Palaeoindian-aged coprolites (Jenkins et al., 2012).

The exact age of the appearance of Native American ancestors in the New World has long been a matter of some debate (see discussion in Meltzer, 2009 and Klein, 2009). While today it is generally accepted that humans did not arrive in the New World until toward the end or after the Late Glacial Maximum or LGM (recently dated to between 26,500 and 19,000 years ago – Clark et al., 2009), that was not always the case. In the nineteenth and early twentieth centuries, arguments for the existence of 'Pleistocene Man' or even earlier forms, in the New World were not uncommon; and some examples are considered later in this review. With this in mind, I assess the record of the earliest North America human skeletal remains from the perspective of palaeoanthropology, rather than bioarchaeology. A baseline for this consideration will be my 1976 review of the earliest skeletal evidence for humans in North America (Smith 1976). I will illustrate how and why the list of early remains is far different today than forty years ago. Additionally, I provide some historical perspective on certain debates concerning the nature of Native American origins, including the role of Aleš Hrdlička's often misunderstood or misrepresented views on the age of humans in the New World.

## European Challenges

A relatively recent challenge to the Asian derivation, or at least total Asian derivation, of Native Americans has arisen from data suggesting that the earliest people in the New World were not specifically Asian in cranial morphology. This interpretation was particularly highlighted by the original interpretations of the Kennewick skeleton, found along the Columbia River in Washington in 1996. This virtually complete skeleton was initially analysed by Chatters (2000) who noted that the skull did not exhibit typically Asian features. In some early discussions of the material, the skull was described as 'Caucasoid' by Chatters, but he later noted that this was not the most appropriate terminology (Chatters, 2001). The European character of the skull actually was emphasised more by early media accounts than by scientists, but Chatters also notes that he and others who initially examined the specimen were doing so from more of a forensic anthropology paradigm than an evolutionary one (Chatters, 2001). This certainly led to an emphasis of the apparent non-Asian features of the specimen.

From a historical perspective, and in the context of more typological constructs, it should be noted that even living Native Americans were generally considered to be a somewhat distinctive 'type' of Asian. For example, in describing Native Americans a half-century ago, Coon (1965, p.152) wrote that they are Asians '... of a peculiar kind, just as they would be Caucasians of a particular kind had the New World been peopled by a small band of Upper Palaeolithic Europeans...'. Coon also noted that Native Americans differed from other Asians in aspects of the central face, some of the same features that

Chatters relied on. Even before Kennewick's discovery, analyses by Steele and Powell (1992, p.140) demonstrated that pre-Holocene North American Palaeoindian crania - with their long, narrow cranial vault and short, narrow faces - fell '...at the periphery of modern north Asian and North American Indian populations and near the Australian and southern Pacific rim populations.' Several other analyses have confirmed the morphological distinctions between Palaeoindian crania and those of later Native Americans (for example, Neves and Pucciarelli, 1991; Lahr, 1995; Jantz and Owsley, 2001, 2005; Powell, 2005). Most recently, Jantz and Spradley (2014) specifically demonstrated Kennewick's affinities to Pacific Rim, particularly Polynesian, populations on the basis of cranial morphometrics and Gill (2014) came to the same conclusions on the basis of discrete traits. Brace and colleagues (2014) found close morphometric relationships between Kennewick and the Ainu and Jomon peoples of Japan. Hubbe and colleagues (2011) found that several early New World crania (not including Kennewick) showed close morphological affinities with a sample of late Palaeolithic specimens from Europe, west Asia and China. They concluded that early Native Americans were part of a regionally mostly undifferentiated sample of early modern humans that existed prior to the emergence of regionally specific morphological features. These studies show that pre-Holocene Palaeoindians are part of a more 'generalised' cranial morphological pattern that characterizes some recent eastern Pacific Rim populations but lack many of the more recently-evolved features characteristic of recent modern Native Americans and north Asians. The similarity to Polynesians is taken as support for a coastal route as a major factor in populating the Americas (Jantz & Owsley 2001, 2005; Jantz and Spradley 2014), which might help explain the very early dates for human presence in South America (see Gibbons, 2014).

Extraction of a high-coverage genome from the Clovis-associated Anzick 1 male infant, dated to between 12,556 and 12,707 years BP (calibrated  $^{14}\text{C}$ ), adds additional strong support for the Asian derivation of Native Americans, as does the genome of a ~24,000 year old individual from Siberia (Rasmussen et al., 2014) and the recent genomic analysis of the Kennewick skeleton itself (Rasmussen et al., 2015). Results of a genome-wide analysis comparing Anzick 1 to 143 non-African modern populations demonstrated that Anzick 1 showed statistically significant closer relationships to all 52 Native American groups than to any of the Eurasian samples examined (Rasmussen et al., 2014). Furthermore, the Anzick infant reflects distinct evidence of gene flow from the ~24,000 year old individual (MA-1) from the Siberian Upper Palaeolithic site of Mal'ta (Raghavan et al., 2014). The Mal'ta genome is described as 'basal' to western Eurasians, closely related to Native Americans, but lacking strong connections to recent east Asians (Raghavan et al., 2014, p.505). The Kennewick "Ancient One" demonstrates closer genetic similarity to Native Americans than to any other group, but interestingly is more related to Native American lineages to the south than in the northern regions of North America (Rasmussen et al., 2015).

The connection of Siberia to western Eurasians is not really surprising. Fifty years ago, the palaeoanthropologist, Andor Thoma (1964, 1973), pointed to distinct similarities between west Eurasian Neanderthals and Palaeosiberians, leading him to suggest what could be termed a 'European' connection between these regions in deep time. The Palaeosiberians, in Thoma's model, reached southern Siberia and there '...under strong selection pressure of the new environment, they were transformed into the proto-mongoloids' (Thoma, 1973: 531). Although the terminology is archaic, the 'Palaeosiberians' and 'proto-mongoloids' reflect the generalised structure and midfacial features that characterize the pre-Holocene Palaeoindians and other groups discussed above. In addition to the Mal'ta genomic evidence, Thoma's model has been strengthened by recent morphological and genetic studies that demonstrate a Neanderthal presence in south-western Siberia (Krause et al., 2007; Prüfer et al., 2014). Thus, if pre-Holocene Palaeoindians and even recent Native Americans can trace as much as a third of their ancestry to 'western Eurasia' (Balter, 2013), the explanation for this is a pattern of population movement from western Eurasia to the east that occurred, or at least began, long before human migrations across Beringia. This means the 'European' features that have confused understanding of the ancestry of Palaeoindians result from deep-time population history of north-western Asia, not from a more direct European source.

Such a more direct possible source for European impact on Palaeoindians has taken the form of a model positing a trans-Atlantic origin for Palaeoindians (Bradley and Stafford, 2004). Termed the Solutrean hypothesis, this model sees strong similarities between Palaeoindian lithic technology and that of the Solutrean. The Solutrean is a European Upper Palaeolithic complex that is found in south-western Europe from about 21,000 to 16,500 years ago and is characterized by precisely flaked leaf points and other points of various sizes and shapes (Klein, 2009). Fossil human remains clearly associated with the Solutrean are rare, fragmentary, and/or of uncertain context (for example, see Smith et al., 1999), thus precluding systematic skeletal comparisons with Palaeoindians. Thus, the Solutrean hypothesis is based primarily on the lithics and some other indirect evidence (Stafford and Bradley, 2012). An analysis of the lithic and other arguments is beyond the scope of this review, but it is noteworthy that these Solutrean/Palaeoindian connections have been suggested before (see Fiedel, 2004) and rejected on both archaeological and other grounds (for example, Straus et al., 2005; Fiedel, 2004). Certainly there are no biological data to specifically support the Solutrean hypothesis and any 'European' biological aspects of Palaeoindians are easily explained by the deep-time connections presented above.

## Age of the initial appearance of humans in the New World

The primary evidence germane to human appearance in the Americas has traditionally been the archaeological record and the earliest widespread evidence is the Clovis culture, dated to between 13,600 and 12,800 years ago and found in the continental United States (Walters and Stafford, 2007). Dates for well-established non-Clovis complexes in Alaska go back to about 14,000 BP and begin to exhibit considerable variation soon thereafter (Goebel et al., 2008). Sites with tools or evidence of human cultural activity purported to be earlier are not compelling - including Calico Hills, Tule Springs, Old Crow and Bluefish Cave (see review in Goebel et al., 2008). However, evidence for pre-Clovis occupations south of Alaska and Beringia is steadily increasing in both quantity and quality (see Gibbons, 2014) as is the evidence for non-Clovis groups generally contemporaneous with Clovis (Jenkins et al., 2012). Still, the oldest of these approaches an age of about 15,000 years ago. Genetic estimates also support a split between Native American and north Asian populations during or just after the LGM, with estimated coalescence dates for three subclades of the C1 mitochondrial haplotype falling between 16,600 and 11,200 years ago (Goebel et al., 2008).

However, this relatively late date for human emergence in the New World has not always been so clear. Specimens such as the Trenton crania, Calaveras skull, Natchez os coxae, Nebraska 'loess' skulls and numerous others were suggested as likely candidates for a much earlier presence of humans in North America (see review in Hrdlička, 1907). Florentino Ameghino (1879) claimed great antiquity for human skeletal remains in South America, especially in Argentina, and ultimately developed a phylogeny of human evolution that derived humans from fossil monkeys he discovered, also in Argentina (Ameghino, 1910, 1911). Finally, the so-called Nebraska man, actually based on a single molar and named '*Hesperopithecus haroldcookii*' in 1922, was touted as a North American anthropoid, indicating that ape (and possible human) evolution could have played out in North America as well as the Old World (Osborn, 1922). Five years later, it was demonstrated that the tooth was from a peccary (Gregory, 1927). Still these arguments regarding human evolution in the New World created a bit of a theoretical and methodological crisis for American anthropology at the time. It is in this framework that the work of Aleš Hrdlička, one of the founders of systematic and scientific biological anthropology in the United States (Spencer, 1979), is best understood and the misconceptions concerning his ideas best addressed.

## Aleš Hrdlička's model for 'peopling of the world'

Hrdlička's view on the origin of Native Americans is not an isolated idea but rather one aspect of his perception of the origin and spread of modern humans throughout the world. These views are presented in a number of publications (for example, Hrdlička, 1920, 1921, 1930, 1939) but sometimes are a bit difficult to isolate from other aspects of his detailed publications (see Spencer and Smith, 1981). Hrdlička basically viewed the origin and spread of modern people in four stages (Hrdlička, 1921). The first was a dispersal of Neanderthals throughout Europe and North Africa, terminating in the emergence of the earliest modern humans, which he termed 'western Palaeolithic man.' Unlike most of his contemporaries, Hrdlička saw the Neanderthals as the logical ancestor of modern humans and believed that early modern specimens, like those from Předmostí (now in the Czech Republic) represented transitional forms between Neanderthals and later modern people (Hrdlička, 1927, 1930). In the second phase, 'western Palaeolithic man' diversified into specific racial types and for the first time established a foothold in Asia. The third phase witnessed populations entering Asia and moving north and east, eventually populating Siberia and then the Americas. The fourth phase in Hrdlička's scheme was the populating of the Pacific islands and the differentiation of peoples in the Old and New World into the current pattern of human biocultural variation.

Hrdlička's insistence that humans did not have a deep ancestry in the New World is fully understandable in light of this model and his insistence on rigorous scientific evidence to support ideas about humans in the past. Between 1898 and 1912 he made a detailed study of all the available evidence attributed to early humans in the New World. He argued strongly that careful analysis of the stratigraphy and context of human skeletal remains, as well as of the skeletal remains themselves, was critical to claims for antiquity and he found that such analyses were unfortunately often inadequate in the case of the purported early American remains (Hrdlička, 1907, 1912). Because of his experience with Neanderthals and earlier fossil humans, Hrdlička felt that evidence of archaic morphology, as well as geological antiquity, was necessary to establish deep antiquity for human skeletal remains. For example, in 1918 (p. 36) he wrote that '...anthropology has a right to expect that human remains of whatever nature assigned to great antiquity should show some adjustment in structural type to such antiquity.' His examination of specimens in the Americas purported to derive from the Pleistocene yielded no such evidence of 'primitive' features - no evidence of anything like Neanderthals in Europe (Hrdlička, 1907, 1912, 1937). At the conclusion of his 1907 monograph, Hrdlička wrote that '...in every instance where enough of the bones is preserved for comparison the stomatological evidence bears witness against their geological antiquity and for their close affinity to or identity with those of the modern Indian' (Hrdlička, 1907, p.98). He goes on to note that this does not preclude the possibility that earlier

humans were in the Americas but only that definitive morphological and geological proof thereof was not available in 1907. Such proof never materialised during his career (Hrdlička, 1937).

Hrdlička was perhaps too zealous in his insistence that the earliest American skeletons did not differ significantly from more recent Native Americans. However, it is important to remember the framework in which these pronouncements were made. Although he never specifically declares this to be the case, Hrdlička is clearly approaching the study of these early American remains from an evolutionary perspective. Yes, he was a taxonomic ‘pigeon-holer’ when it came to recent human crania and in assessments of these purportedly early skeletons he does make reference to specific racial groups recognized at that time. However, it is also the case that his primary perspective on these particular specimens was to assess their antiquity and their evolutionary relationships. In other words, were they modern humans or some archaic human form? Hrdlička’s analyses clearly pointed to the former, and I contend that his equating of these early specimens with ‘the modern Indian,’ as he often wrote, was primarily a means of underscoring their basic modernity and less about their specific affinities within modern humans. It is that same evolutionary viewpoint that characterizes Stewart’s perspective on these earliest American skeletons (Stewart, 1973) and my own similar statements three years later (Smith 1976). As Chatters comments concerning his use of ‘Caucasoid’ to describe Kennewick, I should have been more precise by clearly attributing the morphology of remains known in 1976 to modern humans and not comparing them specifically to more recent Native Americans. In the conclusion, I did state that ‘...from a morphological point of view, the earliest suggested American Indian remains do not align them with any hominid form other than *Homo sapiens sapiens*’ (Smith, 1976, p.140). As I believe was largely the case for Hrdlička, my perspective on the material was palaeoanthropological (evolutionary), not a forensic or bioarchaeological one.

SITE (STATE)	DATE (METHOD)	PORTIONS PRESERVED (SEX/AGE)
Arlington Springs (California)	10,000 + 310 (A) 10,000 + 200 (B)	femoral and other postcranial fragments (?/adult)
Brown’s Valley (Minnesota)	8,000 – 10,000 (C)	cranium and mandible (♂/adult)
Gordon Creek (Colorado)	9,700 + 250 (A)	cranium, mandible, partial postcranium (♀/adult)
Laguna Beach (California)	17,150 + 1,470 (A)	fragmentary cranial and postcranial bones (?/adult)
Los Angeles (California)	23,600 + 1,100 (A)	fragmentary calvaria and postcranial bones (♀/adult)
Marmes (Washington)	10,687 + 215 (B)	cranial, mandibular and postcranial fragments (?/adult)
Melbourne (Florida)	Late Pleistocene (C)	cranial, mandibular, and postcranial fragments (♀/adult)
Midland (Texas)	7,100 + 100 (B)	fragmentary cranium, some postcranial elements (♀/adult)
Minnesota (Minnesota)	Late Pleistocene (C)	cranium, mandible, mostly complete postcranial skeleton (♀/adolescent)
Natchez (Mississippi)	Late Pleistocene (C)	os coxa (♀/adult)
Rancho La Brea (California)	9,000 + 80 (A)	cranium, mandible, some postcranial elements (♀/adult)
San Diego (California)	48,000; 44,000; 28,000 (D)	three partial skeletons (adults)
Taber (Alberta)	30,000 (C)	cranial, mandibular, and postcranial fragments (?/infant)
Tepexpan (Mexico)	11,000 + 500 (A)	cranium, mandible, some postcranial remains (♀/adult)
Vero Beach (Florida)	Late Pleistocene (C)	calvaria, mandible and postcranial fragments (♀/adult)
(A) Direct standard and uncalibrated radiocarbon date on bone collagen from the specimen (B) Direct standard and uncalibrated radiocarbon dating of associated remains (C) Dating by geological, faunal, or other relative technique (D) Amino acid racemization dating		

Table 1. Possible Remains of the Earliest Native Americans. This list is a slightly modified version of Table 1 in Smith (1976). The modifications are in how the information on each specimen is presented. The specimens list and dates are unaltered from the 1976 list.

### The skeletal remains of the earliest Americans: the 1976 survey

In 1976, I prepared a review of human skeletal remains from North America that were posited to date from the Pleistocene or very early Holocene at that time. Reviews of this evidence were provided on several occasions during the early twentieth century by Hrdlička (1907, 1918, 1937) and by his successor at the Smithsonian Institution, T. Dale Stewart (1960, 1973). By 1976, new chronometric dates were presented for several specimens, some of which suggested older ages than were



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available to Stewart (Bada and Helfman, 1975; Bada et al., 1974a,b; Berger, 1975; Berger et al., 1971; Bischoff et al., 1976). These results added new skeletal candidates and older dates to the debate which I felt warranted consideration. Table 1 lists the sites and specimens I considered in 1976. I excluded specimens that were dated or thought to younger than 8,000 years BP, as well as specimens for which a Pleistocene age had already been convincingly countered. I did include the Natchez os coxa because of its early discovery date, between 1837 and 1844, but only for historical reasons. I somewhat arbitrarily limited my focus to North America and although I was able to study the material from Minnesota listed here at a later date, the data and observations I made use of in 1976 were extracted totally from the literature.

My overall conclusion, based on the human skeletal material and chronological information available in 1976, was that there was not compelling skeletal evidence of humans in the New World older than between 20,000 and 27,000 years BP and, as noted above, that none of these specimens exhibited anything but modern human anatomy (Smith, 1976, pp.139-140). The date of 20,000- 27,000 years BP was an extrapolation based on a radiocarbon date published for the Yuha site (Bischoff et al., 1976), as well as dates on the Los Angeles and Laguna Beach specimens. I expressed doubts about older ages attributed to skeletal remains in two cases: the Taber infant skeleton – suggested to be ~30,000 years old (or more) and the so-called San Diego skeletons, dated to as much as 48,000 years BP. Table 1 is quite different from subsequent listings of early American skeletal remains (for example, Steele and Powell, 1992; Fiedel, 2004; Lepper, 2014) and an assessment of why the picture has changed so extensively will provide some insights into the problems often faced in accurately determining the age and context of specimens, particularly those actually or potentially of considerable antiquity. Three examples highlight these problems very well.

### Taber

The Taber infant skeleton was found in 1961 in south-western Alberta. This fragmentary skeleton was recovered in calcium carbonate-cemented sands that appeared to lie between two glacial tills, the upper one representing the Wisconsin glacial maximum (Stalker, 1969). There were no direct dates on the specimen, but its geologic context suggested an age in excess of 18,000 and perhaps as old as 60,000 years (Stalker, 1969). I chose 30,000 years as a conservative estimate of the specimen's geological age based on the information available in 1976. There were no cultural associations with the skeleton and the young age-at-death of the individual and its fragmentary condition precluded extensive morphological analysis. However, published photographs (Langston and Oschinsky, 1963) show exclusively modern infant cranial features. I noted concerns about the geological context but did not rule out the possibility that a late Pleistocene age might be accurate and thus would represent early biological evidence of a modern human presence in North America (Smith, 1976, pp.129-130).

However, the case for Taber's antiquity began to unravel soon after 1976. In the late 1970s, another team returned to the site to attempt to establish the skeleton's context (Wilson et al., 1983). No further skeletal remains were found, but a series of bone-bearing Holocene sand patches were noted. Analysis of the sand matrix still adhering to the Taber infant were a much closer match in chemical makeup and colour to these Holocene sands than to the Pleistocene alluvial deposits (Wilson et al., 1983). The last blow to a Pleistocene age for Taber came when a small segment of the infant skeleton was dated using the AMS radiocarbon method. The resulting age of  $3,550 \pm 500$  radiocarbon years BP (Brown et al., 1983), places the skeleton in the middle Holocene, far younger than the ages claimed for it previously.

### San Diego skeletons

A second example concerns the specimens I listed as the San Diego skeletons in 1976. The San Diego skeletons were remains of several individuals found in and around La Jolla and Del Mar, California. These specimens were studied in detail by Rogers (1963, 1974), whose descriptions clearly establish all of the specimens as anatomically modern. Table 2 gives the dates given estimated for the various specimens. These dates, ranging between 48,000 and 27,000 years ago, were all determined by amino acid racemization dating, a technique that measures the rate of protein diagenesis in bone or shell (Bada and Helfman, 1975). Amino acid racemization was the new rage in the mid-1970s and appeared to hold great promise for dating of skeletal remains. One reason there was so much excitement about the techniques was that it provided the possibility of determining chronometric ages for human remains, both biological and cultural, that were older than the range of radiocarbon at that time. The period from 40,000 BP back to 100,000 years ago or so was a bit of a black hole in terms of accurate chronometric dating at that time, and this was a critical period for understanding the pattern of modern human origins and the role of various archaic human forms, like the Neanderthals, in that process. The San Diego dates emerged in the context of this enthusiasm about amino acid racemization's potential impact on the study of human

evolution. These dates are still the earliest chronometric dates ever associated with early Native American skeletal remains and they created quite a stir in the 1970s.

Although in today's world of better chronology for the appearance of modern humans, 48,000 years BP might not seem so problematic, but in mid-1970s there was no compelling evidence that modern humans existed anywhere earlier than perhaps 40,000 to 45,000 years ago (see Smith, 1985). So a claim of an age of as much as 48,000 years for modern humans anywhere in the world back then was a really big deal, but it was especially so in North America. Because amino acid racemization was a relatively new technique, there was concern that various factors (most prominently temperature during burial or in areas where remains were stored after excavation) could affect the ages determined and such concerns were expressed regarding the age estimates for these burials (Protsch, 1975; see also discussion in Smith, 1976). Also for some specimens, there were already standard radiocarbon dates on associated material of the La Jollan culture ranging from  $5,460 \pm 100$  to  $7,370 \pm 100$  radiocarbon years BP (Rogers, 1963) that cast a shadow of doubt on the older dates. Subsequently, a series of AMS radiocarbon dates on the same skeletal specimens produced ages that range from 4,820 to 6,330 radiocarbon years BP (Bada et al., 1984a; Taylor et al., 1985). The AMS dates are comparable in age to the standard  $^{14}\text{C}$  dates on the La Jollan cultural material; and while this antiquity is certainly respectable for North America, the San Diego skeletons are certainly far younger than they were claimed to be in the 1970s.

Table 2. Amino Acid Racemization Dates for the San Diego Skeletons in 1976 (adapted from Bada et al. (1974a: p.791) and Bada and Helfman (1975, Table 7).

Specimen No. – Location	Date
W-34A – Del Mar	48,000 BP
W-34A – Del Mar	47,000 BP
W-34A- Del Mar	41,000 BP
W-2 – South of Scripps	44,000 BP
W-2 – South of Scripps	27,000 BP
W-12A – North of Scripps	39,000 BP
W-12A – North of Scripp	27,000 BP
W-99 – Batiquitos Lagoon	45,000 BP

### Laguna Beach, Los Angeles and Yuha

Single specimens from these three sites represented the other remains purportedly dated around 20,000 years ago back in 1976. Both Laguna Beach and Los Angeles are partial crania that are fully anatomically modern and were dated to  $17,150 \pm 1470$  and  $>23,600$  radiocarbon years ago, respectively (see Plhak, 1978, 1980). The Los Angeles specimen also yielded an amino acid racemization date of 26,000 BP (Bada and Helfman, 1975). Both specimens lack archaeological associations. As with the San Diego skeletons, subsequent direct AMS radiocarbon dating has determined ages of 5,100 radiocarbon years for Laguna Beach (Bada et al., 1984) and 3,560 for Los Angeles (Taylor et al., 1985). These dates indicate that the Los Angeles and Laguna Beach specimens are mid-Holocene, not Pleistocene, in age.

In the case of the Yuha burial, caliche covering one of the bones of burial was dated to  $21,500 \pm 1,000$  years BP by standard radiocarbon analysis (Bischoff et al., 1976) and an age of  $23,600 \pm 2,600$  BP was later determined based on amino acid racemization (Bischoff and Childers, 1979). However, doubts about the dating were quickly raised, based primarily on the cultural similarity of the Yuha burial to Holocene cairn burials in California deserts (Wilkie, 1978). Subsequent AMS radiocarbon dating directly on the skeleton yielded dates of  $<4 \text{ Ka BP}$ , supporting the mid-Holocene age for the Yuha burial (Stafford et al., 2004).

### What's left and what's new – a concluding perspective

All of the human skeletal specimens suggested in 1976 to demonstrate an age of more than 12,000 years for humans in North America have been shown to be much younger than they were then claimed to be. Even the Tepexpan skeleton (Mexico) is no longer considered 11,000 years old (or older), but rather about half that age based on a uranium series date of  $4,700 \pm 200$  years BP (Lamb et al., 2009). Comparison with the most recent compilation of dates for early material in North America (Lepper, 2014) shows that only seven specimens from my 1976 list are still considered to exceed 8,000

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years of age. These specimens and the ages available for them in 1976 and now are given in Table 3. The oldest of these, Arlington Springs, is now dated almost 1,000 years earlier than in 1976. Gordon Creek and Rancho La Brea still use the same dates that were available in 1976. The Browns Valley and Minnesota (Pelican Rapids) skeletons from Minnesota had estimated ages in 1976, but these estimates have been generally confirmed by direct  $^{14}\text{C}$  dates (O'Connell et al., 2013). Midland is considered about 10,000 years old, but this is not based on chronometric dating; and the Marmes specimens now have  $^{14}\text{C}$  dates that are about 1,000 years less than in 1976. Of course, there are now several other specimens not known or recognized in 1976, so that the sample size for specimens dated earlier than 8,000 years BP is now much larger and more informative (Fiedel, 2004; Powell, 2005; Lepper, 2014). Still, it is important to note that no specimen dates earlier than 13,500 radiocarbon years BP and most are less than 11,000 radiocarbon years BP. Thus, my two major points from 1976 remain basically supported by these new and improved data: skeletal remains in North America belong to modern *Homo sapiens* (*H. s. sapiens*) and there is no skeletal evidence for humans older than 27,000 years on this continent. In fact, current evidence demonstrates that I was too generous in my estimate, as there is no such evidence older than about 16,000 calendar years BP.

Several of the specimens added to the list of earliest Native Americans were recovered in Mexico, including most recently the Hoyo Negro specimen, dating to  $10,960 \pm 20$  radiocarbon years BP (Chatters et al., 2014). Although gracile, this female skeleton exhibits the generalised Palaeoindian morphological pattern discussed previously and does not demonstrate specific affinities to more recent Native Americans; and its D1 mitochondrial DNA haplotype, while derived from Asians, is unique to Americans (Chatters et al., 2014). The Hoyo Negro specimen, along with other Mexican remains of comparable age (see Lepper, 2014: Table 1.1) shows that the distinctively generalised morphology indicated for Kennewick and other Palaeoindian age-equivalent remains in the United States and Canada also extends into Mexico. Work by Neves and colleagues (Neves and Pucciarelli, 1991; Neves and Hubbe, 2005; Hubbe et al., 2010, 2011) demonstrates the extension of this morphological pattern into South America as well.

In a general sense, the fact that these early Americans do not show a clear indication of more derived Asian morphological features is easily understandable in a broader evolutionary perspective. In fact, prior to the mid-Holocene there are very few skeletal specimens that can

clearly be aligned with any modern so-called 'racial' morphological pattern (see Lahr, 1995). An excellent example of this is the case of the three Zhoukoudian Upper Cave or Shandingdong crania first studied by Weidenreich in the 1930s. Although seven individuals were identified in the sample, only the three relatively complete skulls were the subject of careful study. Weidenreich (1938-39, 1946) believed the three skulls had affinities with three different populations (Melanesians, Eskimos, primitive Mongoloids) but he did not note any specific connections with modern north Asians. In fact, he noted that modern north Asian skulls were higher and shorter than those from the Upper Cave but also that this recent pattern likely evolved from the Upper Cave form. The lack of close association between the Upper Cave and recent north Asian cranial has been reaffirmed by multivariate cranial analyses that find a more generalised form (Kamminga and Wright, 1988; Lahr, 1995; Hubbe et al., 2010, 2011) or perhaps affinities with Polynesians (Howells, 1989). A detailed morphometric study that included Pleistocene-aged modern human remains found that specimens like Upper Cave and Minatogawa 1 (Japan -16,400-18,250 years BP) exhibited some recent north Asian features but generally have '...not developed the modern "Mongoloid" configuration, which does not appear until the mid-Holocene' (Habgood, 2003, p.229). Howells (1989) also found that Upper Palaeolithic specimens from Europe were not appreciably closer morphologically to modern Europeans than the Ainu were; and Grine and colleagues (2007) determined that the 36,000 year old skull from Hofmeyr (South Africa) was more like Upper Palaeolithic Europeans than recent Africans.

*Table 3. Specimens from Smith (1976) considered to date earlier than 8,000 BP. See Table 1 for the basis of the 1976 dates. All dates are uncalibrated. For details of the Pelican Rapids and Browns Valley dates, see O'Connell et al. (2013). For the remainder of the 2014 dates and a complete list of specimens now considered 8,000 years old or older, see Lepper (2014).*

Site/Specimen	1976 Date	2014 Date
Arlington Springs	10,000+310	10,960+380
Brawns Valley	8,000-10,000	9,049+82/-72
Gordon Creek	9,700+250	Same as 1976
Marmes	10,687+215	9,870+50; 9,430+40
Midland	7,100+100	c. 10,000
Minnesota (Pelican Rapids)	Late Pleistocene	7,840+70
Rancho La Brea	9,000+82	Same as 1976

Of course all these specimens are older than the early American material, although Minatogawa is only slightly so. However, similar patterns are observed in more recent specimens. Howells (1989, 1995) found that some Mesolithic (early Holocene) European samples were only marginally related to more recent Europeans and the ~11,000-16,000 year old Iwo Eleru specimen from West Africa is more similar to archaic Africans than to recent ones (Harvati et al., 2011). It seems that recent modern morphological patterns do not appear to have much in the way of a Pleistocene time depth anywhere. Seen in the light of this evolutionary perspective, the fact that the earliest Americans (Palaeoindians), at least those older than ~ 8,000 years ago, exhibit a more generalised morphological form, differing from more recent Native Americans, is really not that unusual at all.

However, these differences do not mean that Palaeoindians were not pivotal in the ancestry of recent Native Americans, but rather that there are some evolutionary changes that mark the later development of recent Native American variation. This is aptly reflected by the recent demonstration that Kennewick is clearly allied with Native Americans genetically but not so unequivocally in cranial form (Rasmussen et al., 2015). There has been a tendency to view the origin of Native Americans in a series of 'waves' from Asia, particularly following the linguistic analysis of Native American languages by Greenberg (1987). Greenberg posited three waves with the last representing the Eskimo-Aleut peoples. Recent cranial morphometric analyses often have argued for a two-wave model, with the earlier Palaeoindian 'wave' representing a more generalised morphology that entered the New World prior to the emergence of classically north Asian features and a later 'wave' of people bearing these north Asian features (Powell, 2005; Neves and Hubbe, 2005; Hubbe et al., 2010, 2011; Jantz and Spradley 2014). However, as Jantz and Spradley (2014, p.486) state: 'These later migrants may have displaced the earlier ones, or more likely assimilated some, which would explain the high variability among recent Native Americans' (emphasis mine). As a human palaeontologist who studies the Neanderthals and the nature of their interactions with early modern humans in Europe, I see some potential demographic parallels with the Palaeoindian-recent Native American situation. I am not equating Palaeoindians with Neanderthals in a morphological or evolutionary sense. In fact, I make it clear above that Palaeoindians are modern humans. Still I suspect that Palaeoindians were relatively rare on the landscape, much as was certainly the case for Neanderthals (Smith, 2013, in press). Thus, one could make the case that, in a parallel fashion to Neanderthals, Palaeoindian contributions to recent Native American biology were relatively small, not because of any type of inferiority but just because there were not many of them to be assimilated.

A stumbling block to the 'two-wave' model comes from genetics. The primary mt DNA and Y-chromosome haplotypes, and some autosomal DNA, indicate that all Native Americans descended from a single ancestral gene pool (see reviews in Goebel et al., 2008; Hoffecker et al., 2014; but see Reich et al., 2012 and below). In 2007, Tamm and colleagues suggested that this population existed in Beringia, halting here after migrating from Asia in what is termed the Beringia standstill hypothesis. According to Tamm and colleagues, the standstill would have provided for the emergence of distinctively Native American mutations and would have been followed by a relatively rapid dispersion of peoples into the Americas beginning around 15,000 to 16,000 years ago. Considerable biological diversity, including cranial variation (Roseman and Weaver, 2004), would follow from this rapid dispersion and the subsequent adaptations of small populations to diverse environments and climates (Steele et al., 2007) spread across the New World. While a model derived from stochastic factors, mixed with selection, has robust explanatory power (Powell, 2005), there would appear to be a strong temporal pattern, specifically the Palaeoindian versus later Native American cranial form, that might not fit this model so well, at least not the stochastic aspect of it.

A good, if simple, illustration of this has to do with changing patterns of human head shape from the very late Pleistocene to post-agricultural populations. A good historical discussion of this was provided by Weidenreich (1945), who both reviewed and corrected some racially-based use and misuses of the cephalic or cranial index and provided some insight into its evolutionary significance. This index, determined by dividing maximum cranial breadth by maximum cranial length and multiplying by 100, was first defined by Anders Retzius in 1843 (see Retzius, 1845) and was often used to suggest replacement of one 'racial' group by another, particularly in Europe. Weidenreich showed that such an explanation did not fit the temporal pattern of cranial index change over time and suggested that the general shift from more long-headed people, which began with fossil human forms, towards more round-headed people among recent populations in many parts of the world resulted from evolutionary changes '...whose exact nature is unknown...' (Weidenreich, 1945, p.50). Weidenreich termed this trend the brachycephalization (round-headedness) of recent mankind.

Since Weidenreich's day, several factors have been shown to have impact on the cranial index in humans. One of these is climate, but climate clearly is not the primary factor since the trend toward brachycephalization occurs regardless of climatic circumstances (Beals et al., 1983, 1984). Much more significant is likely the impact of changes in functional demands on the masticatory apparatus. Carlson and Van Gerven (1977, p.495) noted that among Nubian skulls the shift to cereal grain agriculture '...led, secondarily, to an alteration of the growth of the maxillomandibular complex such that the face became progressively less robust and more inferoposteriorly located relative to the cranial vault.' Carlson and Van Gerven go on to suggest that increases in relative breadth and height of the cranial vault resulted from the reduced size and less prognathic nature of the face, which was the more direct result of reduction of the masticatory apparatus (see also Larsen, 2014). Such changes have been repeatedly documented for European and some Asian populations (see Weidenreich, 1945; Henneberg, 1976) and for certain North American groups (Newman, 1962; Steele and Powell, 1992). Palaeoindian crania tend toward being long-headed with lower

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vaults, with some intermediate specimens but no classically round-headed ones (Smith, 1976; Steele and Powell, 1992), but as agriculture dominates subsistence in certain regions, the cranial index and cranial vault height tend to increase. For example, in the Tennessee Valley, Archaic crania, from a hunter-gatherer population, tend toward lower indices (long-headed). Woodland people (incipient horticulturalists) are intermediate and Mississippian people, who are maize agriculturalists, tend strongly toward high indices (round-headed) (see Steele and Powell, 1992, p.318; Smith, unpublished). Interestingly, geographic groups where this trend to higher indices (round heads) is not so strong are areas where agriculture did not have an impact, for example in the Eskimo (Steele and Powell, 1992) and parts of southern Africa (Henneberg and Steyn, 1993).

While it may seem old fashioned to invoke head shape in the current world of geometric morphometrics, I believe that the 'brachycephalization' issue may well explain much of what happened from Palaeoindian times to the advent of recent Native American variation patterns. Of course, accurate explanations for complex biological changes are unlikely to be fully explained by one index of two measurements, but expanding slightly on the cranial index may be useful. If the genetic data are correct in suggesting a single source population for Palaeoindians and recent Native Americans, rather than models positing separate waves of different populations, then the masticatory-functional hypothesis of Carlson and Van Gerven may hold the key. My own data (unpublished) for the three archaeological groups of Tennessee Native Americans show that from the hunting-gathering Archaic people to the agricultural Mississippians, crania get higher (both absolutely and relative to cranial length) and prognathism reduces along with the changes in cranial index discussed above. This is the same general pattern found among the Nubians and a similar pattern characterizes the difference between Neanderthals and early modern Europeans (Bastir and Rosas 2013; Bastir et al., 2007, 2010, Smith 2013; Smith et al., in press), albeit on a different scale. Unlike the examples related to agriculture, the changes in Neanderthal-to-early modern faces involve other selective mechanisms and although the pattern of relationships between cranial breadth, height and length is quite similar, both fossil samples groups remain relatively long-headed. Still the developmental patterns responsible for these changes are likely comparable.

These cranial pattern changes certainly do not explain all aspects of the differences between Palaeoindians and more recent Native Americans. Specifically, they do not explain the development of some of the more north Asian features in the latter group. The comprehensive study of Native American genetic variation by Reich and colleagues (2012) shows that while the vast majority of this variability can be traced to a single migration, two other smaller migration events occurred. If the majority migration represents the Palaeoindians, then these smaller migrations might have introduced the recent features. However, this appears unlikely as these later influences seem relatively small and restricted to groups in the very northern part of recent Native American distribution. As I see it, we are left with the conundrum that genetics generally suggest a single source population for Palaeoindians and more recent Native Americans while many morphometric skeletal studies suggest different source populations.

I find it interesting that Tamm and colleagues (2007), in their presentation of the Beringian standstill hypothesis for the identification of the source population for the peopling of the New World, note something similar in mtDNA to what Reich and colleagues document. They demonstrate a later spread of one mtDNA haplotype into the New World and also the apparent back migration of two mtDNA haplotypes from Beringia into north Asia. Might it be that the Beringian population also gave rise to the emergence of other biological features that are considered characteristic of both north Asian and post-Palaeoindian Native American populations? Like the data presented by Reich and colleagues, these mitochondrial influences appear restricted to northern populations. However, perhaps the morphological features spread much further. Essentially then, all of the variation seen in Palaeoindians, later Native Americans and later north Asians might be derived from multiple migrations from that single Beringian source population. While this idea is speculative at this point, it would appear to offer a possible solution to the morphometric versus genetic view on the peopling of the New World.

Understanding of the peopling of the New World has increased impressively from the 1970s. Today this issue is informed by a tremendous amount of genetic and other biological evidence that both clarifies and complicates the exact nature of the migrations of people into the Americas. Often, there is a certain disappointment that more data do not lead immediately to clear answers to important questions, but the nature of science actually works in a different way. With more data, scholars can ask more detailed question and delve deeper into the intricacies of phenomena, both historic and current. This is the state of the art with the issue of Native American origins. Investigations have moved beyond the simple Asian-origin explanation to more detailed questions of precise population relationships and complex, multidirectional movements and thereby toward a more comprehensive picture of how the Americas were populated. This move to more detailed questions is exactly the same situation that has characterized my area of primary interest, the initial origin of modern people, in recent years. Those of us involved with either of these questions certainly work in exciting, if sometimes confusing, times.



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# The Origins and Context of Palaeoamerican Cranial Morphology: Implications for Discussions about Human Dispersal into the Americas

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## Abstract

The cranial morphology of the Early Holocene remains from Lagoa Santa, in central Brazil, have attracted the attention of researchers since the mid-nineteenth century and have been a central piece in discussions about the biological origins of early American populations. From the point of view of cranial morphology, these early populations have been described as being different from most of the modern Native American populations, generating a long standing debate about the origins of the early Holocene morphological patterns observed in the continent and its implications for our understanding of the processes of human dispersion into and occupation of the continent. Lagoa Santa (eastern central Brazil) is of high importance for this discussion, due to the high density of Late Pleistocene/Early Holocene sites and hundreds of human skeletons recovered from the local rockshelters and caves. These remains are unique in the continent, for they allow the study of the biological characteristics of early American groups from a population perspective, increasing the reliability of the conclusions drawn from the analysis of this material. This chapter summarises some of the morphometric analyses of this collection in the past decade and how these results address and contribute to the discussions about the settlement of the continent. Recent studies can be divided into two topics: the study of the origins of the morphology that characterizes early South American populations; and the study of how this morphological pattern is related to the morphology that characterizes recent Native Americans. To address the first topic, Early Holocene remains from Lagoa Santa were compared to Late Pleistocene remains from Europe and East Asia, and the results suggest that these populations share a common morphological pattern, for instance, they have closer morphological affinities with each other, despite the geographic distance between them, than with modern populations from their own continents. These analyses indicate that the Palaeoamerican morphology is a retention of the morphological pattern that characterized human populations around the planet by end of the Pleistocene and predates the diversification processes that gave rise to the actual human cranial morphological diversity on the planet. Regarding the second topic, different studies have tried to address the best dispersion models that would explain the diachronic morphological diversity in the continent. In the past decade, studies have defended models that assume 1) two discrete waves of human dispersion into the continent; 2) continuous gene-flow between Asia and the Americas during the Holocene; and 3) local morphological adaptations to new lifestyles and a different climate as possible causes for the observed diversity. However, to date no consensus has been achieved among authors addressing these questions and the debate about the best human dispersion model to explain the cranial morphological diversity across time in the continent is still unresolved. This lack of consensus might be the result of our limited understanding of the biological diversity that existed in the continent in the past, and to solve this problem future studies will have to include more comprehensive collections from the New World.

## Introduction

The initial occupation of South America dates to at least 14 cal kyr BP (Dillehay et al., 2008; Dillehay, 2009; Rothhammer and Dillehay, 2009), with the Pacific coast showing the earliest accepted archaeological evidence for human groups on the continent, associated with groups that probably depended heavily on coastal resources (Sandweiss et al., 1998; Dillehay, 2000; Dillehay et al., 2008). Early human evidence on the continent is more common in the Pacific rim and Andean regions (Dillehay, 2008), although there is no doubt that by 11 cal kyr BP most of the continent was already occupied (Salemme and Miotti, 2003), with groups dwelling in forest environments (Roosevelt et al., 1996; Guidon et al., 1998), bushy savannahs (Correal, 1990; Araujo et al., 2008; Araujo and Feathers, 2008;) and cold and semi-arid steppes and plains (Steele and Politis, 2009; Bayón et al., 2011).

These early settlements differ considerably from the early cultures described for North America, especially when compared to the megafauna-specialized Clovis culture (Dillehay, 2000). So far, South America lacks convincing evidence of a systematic exploitation of megafauna (Hubbe, A. et al., 2007; 2009, 2013; Borrero, 2009), although evidence of human and megafauna coexistence through the end of the Pleistocene/beginning of the Holocene has been reported in Brazil (Neves and Piló, 2003; Hubbe A et al., 2009, 2013) and Argentina (Politis et al., 2003; Borrero, 2009). It is probable that South America's occupation followed coastal routes (Rothhammer and Dillehay, 2009), as recently proposed for North America's Pacific coast (Dixon 2001; Erlandson et al., 2011). However, a clear connection between these dispersion movements is still to be established. There is little doubt that these Late Pleistocene/ Early Holocene groups were mobile, covering large territories to meet their subsistence needs. Certainly, the adaptation and colonization of new ecological niches must have posed a challenge to these initial groups, with social and ritual considerations having important roles in the creation of mobility strategies (Dillehay, 2008: 42).

It is likely that the lifestyle of early South Americans changed around 10 cal kyr BP when more permanent settlements start to appear in distinct regions of the continent (for example, Arriaza et al., 2008; Araujo et al., 2008; Dillehay et al., 2003; Dillehay, 2008; Piperno and Stothert, 2003; among others). This shift, which predates the domestication of plants and animals on the continent probably involved the establishment of logistic centres around which mobile groups were organized (Dillehay, 2008). These more permanent settlements can be seen as precursors to the diverse local cultural traditions that developed in the Middle Holocene.

From a biological perspective, little can be inferred about the first millennia of human presence on the continent, since human remains from this period are scant. Excluding a few individual skeletons in North, Meso and South America (Powell, 2005; Waguenspack, 2007; Feathers et al., 2010), osteological remains from the end of the Pleistocene are not found in the archaeological record. Therefore, attempts to reconstruct the biological characteristics and diversity of early Americans depend on estimates based on later material, which so far have been unable to offer a consensus regarding the origins of Native Americans' biological diversity. Early Holocene skeletal samples are more common in South America than in North America (Jantz and Owsley, 2001; Powell, 2005; Waguenspack, 2007) and have been described in Brazil (Hubbe et al., 2004, 2007; Neves and Hubbe, 2005; Neves et al., 2005, 2007a), Colombia (Neves et al., 2007b) and south Chile (Neves et al., 1999), although collections also exist in Peru (Benfer, 1990) and central Chile (Passig et al., 1986). The cranial morphology shared by early skeletons in the continent has been described as presenting a peculiar morphology. Recent studies have indicated that they share a morphological pattern not seen among most of the later Native Americans (Neves and Hubbe, 2005; Hubbe et al., 2010, 2011). Indeed, studies show a wide array of populations that would have closer morphological affinities to them than recent Native Americans: Australo-Melanesians (Powell and Neves, 1999; Jantz and Owsley, 2005; Neves et al., 2007a; Hubbe et al., 2010), Sub-Saharan Africans (Neves and Pucciarelli, 1989; Neves and Hubbe 2005), generalised Asian groups (Brace et al., 2004; Seguchi et al., 2011) or even European populations (Chatters, 2001).

This early morphological pattern, sometimes referred to as Palaeoamerican (Neves and Hubbe, 2005, but see Gonzalez-José et al., 2008 for a critic on its use), is characterized by long and narrow crania, low and projecting faces, and low orbits and nasal apertures (Neves and Hubbe, 2005; Hubbe et al., 2010, 2011). This pattern contrasts with the morphology present among recent Native American groups, that varies around a central tendency characterized by short and wide neurocrania, high and retracted faces, and high orbits and nasal apertures, although there is considerable variation around this central tendency (Gonzalez-José et al., 2003, 2008; Pucciarelli et al., 2006; de Azevedo et al., 2011). Although the Palaeoamerican and late Native American morphological patterns overlap to a great extent when individual variation is taken into account (González-José et al., 2008), when contrasted to modern worldwide variation, these differences are not subtle, being of roughly the same magnitude as the difference observed between recent human populations from distinct continents (Neves and Hubbe, 2005; Neves et al., 2013). When assessed within the comparative framework of worldwide craniometric human variation, early American groups often show stronger morphological affinities with Australo-Melanesian and African samples, while most Amerindian groups share the morphological pattern observed today among recent east Asian populations (Neves and Hubbe, 2005; Hubbe et al., 2010).

The morphological differences between Early and Late American skeletons were initially noticed by nineteenth century scholars studying the skeletal remains from Lagoa Santa, in east-central Brazil. Following the typological paradigm accepted by those scholars, some of these authors deemed the differences between early and late groups large enough to constitute distinct human races, the early 'Lagoa Santa Man' (Rivet, 1908). In fact, the antiquity and the nature of the Lagoa Santa individuals called the attention of many scholars in Brazil, Europe and the United States (Lacerda and Peixoto, 1876; Kollman 1884; Ten Kate, 1885; Quatrefages, 1887; Hansen 1888; Virchow, 1892; Hrdlicka, 1912), especially since their morphological characteristics were so different from recent Native Americans (Lacerda and Peixoto, 1876; Ten Kate, 1885; Hansen, 1888; Rivet, 1908; Imbeloni, 1938). Today, Lagoa Santa is one of the two regions in the entire continent with enough individuals recovered from early contexts that permit their study from a population perspective, allowing for more reliable extrapolations about the biological characteristics of Early American groups. The second region is Bogotá Savannah, in central Colombia,

where a series of early skeletons have been recovered from local limestone rockshelters. This material has been covered in detail by Neves et al. (2007b) and represents a collection of ~20 skeletons dated to between 11.5 and 6.5 ky BP, coming from only a handful of sites. No other collection of early specimens presents numbers even close to these (Waguenspack, 2007; Neves et al., 2013).

Even when compared to the Bogotá Savannah, Lagoa Santa is remarkable in terms of its archaeological record. During almost two centuries of excavations in the area over 100 human skeletons dated to between 11.5 and 7.5 14C kyr BP were recovered. Consequently, the Lagoa Santa human remains represent by far the largest series of early skeletal remains from the Americas (Neves and Hubbe, 2005). This material has been repeatedly used in studies about the biological diversity and the mode of dispersion of human groups into the continent (for example, Neves and Pucciarelli, 1989, 1991; Powell and Neves, 1999; Neves et al., 2004, 2005, 2007a, 2013; Powell, 2005; Van Vark et al., 2003; González-José et al., 2008; Hubbe et al., 2010, 2011; de Azevedo et al., 2011; Seguchi et al., 2011), as well as studies dealing with aspects of their lifestyle (Da-Gloria, 2012; Hubbe A et al., 2009; Mendonça de Souza, 1995; Neves and Corneiro, 1997; Neves and Piló, 2003; Prous and Fogaça, 1999).

The main concern regarding the Lagoa Santa remains has been to explain the origin of its peculiar morphological pattern when compared to most recent Native American populations. The existence of two distinct morphological patterns across time indicates that the process of human dispersion into the continent might have been more complex than traditionally assumed. Several studies of early American cranial morphology suggest that the differences observed between early and later American groups are too large to be accommodated into a single expansion event into the continent. Instead these works have argued for two dispersal events into the Americas by populations sharing a common ancestor in East Asia (Neves et al., 2004, 2007a, b; González-José et al., 2005; Neves and Hubbe, 2005; Hubbe et al., 2010). Others, however, consider that the morphological differences between early and late Native American populations result from differences accumulated through time in concert with local microevolutionary forces, such as genetic drift and natural selection, acting on cranial shape (Powell, 2005; Perez et al., 2007, 2010) or were a result of the continuous influx of diversity from Beringia into the continent (González-José et al., 2008; de Azevedo et al., 2011), an interpretation consistent with most, though not all, genetic evidence (Bonatto and Salzano, 1997; Zegura et al., 2004; Tamm et al., 2007; Wang et al., 2007; Fagundes et al., 2008; Rothhammer and Dillehay, 2009; but see Perego et al., 2009; Reich et al., 2012).

Consequently, the study of the origins of the morphological pattern of early Americans, as well as the process through which the morphological diversity seen in the continent along time originated, is key to understanding details about the human dispersion into the New World in the past. Two questions regarding the evolutionary context of the Palaeoamerican morphology have been extensively debated in the literature in recent years, and this chapter summarises the results of some of the recent work on this subject (for example, Hubbe et al., 2010, 2011; Neves et al., 2013). The first question relates to the origin of the Palaeoamerican morphology. More specifically, it addresses the question of whether the Palaeoamerican morphology is unique to the continent or if it can be traced back to ancestral populations outside the continent. Elucidating if the Palaeoamerican morphology is a local development or if it is related to the evolutionary history of modern humans outside the Americas is an essential first step in explaining its origin and how it related to the process of human dispersion into the continent. The second question relates to the origins of the recent Native American morphological pattern and its relationship to the early Palaeoamerican morphology. Many studies have focused on this question, since the definition of the degree of association between these morphological patterns can shed light on the pattern and number of dispersion waves into the New World.

In exploring these questions, Lagoa Santa has been of unique importance, due to the size and chronological frame of its skeletal collections. Therefore, very few studies dealing with early Americans' biological diversity have not included the Lagoa Santa material or parts of it. Due to its preponderance in the studies about the morphological characteristics of Early Americans and its contribution to the discussion about the tempo and mode of the human dispersion into the New World, this chapter will precede the discussion of the morphological analyses of early South American remains with a general description of Lagoa Santa's archaeological background and history of discoveries, complementing it with new data generated by the latest research of the past decades.

### Lagoa Santa archaeological record

The karstic region of Lagoa Santa (Figure 1) derives its importance from the studies of early humans in the continent from the long history of palaeontological and archaeological excavations of its caves and rockshelters, and the relatively well preserved archaeological packages dated to the beginning of the Holocene. The region became famous during the nineteenth century thanks to the systematic work of the Danish naturalist, Peter Lund, who explored hundreds of caves in the region between 1835 and 1844 and intensively excavated around 60 of them (Lund, 1844, 1845; Holten and Sterll,

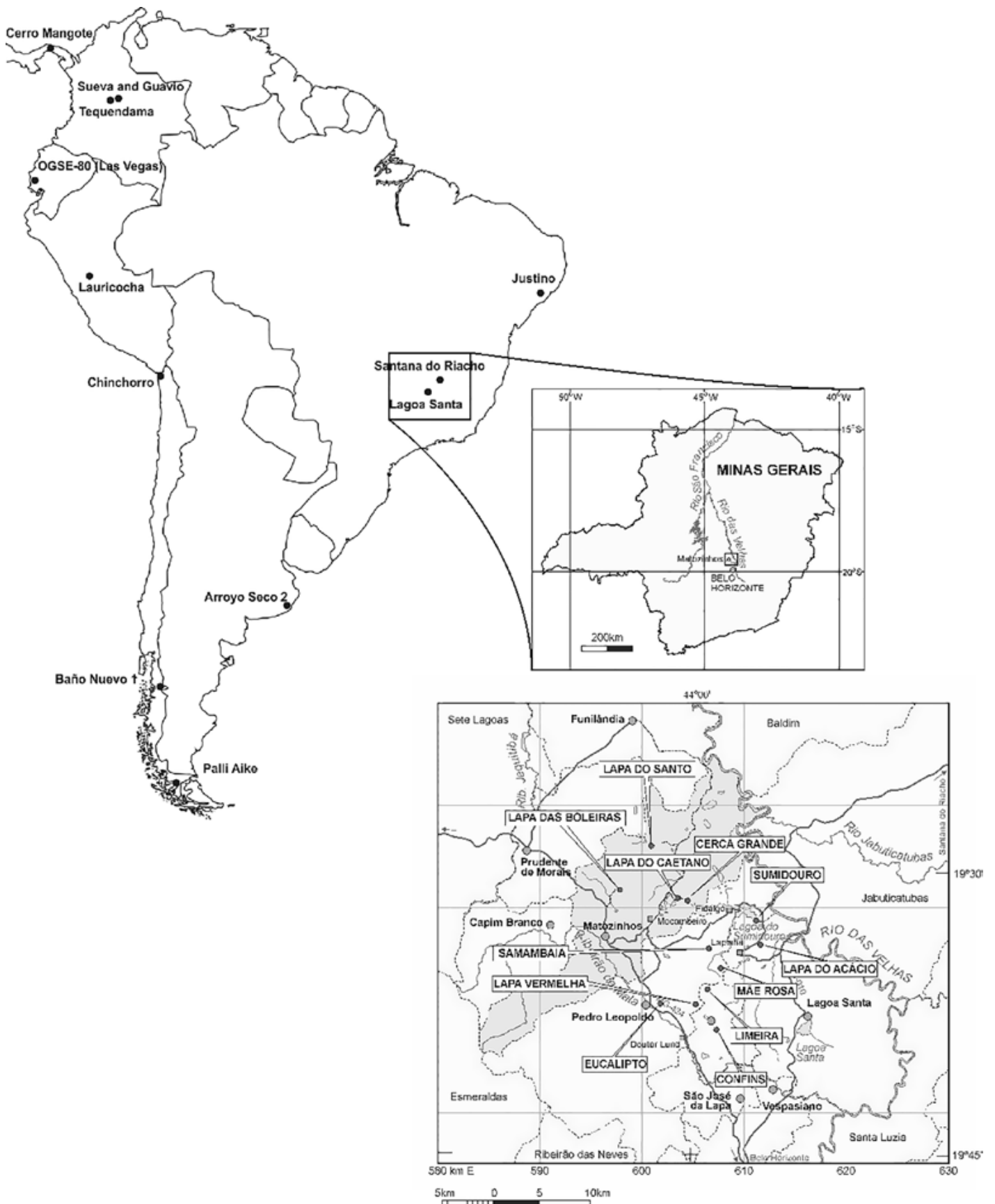


Figure 1. Location of Lagoa Santa and other important archaeological regions with early human remains in South America



1999). Lund was primarily interested in the Quaternary faunal deposits in the region and based on his findings, described several new genera and species of extinct mammals that inhabited the region in the past. However, in the context of this chapter his most significant contribution was the discovery of human remains associated with extinct megafaunal specimens inside Sumidouro Cave (literally 'swallet cave'). The Sumidouro remains, recently dated to a minimum age of ca. 8,500 cal yr BP (Neves et al., 2007a), were among the first evidence of an older presence of human beings in the continent, quickly becoming a major topic of discussion among European and American scholars (for example, Hansen, 1888; Hrdlička, 1912; Lacerda and Peixoto, 1876; Rivet, 1908).

Lund's work certainly inspired many new researchers to explore the caves and rockshelters of the region during the following centuries. Of special interest to this chapter is the work of the French-Brazilian mission (Laming-Emperarie, 1979; Prous and Fogaça, 1999), who recovered the oldest evidence of human evidence in the region: a young female skeleton recovered from Lapa Vermelha IV, a 14 m deep fissure filled with sediment and faunal remains, but with scant evidence of formal human presence. The skeleton was not recovered inside a burial context, being probably the result of a body that was discarded into the fissure. The skeleton was originally dated to 11.4–16.4 cal kyr BP (Laming-Emperaire, 1979), based on its stratigraphic position between charcoal concentrations. New OSL dates agree with the date range of this skeleton, suggesting a range of between 12.7 and 16.0 cal kyr BP (Feathers et al., 2010). Although only one individual, the skeleton from Lapa Vermelha IV is currently one of the oldest in the Americas and attests for the presence of human beings in the region of Lagoa Santa since at least the final millennia of the Pleistocene.

Other research teams during the twentieth century excavated a great number of caves and rockshelters in the region with evidence of early human occupations, and generated relevant collection of early human skeletons. Hurt and Blasi (Hurt, 1960, 1964; Hurt and Blasi, 1969) excavated the Cerca Grande complex, from where 17 burials dated to 9,500 and 8,000 14C yr BP were recovered. Finally, Harold Walter led a team of amateur archaeologists who excavated many different sites, recovering early human remains from Lapa Mortuaria and a high number of skeletons from different sites in the region (see Neves and Hubbe, 2005 for a complete list of well-preserved skulls from Lagoa Santa, and Strauss, 2010 for a discussion of their chronology).

Since 1999, a long term archaeological project in the Lagoa Santa region has been led by Prof. Walter A. Neves (Universidade de São Paulo, Brazil). Over this decade of work, two rockshelters with deep archaeological packages were systematically excavated (Araujo et al., 2008), one of which – Lapa do Santo – has a high concentration of human burials. To date, 32 burials dated to between 9,200 and 7,000 14C yr BP were recovered from Lapa do Santo, showing a wide array of burial practices, including complex secondary ritual manipulation of human remains in a significant part of them (Strauss, 2010, 2011, 2012; Strauss et al., 2011a, 2011b).

The new dates generated for the region showed that Pleistocene individuals are quite rare and only the individual from Lapa Vermelha IV (Luzia) has been dated to before the Holocene. Despite the presence of Pleistocene dates at the bottom of the archaeological record in the rockshelters (for example, Araujo et al., 2008), the systematic use of these spaces as burial ground did not start until ~9,500 14C yr BP, suggesting a possible shift in the cultural background of groups living or moving across the region around this date.

During the last 13 years, the permanent lake shores of the region were prospected and evidence of human presence in the form of lithic artefacts has been recovered dated to c. 8,300 14C yr BP (Araujo and Feathers, 2008; Araujo et al., 2013), suggesting a possible increase in the logistic use of the regional resources by populations that established themselves in Lagoa Santa during the beginning of the Holocene. Inside rockshelters, the pattern of secondary burials described in Lapa do Santo contradicts the notion that early groups of Lagoa Santa had simple and homogeneous burial practices (Strauss, 2010, 2011, 2012; Strauss et al., 2011a, 2011b). In fact, the burials recovered from this site show a complex ritual processing of the dead, frequently dichotomizing cranial and postcranial remains by organizing bundles of the later (sometimes of more than one individual) around and/or inside opened skull cases (Strauss, 2010).

The project in Lagoa Santa also excavated palaeontological sites and systematically dated megafaunal remains of the region, through which it was able to show a significant chronological overlap between human groups and extinct megafaunal species. At least the saber-tooth cat (*Smilodon* sp.) and one type of ground sloth (*Catonyx cuvieri*) survived into the Holocene (Neves and Piló 2003), although no evidence of direct interaction between human and megafaunal species have been reported for the region (Hubbe, A. et al., 2009, 2012, 2013), suggesting that these hunter-gatherers were not focusing on large prey. The faunal assemblage recovered from the Lagoa Santa archaeological records is strongly dominated by deer (*Mazama* sp.) with a minor participation of medium and small mammals (armadillos, wild pigs and rodents), as well as birds, lizards and snails. The specialization towards smaller fauna is supported by the lack of a lithic points industry specialized to this end, with the local lithic assemblage being composed mainly of small and micro flakes made out of quartz, with only minor changes observed over the more than 3,000 years of occupation of the local rockshelters (Araujo et al., 2008). The

diet of these populations appears to have included a larger amount of cariogenic items (rich in carbohydrates) than typical hunter-gatherer populations, which resulted in unusually high prevalence of dental caries among the local groups (Neves and Cornero, 1997; Neves and Kipnis, 2004; Da-Gloria, 2012).

In summary, the early archaeological sites of Lagoa Santa show the presence of humans by the end of the Pleistocene, who progressively increased their use of the landscape, developing a specific cultural tradition that clearly reflects their adaptation towards the local landscape. The local cultural development, reflected in their technology, treatment of the dead and even dietary practices, contrast sharply with the typical image of early American groups elsewhere in the continent and favour the idea that by the beginning of the Holocene the Americas were occupied by diversified groups that developed specific and unique ways to handle the landscape around themselves (Dillehay, 2008).

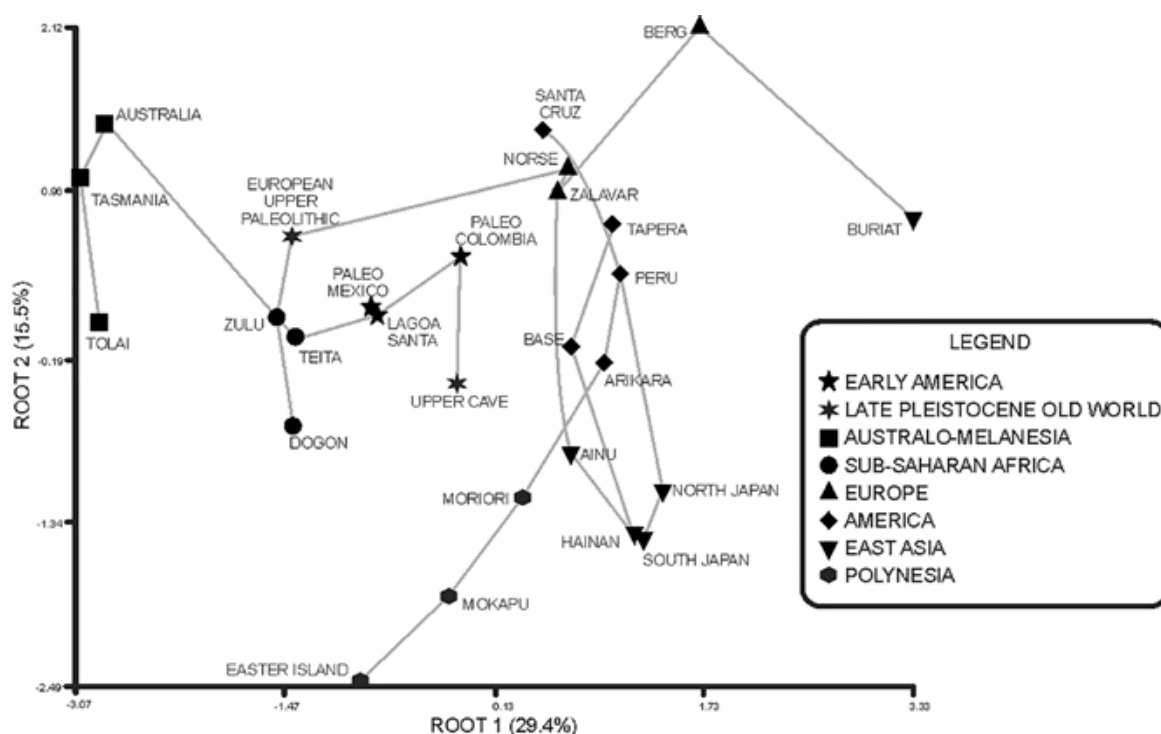


Figure 2. Cranial morphological affinities between early American and Late Pleistocene Old World series in reference to modern human worldwide morphological variation.

## Palaeoamerican morphology in its late Pleistocene context

As presented above, the early human groups that inhabited Lagoa Santa during the first millennia of the Holocene share a distinct cranial morphological pattern when compared to most of the late Native American populations. These differences might denote important biological differences as well as important levels of diversity in the continent during the Holocene, which might be a product of the complex processes of human dispersal into and occupation of the New World in the past. To explore the origins of this morphological diversity in the continent, two lines of research have been followed in the past decades. The first, resumed in this session, refers to the origins of Palaeoamerican morphology. The second, addressed in the subsequent session, addresses the origin of the Late Native American morphological variation and how it relates to Palaeoamerican morphology.

The main goal of the studies dedicated to understanding the origin of the Palaeoamerican morphology has been to contextualise this morphology in the continent as well as on the planet, to elucidate if this morphological pattern is unique to the Americas or if it can be seen in the context of the evolutionary processes that characterize modern human cranial morphology worldwide. Although this morphological pattern is better observed among Lagoa Santa populations, due to its large sample size, it is not unique to this region, being found widespread in South America by the end of the Holocene. In fact, every human skull dated to more than seven thousand years BP, compared so far with Lagoa Santa, shows high morphological affinities with this population and share the Palaeoamerican morphological pattern. In South America, it has been described in samples from east-central Brazil (Lagoa Santa; Neves and Hubbe, 2005; Neves et al., 2007a) and Colombia (Bogotá Savannah; Neves et al., 2007b), as well as in isolated specimens from south-east Brazil (Capelinha; Neves

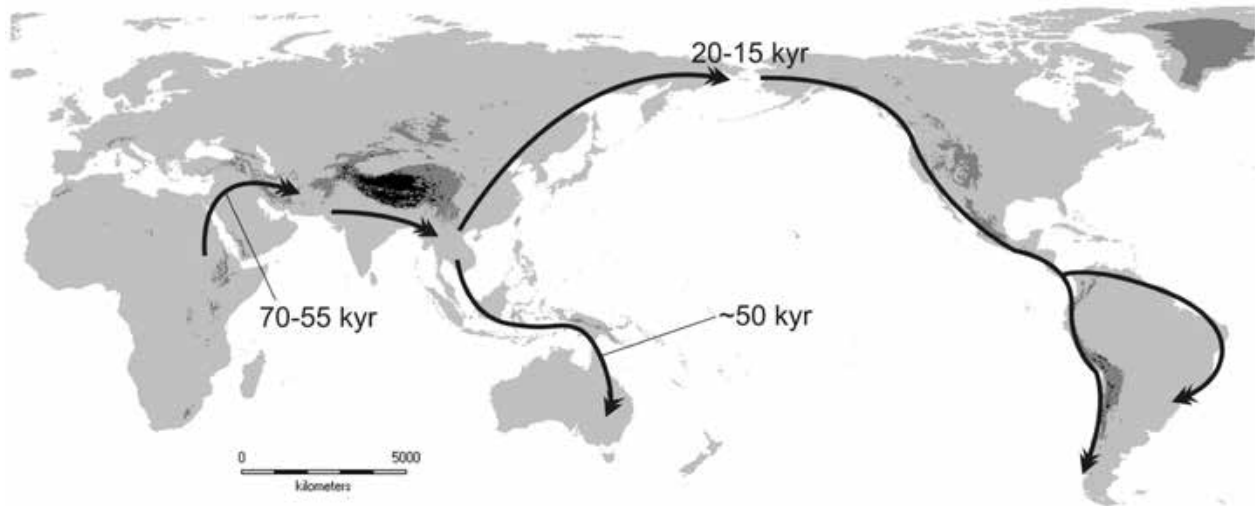


Figure 3. The morphology of early American groups might result from retention of the morphology of the first human groups, which left Africa between 70 and 55 kyr BP. In this sense, the settlement of the New World can be seen as a direct extension of the human dispersion out of Africa into Southeast Asia and Australia. Dates presented are an approximation based on the recent literature (Mellars, 2006; Dillehay, 2009; among others).

et al., 2005), north-east Brazil (Toca dos Coqueiros; Hubbe et al., 2007) and southern Chile (Palli Aike; Neves et al., 1999). However, distinct cranial morphology has also been observed in early skulls from Mesoamerica (Mexico; Gonzalez-José et al., 2003) and North America (Jantz and Owsley, 2001; Powell, 2005). Therefore, there is currently a consensus that the entire continent was occupied by human groups sharing a common morphological pattern by the end of the Holocene.

Cranial morphology is largely defined by stochastic evolutionary processes (for example, Harvati and Weaver, 2006a, b; Relethford, 1994; Roseman, 2004), with selective adaptation being restricted to extreme regions or localised anatomical regions in the skull (for example, González-José et al., 2005; Harvati and Weaver, 2006a,b; Hubbe et al., 2009). Consequently, cranial morphology has been used widely to reconstruct phylogenetic histories between human populations. Recently, a study compared the cranial morphology of Early Americans with Late Pleistocene individuals from East Asia and Europe (Hubbe et al., 2011), with the objective of testing whether Palaeoamerican morphology is a unique process to the New World or if it is related to the evolutionary processes that were shaping modern human morphology worldwide. The comparison is based on linear measurements of the skulls that together represent the morphology of the individuals included in the analyses. The Late Pleistocene and Early American groups were analysed within the frame of modern human cranial morphological variation, by comparing them to the reference series measured by Howells (Howells, 1973, 1989). Figure 2, adapted from Hubbe et al. (2011), shows the comparison between early Americans and Late Pleistocene Asians and Upper Palaeolithic Europeans, when compared to the worldwide morphological variation. The graph shows how similar series are to each other in two ways: the distribution of the samples along axes represents their morphological affinities according to the first two canonical variates, for instance, the closer the dots on the graph, the more alike their skulls. The lines connecting the series represent the Minimum Spanning Tree of the biological distance matrix and represent, according to this statistic, the shortest path connecting all series (see Hubbe et al., 2011 for details on the methods applied). In other words, series connected by lines are more similar to each other. The two approaches complement each other, giving a more reliable representation of the morphological affinities between series (see Hubbe et al., 2011, for justifications of the methods). When only the canonical variate information (position of the dots on the graph) is taken into account, all early samples appear closer to each other on the central region of the graph, in proximity to the Sub-Saharan African series, while the recent samples present a general geographic logic, with series from the same region appearing closer to each other. As expected, late and recent Native American groups appear to be associated with East Asian populations in the first canonical variate, as do some of the European samples (Norse and Zalavar). Furthermore, the MST connects all early samples to each other and to Sub-Saharan Africa. No connection between the early series and modern samples from their respective geographic regions can be observed, with the exception of European Upper Palaeolithic and Norse. Therefore, this analysis strongly supports that early Americans are more similar from a cranial morphology point of view to other Late Pleistocene groups on the planet than to recent populations from the same continent.

In the last decades, there has been a growing consensus that all modern human groups shared a late common ancestor in Sub-Saharan Africa and, as a consequence, all Late Pleistocene/Early Holocene groups derive from a single dispersion out of that continent. This idea is based on the fact that early modern humans, dating to the time period of the late modern human expansion (60-30 kyr BP), tend to be more similar to each other than to later populations from the same region

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(for example, Stringer and Andrews, 1988; Bräuer, 1992a, b; Stringer, 1992, 2002; Grine et al., 2007, Harvati et al., 2007; Harvati, 2009).

In this context, the origin of early American morphology is a relevant question, especially given that it also differs from the morphology that is seen in contemporary east Asia, the region from which these groups most likely dispersed into the New World. The analysis presented in Figure 2 favours the idea that this morphology might be a retention of the morphological pattern seen in the first modern humans leaving Africa (Neves et al., 2003), between 70 and 50 thousand years ago (Harpending et al., 1998; Macaulay et al., 2005; Mellars, 2006; Takasaka et al., 2006) and would thus precede the morphological differentiation in east Asian populations that likely occurred during the early Holocene. In this case, the first modern human expansion out of Africa into Asia, which likely followed a coastal route along south Asia (Lahr, 1995; Mellars, 2006), separated after reaching South-East Asia, with one branch expanding south into Australia and the other expanding north, towards Beringia, and subsequently into the Americas (Figure 3).

Retention of ancestral traits has also been observed in Late Pleistocene specimens from Africa (Grine et al., 2007), Europe (Harvati et al., 2007), East Asia (Neves and Pucciarelli, 1998; Harvati, 2009) and Australia (Schillacci, 2008). A common undifferentiated morphological pattern across Eurasia in the Late Pleistocene is consistent with the predictions of the Single Origin Model of modern humans, favouring a common recent ancestor for Late Pleistocene groups around the Old World (Stringer and Andrews, 1988). Therefore, these studies broadly support the idea that the morphological diversity seen among modern human groups today is a process of late differentiation that probably took place during the Holocene. In this scenario, the closer morphological affinities observed between Early Americans, European Upper Palaeolithic and Upper Cave samples presented here suggest that the largely undifferentiated Late Pleistocene modern human morphology also dispersed into the New World.

The fact that Palaeoamerican morphology might reflect a retention of the ancestral modern human morphology observed in the late Pleistocene Old World has implications for the settlement of the New World, especially if adaptation to cold climate is one of the forces responsible for the morphological differentiation in modern humans, even if only of specific anatomical regions (Roseman, 2004; Harvati and Weaver, 2006a,b; Hubbe et al., 2009; von Cramon-Taubadel, 2009). Since crossing the Bering Strait is believed to be the best route for early groups getting into the New World (Dixon, 2001; Goebel et al., 2008; Dillehay, 2009), this crossing through a harsh, cold environment must have been a relatively quick process, otherwise these populations would show evidence of cranial morphological adaptation to a cold climate. The speed of this process, however, is hard to evaluate at the moment given that the duration of the processes of morphological adaptation and response to environmental factors is poorly understood.

This suggestion goes against molecular evidence, which has recently proposed a period of biological isolation of proto-American groups, possibly in Beringia, between 35 and 25 kyr BP (Tamm et al., 2007; Gonzalez-José et al., 2008; Kitchen et al., 2008; Mulligan et al., 2008), although no major environmental or geographic barrier between Beringia and east Siberia existed to explain this isolation. Also, the idea of rapid migration following a coastal route has been proposed in recent years to explain the settlement of the New World (Dixon, 2001; Fagundes et al., 2008; Dillehay, 2009). It is reasonable to assume that the same pattern of dispersal was also adopted by earlier human groups prior to their arrival in the Americas (Mellars, 2006). Therefore, it is possible that rapid coastal migration had already been adopted in Asia by Late Pleistocene human groups for a relatively rapid crossing of the Bering Strait. In this context, coastal environments could represent quick range expansion pathways, providing a relatively homogeneous ecological system for groups to spread without the necessity of significant technological innovations (but see Westley and Dix, 2006, for a critique of the diachronic stability of coastal environments).

### Origins of morphological diversity during the Holocene

While the view on the origin of Palaeoamerican morphology described above has not been contested or contradicted by new analyses, the same cannot be said for the discussion about the origins of the morphology that characterizes most of the recent Native American groups. The increase of morphological diversity during the Holocene and the appearance of a new morphological pattern in the continent, closely resembling the morphology seen in modern east Asian groups, has been explained by either multiple dispersion waves into the continent (Neves and Hubbe, 2005; Neves et al., 2007a,b; Hubbe et al., 2010), a result of local microevolutionary processes (Powell, 2005; Perez et al., 2007, 2010) or the result of a continuous gene flow with north-east Asia during the Holocene (González-José et al. 2008; de Azevedo et al., 2011). Defendants of the first scenario argue that the differences between early and late morphological patterns are so large that they cannot be explained only by local microevolutionary forces. Under this scenario, the morphological pattern of Early Americans represents the morphology present on the planet by the end of the Pleistocene and was brought into the New World by

the initial settlers crossing the Bering Strait. A new morphological pattern, similar to the one seen among recent east Asian groups, was brought into the Americas by a second wave of dispersion (but not necessarily only one discrete migration), which largely replaced the early pattern, although groups sharing a similar morphology with the early groups have been reported during the mid-Holocene in Colombia (Neves et al., 2007b) and Late Holocene in Baja California (González-José et al., 2003), Patagonia (Lahr, 1995) and central Brazil (Atui, 2005).

The second scenario developed to explain the morphological diversity observed across time in the Americas assumes that the morphological changes can be explained by local changes in time. This scenario has received some support from dental morphological studies (Powell, 2005) and studies in Argentina comparing cranial shape to molecular data (Perez et al., 2010), but has been considered less parsimonious than multiple migrations from or continuous gene flow with Asia in studies that tested which scenario fitted best the morphological diversity in the continent as a whole (Hubbe et al., 2010; de Azevedo et al., 2011).

The third and most recent scenario proposed to explain morphological diversity in the continent assumes that the early populations that entered the continent showed already high levels of morphological diversity and that the continuous gene flow between American and north-east Asian groups shaped the morphological diversity of American groups across time (González-José et al., 2008; de Azevedo et al., 2011). This proposal overlaps with the dual dispersion model by assuming that the diversity observed in the continent depends on the influx of extra diversity from outside the continent. The difference between these scenarios, thus, is the nature by which this influx occurred, with the first scenario defending more discrete migrations and the second maintaining that gene-flow was constant and continuous between Asia and America throughout the duration of the Holocene.

This lack of consensus in the process of human occupation of the continent is also observed among studies of the genetic variation of Native American groups. Largely restricted to recent populations, molecular studies in the past 25 years have defended between one and three discrete migrations into the continent (Bonatto and Salzano, 1997; Zegura et al., 2004; Tamm et al., 2007; Wang et al., 2007; Fagundes et al., 2008; Perego et al., 2009; Reich et al., 2012), sometimes defending continuous gene flow with north-east Asia (Tamm et al., 2007; González-José et al., 2008) or even a period of isolation of Proto-Americans (Tamm et al., 2007; Kitchen et al., 2008) from Asia before the dispersion into the New World. This lack of consensus among molecular data has hindered attempts to conciliate the morphological with genetic evidence (for example, Greenberg et al., 1986; González-José et al., 2008) difficult and prone to criticism.

Consequently, although the increased morphological diversity in time and the shift in morphological pattern across time in the Americas suggests an influx of further diversity into the continent, at present it is impossible to offer a more definite opinion on whether this was a product of multiple discrete migrations into the continent or a result of gradual influx as a result of continuous contact and gene flow between north-east Asia and North America.

Finally, although authors tend to extrapolate their conclusion to the entire American continent, it has to be noted that the early American series available to date all come from South America. Morphological analyses can be seen to favour the notion that all early North, Central and South American groups shared a common morphology, since Lagoa Santa and Early Colombian groups show the same morphological pattern seen in other parts of the planet by the end of the Pleistocene. Consequently, the increase in morphological diversity and the late appearance of a new morphological pattern in the continent was probably a continent-wide event. However, it is possible and reasonable to assume that the processes by which this influx of morphological diversity occurred in the continent might have been different between North and South America. As argued extensively in the literature (for example, Dillehay, 2008), there is enough archaeological evidence to show that the early South American groups do not culturally resemble early North American groups. Therefore, the same might be true of the biological characteristics of early populations in each continent. For instance, it is possible that in North America this influx was a result of a continuous influx with Asia, whereas in South America this same event could have taken place through more discrete waves of dispersion. This scenario has some support from recent molecular studies that suggest that continuous gene flow with north-east Asia was probably restricted to the northern regions of North America (Tamm et al., 2007; Reich et al., 2012). Also, discrete dispersion waves in South America has received some support by molecular studies, who suggested two discrete dispersion waves inside the continent, based on rare mtDNA lineages (Perego et al., 2009) and a much higher degree of between populations diversity in non-Andean native South Americans (Tamm et al., 2007).

Yet, many other molecular studies would refute this idea and defend one single wave of dispersion into South America (Greenberg et al., 1986; Tamm et al., 2007; Reich et al., 2012) or even the Americas as a whole (for example, Zegura et al., 2004; Wang et al., 2007). At present, it is hard to corroborate or refute a particular scenario of how populations dispersed across the continent, which highlights the fact that our data about early American groups is biased by being restricted to



South America and that any model to explain the origins of the first South Americans does not necessarily apply to North America.

## Conclusions and future research directions

The importance of the Lagoa Santa region, with its dozens of late Pleistocene/early Holocene sites and hundreds of human burials, to the studies of the characteristics of early human groups in South America cannot be highlighted enough. The human presence in the region during the final millennia of the Pleistocene and early Holocene shows a series of groups adapted to the local environment, with lifestyle and burial practices remarkably different from that seen in other regions of South and North America. By itself, this shows that the early Holocene populations in the New World presented significant cultural diversity between themselves, being one more distinct piece of the mosaic of cultures that were present in the continent (for example, Dillehay, 2000, 2008; Dixon 2001; Arriaza et al., 2008; Goebel et al., 2008). This cultural diversity shows a quick process of differentiation in the initial periods of the human presence in the continent, showing that no matter who came into the Americas or how fast the colonization wave dispersed through the landscape, by 10,000 cal yr BP the continent shows signs of people adapting to their own landscape and developing clear local traditions that are defined by more than their technological background.

Yet, the same cannot be said from their biological characteristics, since as far as cranial morphology is concerned, the early Holocene populations of the continent show low levels of variation and a morphological pattern that is not the one most widespread among Late Holocene Native American populations. This strongly suggests a significant influx of extra morphological (and biological) diversity into the continent during the Holocene, either by a continuous gene flow with Asia or by multiple discrete dispersion waves into the continent during this time. Consequently, from the perspective of cranial morphology, the actual biological diversity of Native Americans does not derive exclusively from the early Palaeoamerican populations that settled the continent, and a linear causal connection between early and late populations on the continent should be established only when empirical data strongly supports it. In other words, our analyses of the Lagoa Santa remains in the past decades (Neves and Hubbe 2005; Neves et al., 2007b, 2013; Hubbe et al., 2010, 2011) as well as the ones presented here add to the growing body of evidence that the processes associated with the settlement and dispersion of human groups across the Americas were neither simple nor straightforward, and involved the complex interaction between different cultures and possibly biologically distinct populations during the entire period that humans occupied the continent.

Consequently, although the increased morphological diversity in time and the possible shift in morphological patterns across time in the Americas favours an influx of further diversity into the continent, at present it is impossible to offer a more definite opinion on whether this was the product of multiple discrete migrations into the continent or the result of gradual influx as a result of continuous contact and gene flow between north-east Asia and North America. This difficulty derives from the lack of good comparative data sets, with series that represent accurately the continent's past morphological diversity. Most studies of morphological diversity in South America do not incorporate the biological diversity seen during the Middle Holocene, including only representatives of early and late Holocene populations (for example, Hubbe et al., 2010; de Azevedo et al., 2011, but see Perez et al., 2010 for an exception), where in theory the Middle Holocene (between 7 and 4 kyr BP) must have been a period of intense morphological differentiation, either due to population replacement (dual-dispersion scenario), continuous influx of extra diversity from Asia via North America, morphological adaptation to new environmental factors (changes in life-style or climate) or any combination of these processes.

With this framework in mind, it is imperative that future work focuses on Middle Holocene populations in order to test the biological origin(s) of early South Americans and how the initial occupation(s) of the continent gave rise to the actual continental biological and cultural diversity. If the question about the origin of the morphological diversity seen in the Americas in the past is ever to be solved, more international collaborative initiatives must be established, focusing both on the analysis of larger datasets and on the creation of public and virtual databases that house information about the collection currently curated in the many archaeological and natural history museums of the continent.

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# Human Dispersal and Late Quaternary Megafaunal Extinctions: the Role of the Americas in the Global Puzzle

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## Abstract

As Alfred Russell Wallace once wrote, we live in a zoologically impoverished world, from which most of the largest, strangest and most spectacular animals disappeared quite recently. About two thirds of all animal species larger than 50 kg (the so-called megafauna) were extinct from the late Pleistocene onwards, starting in Australia at about fifty thousand years ago and following humans' footsteps is their expansion throughout Eurasia and the Americas. The extinctions went on through the Holocene, reaching islands all around the globe, that can be seen as 'time machines' where megafauna survived for millennia after the continental extinctions, such as the Caribbean, the islands off Alaska, and Wrangel Island in the Arctic Ocean. In Madagascar and New Zealand, extinctions are but a few centuries old. These late Quaternary extinctions were a global phenomenon that begs for a global explanation. Climatic hypotheses fail to explain these patterns for several reasons, for example, there were dozens of other glacial cycles throughout the Pleistocene, without associated mass extinctions; extinctions in Australia and the islands did not coincide with glacial peaks; and climate changes cannot explain why extinctions were systematically more recent on islands. However, the pieces of the puzzle immediately fit together when we observe the clear correspondence between the dates of humans' arrival and of megafaunal extinction in each landmass. Bernardo Araujo recently analysed the chronology of extinctions of megafaunal genera around the world. He found that extinctions took place closer than expected by chance to periods of high climatic variation alone in only two of the analysed cases, to dates of human arrival alone in seventy-four cases, and to both in eight cases, with 40 cases unexplained. Thus, anthropogenic impact is the most plausible and parsimonious main cause of the late Quaternary extinctions. In a modern view, the extinctions were a long process that took several millennia to occur in most continents, with a few stragglers like the Irish elk and the North American mastodons. Low reproductive potential was the main determinant of the extinct species; the apparent selection by size is an artefact of the inverse correlation between the two variables. The absence of evolved instincts against newly arrived humans, the difficulty of conserving meat and the lack of perception of the world's finitude must have contributed to the outcome. Thus, human-megafauna interactions are an important and undervalued part of human history that merits being represented on the UNESCO World Heritage List. Furthermore, learning from the extinctions of the past is crucial to allow us to minimise extinctions in the future. Candidate sites in the Americas might include those that show consumption of megafauna (such as Monte Verde), remarkable rock paintings (such as Serra da Capivara, Brazil) and the latest American megafauna (such as Las Breas de San Felipe, Cuba).

## Introduction - the late Quaternary extinction sequence

In 1876, Alfred Russel Wallace wrote: 'we live in a biologically impoverished world, from which all the hugest, and the fiercest, and the strangest forms have recently disappeared' (Wallace, 1876, p. 150; quoted in Grayson, 1984). The sense of incompleteness felt by Wallace, at a time when palaeontology was still a young science, is well justified. In the last 50,000 years - the blink of an eye in geological times - the planet has lost an impressive array of large animals, including mammoths, mastodons, woolly rhinos, sabertooth tigers, giant ground sloths, gliptodonts, moas, elephant birds, marsupial lions and many others. These recently lost beasts represented about two thirds of all the world's megafauna - here defined as animals with adult body weight above 50 kg. For example, at least 97 of 150 genera of large mammals were lost between 50 thousand years ago (henceforth ky) and 500 years ago (Turvey and Fritz, 2011). When trying to understand the causes of this huge 'prehistoric revolution' (Martin and Klein, 1984), it is crucial to note that these extinctions were not an event well-defined in time, but rather a process: the megafauna disappeared at markedly different times in different parts of the planet. We will briefly review this dramatic sequence.

The extinctions first reached Australia, around 50 ky. By that time, the spectacular Australian fauna included the diprotodonts (genus *Diprotodon*), giant marsupial browsers that could weigh almost three tons; *Palorchestes*, ecological equivalents to tapirs; *Thylacoleo carnifex*, the 'marsupial lion' (actually a leopard-sized large carnivore) and a whole family of giant short-nosed kangaroos, the Sthenurinae (Murray, 1984; Johnson, 2006). Aside from the mammals, there were gigantic reptiles such as *Megalania prisca* that resembled an oversized Komodo dragon, *Wonambi naracoortensis*, similar to a large anaconda, plus some huge terrestrial birds, *Genyornis newtoni*. The Tasmanian 'wolf' or thylacine, *Thylacinus cynocephalus*, often considered endemic of Tasmania (where it survived until 1936), was also found throughout Australia at that time. In continental Australia, the extinctions took place during an 'extinction window' that went from 50 to 40 ky, with a peak at around 46 ky (Roberts et al., 2001). A recent claim by Wroe et al. (2013) that the extinctions in Australia were spread in time since the Middle Pleistocene does not seem consistent, because the species at that time were nearly all from the same genera as the ones that disappeared during the 'extinction window', and thus they are likely to represent taxonomical splitting rather than a truly different species set. An interesting point is that in Tasmania the extinctions happened distinctly later than in continental Australia, around 41 to 40 ky (Turney et al., 2008).

In Eurasia, the extinctions were quite spread out in time, roughly presenting two pulses (Turvey and Fritz, 2011). In the southern latitudes, around the Mediterranean Basin, most species vanished between 45 and 20 ky. The extinctions in the northern latitudes came much later, from 14 to about 9 ky. Some stragglers survived even later, such as the 'Irish elk' (*Megaloceros*) in the Ural Mountains until some 7,700 years ago (Stuart et al., 2004). Among the main losses suffered in Eurasia were the Eurasian mammoths (*Mammuthus primigenius*), woolly rhinoceros (*Coelodonta antiquitatis*) and cave bears (*Ursus spelaeus*). The coexistence of humans with this striking fauna, including the hunting activity, is richly documented in the superb Cro-Magnon rock paintings, in sites such as Altamira, Lascaux and El Pindal. This coexistence lasted until the big animals became extinct, soon followed by their artistic representations.

In North America, the extinction process was comparatively 'quick', as it took place mostly between 13.5 ky and approximately 11 ky. Again, some stragglers survived until more recent times, such as the mastodons (*Mammuthus americanum*), whose last records, in the region of the Great Lakes, are dated to 9,900 years ago (Woodman and Athfield, 2012). The North American megafauna at this time was very rich and much more similar to Africa's present fauna than we could imagine, based on the remaining species there (Anderson, 1984). Among others, there were North American mammoths (*Mammuthus columbi*), mastodons, giant ground sloths (see next paragraph) and also camels (*Camelops hesternus*), horses and bison, including the huge long-horned bison (*Bison latifrons*). Furthermore, North America was home to an exceptionally rich carnivore fauna, including the giant bear (*Arctodus simus*), the sabertooth tiger (*Smilodon fatalis*), the only slightly smaller scimitar cat (*Homotherium serum*), lions (*Panthera leo atrox*), oversized wolves (the dire wolf, *Canis dirus*) and cheetahs (*Miracinonyx trumani*) (Flannery, 2001).

In South America, the extinctions were spread along a longer period of time than in North America, from about 13 ky to 7.8 ky (Barnosky and Lindsey, 2010). This means that, although there is a considerable overlap in time between the continents, many of the South American extinctions took place after the process was mostly completed in North America. The South American megafauna, like their North American counterparts, also included at least two species of elephants (from the genera *Haplomastodon* and *Cuvieronius*), sabertooth tigers (*Smilodon populator*) and a rich diversity of ground sloths (families Megatheriidae, Megalonychidae, Milodontidae and Nothotheriidae). The largest ground sloths (genera *Megatherium* and *Eremotherium*) were huge, slow animals that could weigh more than five tons. Besides, there were large native grazers similar to hippos called toxodonts (*Toxodon platensis*), many gigantic armadillo-like gliptodonts and a rich diversity of roamed beasts including highly peculiar animals like *Macrauchenia* as well as more familiar horses (*Equus*). Although today South America is relatively poor in megafauna - the tapirs, jaguars and marsh deer are the few remaining large mammals - this was not by any means true about 15 thousand years ago.

The extinctions were not limited, by any means, to the Pleistocene-Holocene boundary - on the contrary, they went on through the Holocene. That is why it is more correct to talk about 'late Quaternary extinctions' rather than using the misleading expressions 'Pleistocene extinctions' or 'Pleistocene-Holocene extinctions', the latter seeming to imply that they happened in the boundary between the two epochs. It was indeed well into the Holocene that the extinctions finally reached some 'time machines' where some last members of the vanished megafauna still survived. These time machines - places where intact Pleistocene ecosystems could still be found well into the Holocene - were the islands.

In the Caribbean, all several dwarf giant ground sloths became extinct from about 6 ky to 4.7 ky, at least some 4,500 years later than anywhere in the mainlands of either North or South America (Barnosky et al., 2004; Steadman et al., 2005). The most recent records are from Cuba, the largest island in the Caribbean. In Beringia, mammoths (*Mammuthus primigenius*) survived on the island of St Paul (near Alaska) (Guthrie, 2004) and Wrangel (to the north of Siberia) until some 5 ky and 4 ky respectively. The last date (Vartanyan et al., 1993) is more than seven thousand years after the Younger Dryas, the last cold event of the last glacial cycle. In the Mediterranean, at least five species of dwarf elephants of the genera *Elephas* (*Palaeoloxodon*) and



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*Mammuthus* became extinct over twenty islands. Most of these findings are not dated; the few existing dates are not quite reliable but if correct they would point to the survival of elephants until as recently as 4 ky in the Aegean islands (Theodorou et al., 2007 in Liscaljet 2012). A dwarf elephant is also present in Egyptian wall paintings of the eighteenth dynasty (near 3.5 ky), suggesting that the Egyptians coexisted with these now extinct animals in historical times (Masseti, 2001). Other quite recent - possibly Holocene - losses in the Mediterranean islands included several species of dwarf hippopotamus (genus *Hippopotamus*) from Crete, Sicily, Malta and Cyprus (Petronio, 1995).

Two of the most spectacular cases, however, were Madagascar and New Zealand -where the disappearance of the megafauna was most recent. In Madagascar, a dozen species of spectacular giant lemurs became extinct between 2,000 and less than 400 years ago, when the last of them, the man-sized *Megaladapis edwardsi*, was seen by the French governor, Etienne de Flacourt (Flacourt, 1658). Flacourt may also have seen the last of the half-ton elephant birds (*Aepyornis maximus*). When the European colonizers arrived, huge elephant bird eggshells still littered the beaches of the island's south and south-eastern coasts, pointing to a very recent extinction indeed. Furthermore, Madagascar also lost pigmy hippos and giant fossas (Dewar, 1984). In New Zealand, there was an equally spectacular fauna of a dozen species of moas, large terrestrial birds up to three metres tall, plus the gigantic Haast's eagle *Harpagornis moorei*. All these huge animals went extinct as recently as between 900 and 500 years ago (Trotter and McCulloch, 1984).

Unlike any other extinction wave in the geological past, this one appeared to be size-selective: only the largest animals were extinct (Lyons et al., 2004). The Quaternary extinctions deprived the planet of most of its large animals, but had little effect on the small ones.

The aim of this article is to briefly discuss how the late Quaternary extinctions relate to human dispersal across the planet, how this affects our views of human history, and the role of American sites in conserving this memory.

### Pitfalls of the climatic explanations for the late Quaternary extinctions

Ever since Wallace, there has been much controversy on what caused the Quaternary extinctions, a dramatic revolution in the history of life so close to our time. The hypothesis that the demise of the big animals had been caused by climate changes was a favourite for near a century after Wallace (Grayson, 1984); it is still popular and has been proposed in many regional studies to explain the disappearance of Pleistocene faunas (review in Koch and Barnovsky, 2006). From a global perspective, however, the climatic hypothesis fails to explain too many of the extinction patterns; six of its main pitfalls are briefly pointed out below.

Firstly, climatic hypotheses do not explain the regional asynchrony of the extinctions. Climatic events linked to the last glacial cycles were planetary events that affected the whole planet at the same time, for example, cold peaks were also linked to dry periods in tropical regions. Nevertheless, as we saw, the extinctions took place at completely different times in different places around the world.

Secondly, the chronology of the last glacial cycle does not explain the timing of extinctions in several parts of the world. For instance, in Australia the extinctions occurred mostly within a relatively mild period about twenty thousand years before the Last Glacial Maximum that lasted from about 23 to 18 ky. On the other extreme of the time scale, the insular extinctions all occurred several thousand years after the end of the Younger Dryas, the last cold event of the glacial cycle, at about 13 to 11.5 ky (Burney and Flannery, 2005).

Thirdly, in the Pleistocene there were at least 31 other glaciations before the last, without any wave of extinctions associated to them (Cione et al., 2003; Barnosky et al., 2004; Johnson, 2006). The recent suggestion by Wroe et al. (2013) that the last glacial cycle was notably more intense than the previous ones, at least in the Sahul, is not convincing because intensification can be observed only in the warm (interglacial) phases that which are not implied in the extinctions in the climatic hypothesis. On the other hand, there is little difference where it matters, that is, among the cold extremes of the last cycles (see Wroe et al.'s own figure 5).

Fourthly, climatic hypotheses cannot explain why the extinctions on islands all over the world, independent of their latitudes and longitudes, were systematically more recent than in the continents - all of them in the Holocene, a period of relatively stable climate.

Fifthly, climatic hypothesis would predict many extinctions among plants that are usually more affected by climate changes than animals, but this prediction conspicuously fails: there was no wave of floristic extinctions in the Quaternary.

Sixthly, the climatic hypothesis predicts that small warm-blooded animals would be more affected than large ones, because the former have higher surface/volume ratios and thus less efficient homeothermy (Thompson, 1917). But what happened was exactly the opposite: the large animals were the ones that disappeared.

The Quaternary extinctions are a global phenomenon that begs for a global explanation. Arguably, a major reason why the subject still seems puzzling is that many studies have tried to explain the extinctions using regional approaches, thus losing sight of the immense explanatory power of a comparative, global analysis. The pieces of the puzzle indeed immediately fit together when we observe the close similarity between the dates of human arrival and the extinctions in each land mass. A quick review of modern man's spread across the globe may be useful here. I make no claim to present a detailed appraisal of the complex process of colonization of our planet; rather, I intend to provide only a brief sketch of the main events.

### Man's dispersal across the planet

Modern humans originated in eastern Africa and had most of their existence restricted to a relatively small part of the world. The oldest dates for our species are at least 160 ky and the oldest ones out of Africa - in the Middle East - are about 120 ky. From the Middle East, modern humans dispersed to Tropical Asia and remained restricted to these regions until about 50 ky (Stringer and Andrew, 2005).

From there, the first new land mass to be colonized was Australia, reached by humans at about 50 ky. As the colonizers came from the north, the last part of Australia to be reached was the southern tip, where Tasmania lies. At the time, Tasmania was connected to Australia, New Guinea and smaller islands forming a single landmass, Sahul.

The expansion of humans towards the temperate parts of Eurasia started at a roughly similar time, at over 40 ky, but this was a much longer process as humans seemed to have reached the cold areas of the gigantic Eurasian continent, such as northern Siberia, by less than 20 ky. It was the first time humans had to colonize a continent against a temperature gradient - from warm to cold - and possibly this factor helps to explain why it took so long (Araujo, 2013).

However, once reaching the eastern tip of Eurasia, humans had free access to the Americas, as Eurasia and North America were then connected through Beringia. North America was reached around 15 ky or a little before this. At the time, northern North America was still covered by a thick ice cover, because the deglaciation following had still not finished. Progression through this part of the continent seems to have been slow, but at about 13.5 ky is the first evidence that humans had reached North America's central plains.

Within the Americas, and especially in South America, the colonization frontier seems to have expanded at quite different speeds in different directions. The oldest reliable archaeological dates in South America are from Monte Verde, near Puerto Monte, in southern Chile, at over 14 ky. This striking date seems consistent with the hypothesis of a faster colonization route along South America's Pacific coast. For pre-technological people, the Andes were surely an imposing geographical barrier and this may have conditioned a 'fast' (lasting a few hundred years) movement southwards through the narrow land strip between the Pacific and the gigantic mountain chain. To the east of the Andes, with a more complex geography and dense forests, human expansion seems to have been much slower than on the west coast.

The last places to be reached by humans were the islands, all around the world, for the obvious reason that reaching them only became possible after the invention of efficient watercrafts, capable of traversing extensions of saltwater (with the exception of land-bridge islands such as Tasmania, which were connected to the continents at times of low sea levels during the late Pleistocene). The first important oceanic islands in the Americas that were reached by humans were the Caribbean islands, at nearly 6 ky. The Mediterranean islands seem to have been reached slightly later, and Wrangel, the home to the last mammoths, was occupied at about 4 ky. Madagascar, one of the world's largest islands, was first reached by humans only about 2,300 years ago and surprisingly, the first colonizers came from south Asia rather than Africa. Finally, New Zealand was the world's last large landmass to be reached by humans, just about 900 years ago.

### A quantitative, global analysis making use of improved dating

The striking similarity between these dates of human arrival and the dates of the extinctions at the different landmasses across the world has been pointed out by many authors, including Martin (1984, 2005), Fernandez (2000), Lyons et al. (2004), Burney and Flannery (2005), Johnson (2006) and Gillespie (2008). However, Bernardo Araujo (2013) provided the first global

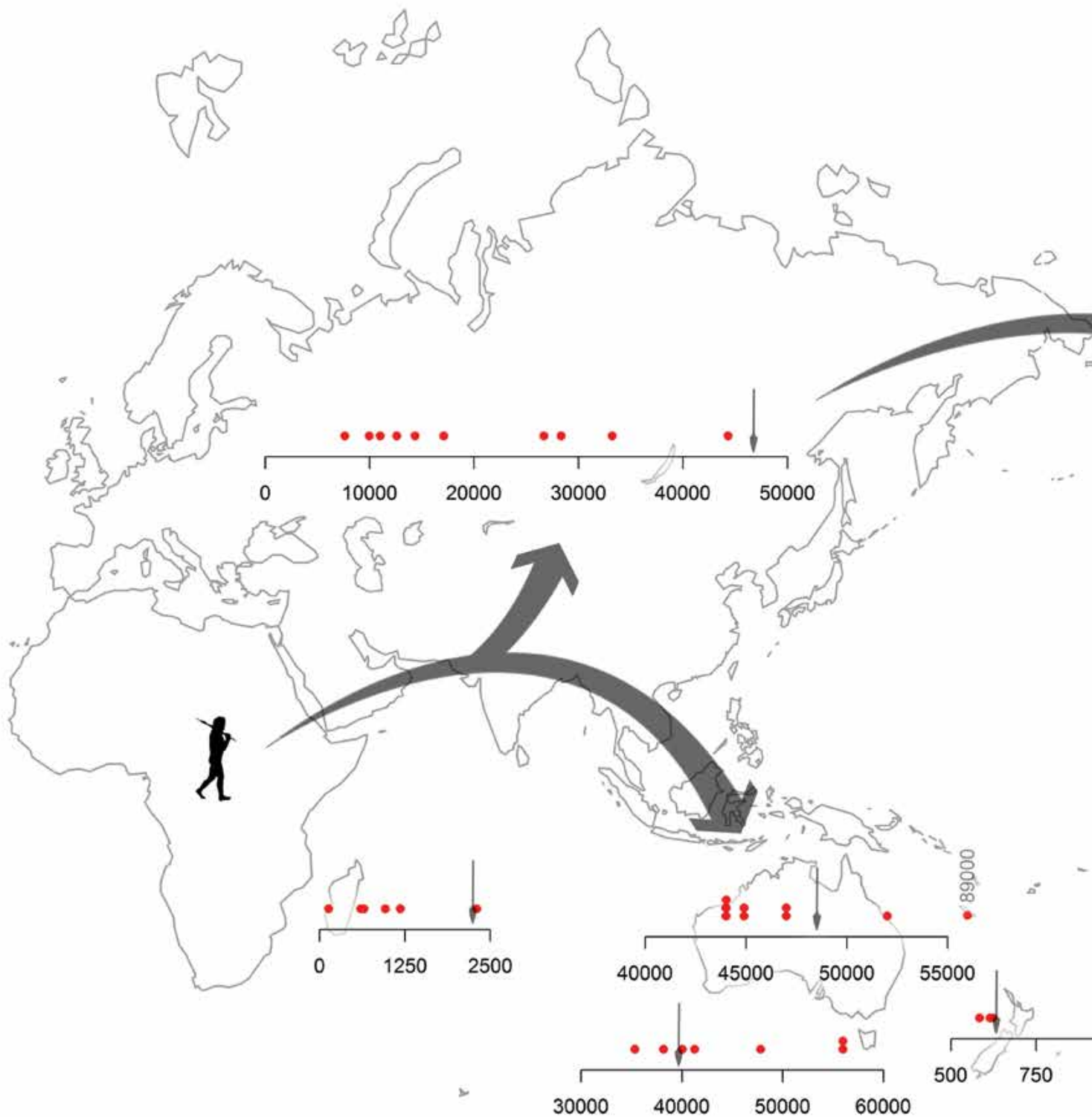
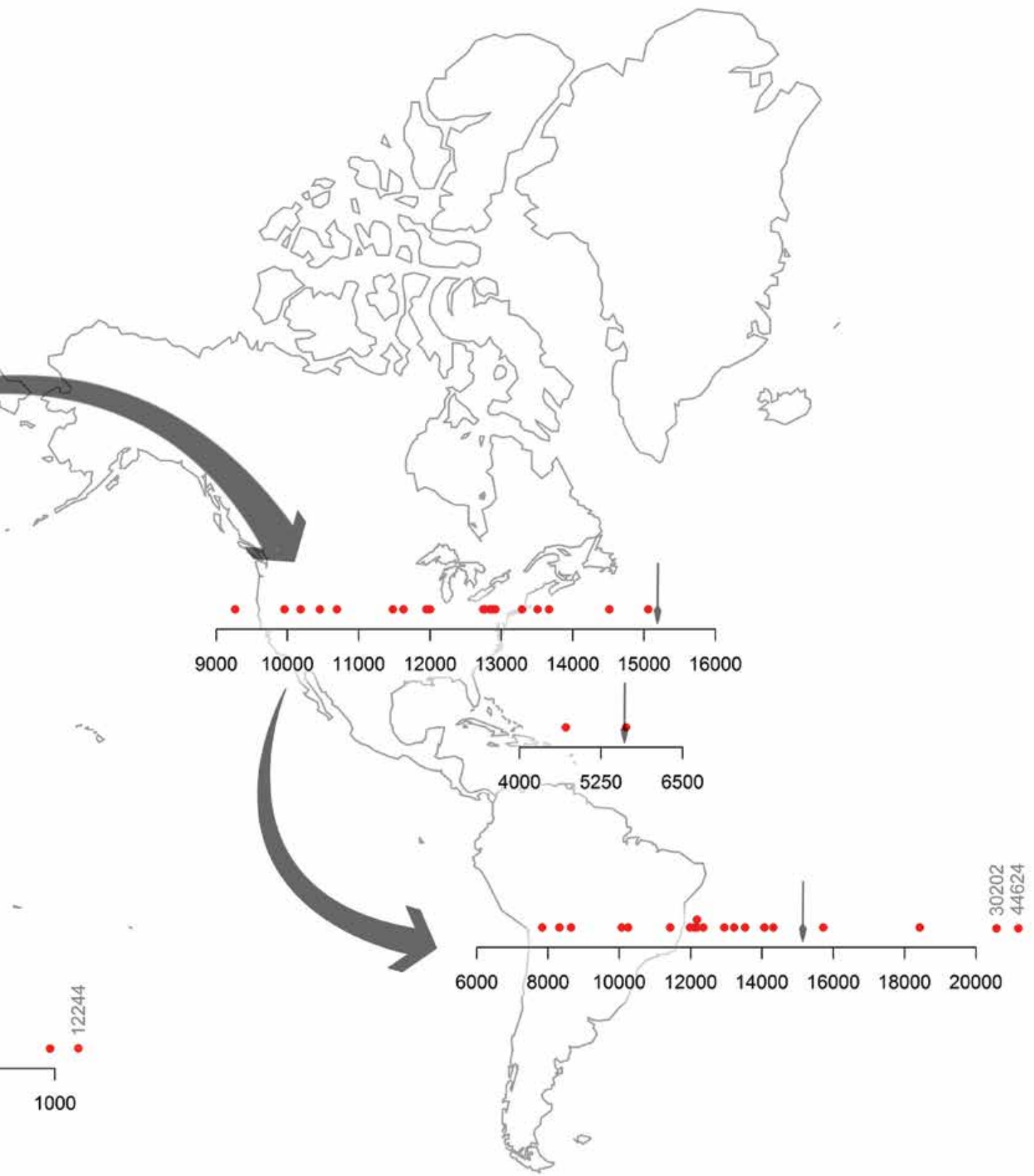


Figure 1. The timing of human arrival and megafaunal genera extinction across the world in the late Pleistocene and Holocene, as analyzed by Bernardo Araujo (2013). The displayed quantitative axes show the last known dates of occurrence at each landmass (calibrated dates, in years before past) of megafaunal genera (red dots). Grey spears point to the time of first known dates of human presence at each landmass. The large grey arrows show the main routes of human dispersal across the globe. © Bernardo Araujo.



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quantitative analysis of the relations between the timing of the megafaunal extinctions, climatic changes and human arrivals to each of the world's land masses, taking advantage of the massive recent progress in dating methods. Using inaccurate time frames in quantitative analyses (for example, as in Prescott et al., 2012, for human arrival), it would be difficult to disentangle the effects of different putative causes for the extinctions (Lima-Ribeiro et al., 2012).

In Araujo's (2013) analysis, the intensity of climatic variation in the late Pleistocene and Holocene was assessed through the North Greenland Ice Core Project data on oxygen isotopic composition on ice cores (Andersen et al., 2004). This database comprises  $\delta^{18}\text{O}$  data (a temperature proxy) for the last 122 ky. Megafaunal dates and human dates were obtained from literature for nineteen regions of the world where these events took place at markedly different times. The regions considered in the analysis were Australia, the Caribbean, Japan, Madagascar, New Zealand, Tasmania, Wrangel Island, Beringia (north-westernmost North America and north-easternmost Eurasia), central North America, eastern North America, western North America, northern Europe, southern Europe, west Siberia, central Russia, northern South America, central South America, Patagonia and the Andean region (the Andes and South America's western coast). Only calibrated dates, regarded as reliable according to the Mead-Melzer modified scale (Barnosky and Lindsey, 2010) were used. The database included 2,088 megafaunal dates (for 67 genera) and 762 archaeological dates.

Araujo's (2013) main results are summarised in Figure 1. The dates shown are the last known occurrences of each megafaunal genus and the first known human presence in each landmass. For sampling reasons, the last known date of a fossil genus tends to overestimate how long ago the extinction occurred and the first known human date tends to underestimate how old is the arrival (Signor and Lipps, 1982; Buck and Bard, 2007). Taking this in account, the clustering of the extinctions dates around the times of human arrival can be clearly seen. Comparing the two variables (human arrival and climate variation), the extinction times were nearer than expected by chance only to the time of human arrival in 76 cases (each case being the extinction of a genus in one of the 19 regions). On the other hand, the time of the extinction was closer than expected by chance only to the times of intense climate change in just 2 cases (a value close to the expected by a random placement of the extinctions along time). Extinctions were closer than expected by chance to both human arrival and times of intense climatic variation in 8 cases, and to neither of these variables in 40 cases, out of a total of 126 cases. These findings provide clear support for the hypothesis that anthropogenic impacts, rather than climate variation, were the main driver of the late Quaternary extinctions.

The eight cases where the extinctions were close in time both to human arrival and to climatic variation were mostly in the Americas. In these continents, human arrival approximately coincided in time with the events linked to the Younger Dryas, the last cold phase of the last glacial cycle. This finding is consistent with the view that climate changes actually played a role in the late Quaternary extinctions. But what role was this? Several authors have interpreted this kind of result as a 'synergy', for the Americas (Barnosky et al., 2004; Lima-Ribeiro and Diniz Filho, 2013) and elsewhere (for example, Nogués-Bravo et al., 2008, Lorenzen et al., 2011). However, this terminology can be misleading, by seeming to attribute similar roles to both factors: climate and humans. Synergy refers to an interaction between two or more factors that, when acting together, produce an effect that is larger than or different from the sum of their individual effects. However, the global approach provides 'natural experiments' in time and space that allow us to separate the factors: the megafauna survived through many other intense glacial cycles throughout the whole Pleistocene and it also persisted well into the Holocene in islands not yet reached by people. Both lines of evidence show that if it were not for the anthropogenic impacts, it is unlikely that the megafauna would have become extinct. Thus, climate changes seemed to have acted mostly as intensifiers, when they coincided with humans' arrival in a given landmass. In the context of logic, one could say that human arrival was the necessary cause of the extinctions - without it, the megafauna would not have disappeared - while climate change was just a contributory cause - by itself it would have little effect, but once present it played a role as well.

### The associational critique and why it does not refute the anthropogenic hypothesis

Within archaeological contexts, a question often raised regarding the anthropogenic hypothesis is, if it is correct, then why there are relatively few sites showing associations between humans and megafauna? This has been called the 'associational critique' (Meltzer, 1986). Is this pattern incompatible with the hypothesis of anthropogenic impacts?

To answer this question, let's suppose just for a moment, that the anthropogenic hypothesis is correct. If so, using the mammoths as an example, in which proportion of mammoth sites would we expect to find associated archaeological remains? First, we must keep in mind that the time of coexistence of mammoth and humans, until mammoths became extinct, was a tiny part of the geological time range of mammoth records (Lister and Bahn, 2009). But this is still not the point. About twenty centuries in North America was the time of coexistence of mammoths and humans in the same continent, but *in any one locality the coexistence was much shorter still*. Thus, one would have to be very lucky indeed to find an archaeological site from precisely the few decades or so when mammoths and humans coexisted in *that given locality*. In any other case, he (she) would



find only mammoths without humans (before coexistence) or humans without mammoths (after coexistence). The expected pattern would be that a small fraction of megafaunal sites would have archaeological remains, and that is what is found.

Recently, Surovell and Grund (2012) presented another, complementary, refutation of the associational critique. They compared the relative temporal depths of coexistence (time spans between human arrival and megafaunal extinction, in proportion of the whole length of the archaeological record) among Australia, North America and New Zealand. Furthermore, they modelled taphonomic biases and also human demography to estimate how long it would take for humans to become abundant in a given landmass after their first arrival. Their results show that kill sites would be expected to be very common in New Zealand, to have intermediate frequency in North America and to be extremely rare or absent in Australia. This order of frequency of kill sites again is similar to the patterns we observe in the real world.

### A modern view of the anthropogenic hypothesis

It is interesting to think about the process that resulted in these patterns. The hypothesis that the late Quaternary extinctions were caused by anthropogenic impacts has been considerably improved, in light of more recent knowledge, since it was put forward by Paul Martin (1967, 1984). A modern view of the anthropogenic extinctions as part of our early history would be as follows.

Except where megafauna co-evolved with early hominids (in Africa and south Asia, where there were few extinctions, and northern Eurasia, where they were quite spread across time), there is no reason to expect that big animals would have evolved instincts to avoid man. This is the phenomenon of 'island naivety', well known from many historical examples (Diamond, 1984). In the most plausible scenario, big beasts in the newly-colonized lands were quite unaware that humans could be dangerous hunters - to their downfall.

Putting the extinctions in the perspective of the time in which they happened, at least in three aspects, helps us understand that crucial period of human history. First, there was neither agriculture nor livestock - probably not a coincidence, as they were invented only after the megafauna disappeared. Thus, consumption of meat from large animals was probably indispensable for feeding a growing human population and if humans had any access to this resource - and technologically they had - one would hardly expect that they would not have used it. Second, once a large beast was killed, there was no efficient way to conserve vast amounts of meat. There were some valiant attempts such as underwater meat caching, first discovered in the Heisler site in Michigan (Fisher, 1995), and possibly the use of salt as well - but this was hardly enough. Therefore, a highly efficient use of megafaunal meat is unlikely. Third, people living at the time of our species' dispersal did not even know that the world had an end. They went on finding virgin hunting fields, until one day - in the Americas, probably the day when the southernmost tip of Tierra del Fuego was reached - there were no more. Given these three points, if we put ourselves in the shoes of a Clovis or any other people of the time, how could we expect them to use the megafauna in a cautious, sparing way? What for, not knowing that the world had an end? Such restraint may make sense from our perspective, but not from theirs.

Although in its original modern formulation (for example, Martin, 1967, 1973), the hypothesis of anthropogenic impacts puts much emphasis on hunting as the main extinction mechanism (hence its common label the 'overkill hypothesis'), more modern views have highlighted a diversity of anthropic impacts, all of which must have affected megafauna to different extents. Among these factors are introduced diseases (MacPhee and Marx, 1997) and fire. The later process is well documented, especially in Australia (Flannery, 1994; Johnson, 2006; Rule et al., 2012) and in North America (Flannery, 2001; Kerr, 2003; Gill et al., 2009). Increased frequency of fire actually seems to have been a consequence of the decline of plant-eating beasts, but it may have further affected the megafauna through habitat changes. Besides, some of the extinctions must have been caused indirectly through cascading ecological effects, especially the demise of large carnivores and scavengers. It is unlikely that the Clovis extinguished sabertooth tigers through hunting them for meat; there must have been easier sources of protein around. However, after all their big prey species were gone, sabertooths were doomed as well. The same must have applied to the huge North American teratorn birds and other large scavengers that depended on megafauna. The California condor's habit of scavenging on stranded marine mammals must have emerged as a much-needed ecological niche shift after its usual food sources had all but disappeared.

Another point is that it was not a 'quick' extinction at all, as had been proposed by Martin's 'blitzkrieg' version of his hypothesis (Martin, 1973). The extinctions were a long historical process that lasted several thousand years in each continent, with a few stragglers left even after that, as expected - the last on the islands. A comment here about the time scale involved in the events here described could be useful. Palaeontologists work with so-called 'geological time', which comprises very long time scales, often in the order of millions or billions of years. Besides, the farther away we look to a given time span in the past, the shorter it seems. There seems to be little difference between 40,500 to 40,000 years ago, but from Columbus to us it seems a long time. This trap of our perception and Martin's unfortunate expression help to explain many misunderstandings about the anthropogenic hypothesis. 'Blitzkrieg' means lightning war, but it was not a war at all, nor was it quick. As far as we know, the

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animals were hunted not because of our species' urge for killing, but because they provided valuable resources for which there were no substitutes at the time. It was a very long process that took several millennia in continents and centuries in large islands.

The Quaternary extinctions do not imply that humans were terrible hunters. Big, slow-breeding animals are the most vulnerable to hunting. The species that became extinct had low fecundity, usually approximately less than one young per female per year (Johnson, 2002). Wallace's first impression - that the extinctions affected preferentially large animals - is an artefact of the negative correlation in nature between body size and breeding rates. Big animals might not have even been a major component of the diet and even so, they would be expected to become extinct. For example, Johnson (2006) estimated that a group of ten Australian aborigines needed to kill only about two diprotodonts per year to extinguish a population of these huge marsupials. The point with the late Quaternary extinctions was not the intensity of the hunting - it was the fragility of the hunted.

Altogether, from an ecologist's point of view, it is not surprising that humans' arrival in the new continents would have extinguished megafauna - it would be surprising if it had not.

### The conservation of the memory of the human-megafauna interactions and the south-central American sites

In light of the evidence now available, without the anthropogenic impacts following human dispersal, nobody would be talking of 'Quaternary extinctions' today. It remains quite plausible that anthropogenic impacts were magnified by climatic events in some places, but climate change does not seem to be a major cause. However, regardless of whether anthropogenic impacts were the main cause or 'just' one of the major causes, what we know today is more than enough to show that these extinctions were one of the main events in the history of man's interactions with natural environments, as our species dispersed across the planet. Yet, perhaps because of the relative recency of Martin's hypothesis, or perhaps because the extent of humans' role is still debated, these are undervalued pages of our history. The late Quaternary extinctions are a fascinating subject that have seldom received the attention they deserve in education or in the media. The UNESCO World Heritage Convention can have an important role in changing this scenario.

The Americas must play a special role in the effort for changing this scenario. After all, the Americas were the New World, not just in the familiar, Eurocentric, cultural way - they were also the biological New World. The Americas were the last continents to be reached by modern humans and therefore the continents where megafaunal extinctions as a whole were the most recent. They therefore have a crucial role in preserving the memory of our interactions with the extinct large animals. Herein, we would like to tentatively propose three American sites which can be particularly valuable for this goal.

The first is Monte Verde in southern Chile. With its very old dating, Monte Verde is of course a key site in understanding human dispersal into the continent. But there is more to it; Monte Verde also illustrates particularly well the use of megafauna by humans, with a chunk of gomphothere meat found in an archaeological context. As Monte Verde is likely to reflect the oldest colonization of the continent, this finding may well represent a snapshot of the early utilisation of the just discovered South American megafauna.

The second site is Serra da Capivara, within Serra da Capivara National Park, in Piauí state in north-eastern Brazil. This is also a highly valuable site, not because of its unreliable claims to greater antiquity, but for its richness in rock paintings, many of which represent extinct species and their interactions with the early settlers. To our knowledge, there is no other site which represents so well human-megafauna interactions in Brazil. Besides, these paintings unfortunately are threatened by vandalism, which increases the urgency of efforts to conserve them.

The third site proposed is Las Breas de San Felipe, in Cuba. It would be important to represent the last of the American extinct megafauna and its interactions with humans. Hence, Cuba was home to the last surviving megafauna in the Americas. The most recent records are from the sites of Las Breas de San Felipe and Solapa de Silex, with human artefacts associated to dwarf giant ground sloths (genera *Parocnus* and *Megalocnus* respectively), dated to 5.7 and 4.7 ky respectively (reliable calibrated dates). Las Breas de San Felipe is a tar pit, a kind of miniature Rancho Las Breas, the famous Californian tar pit site (Iturralde-Vinent et al., 2000). Among Cuban sites, Las Breas de San Felipe is the richest, with easiest access and thus the one that presents more potential to be nominated to the UNESCO World Heritage List, despite the slightly younger dating of Solapa de Silex's ground sloths (MacPhee et al., 2007).

Conserving evidence of human-megafauna interactions is important for us to learn from our history - about when our impacts on nature were severe, when they were not, and what caused the different outcomes. It is also a useful reminder of the fragility of nature - especially of the big animals - to our actions, in a time when so many people still deny the full magnitude of our impacts on the natural systems. Now that we are extinguishing species at unprecedented rates, more than ever we need to learn from the past. As Paulinho da Viola (1972) sang in '*Dança da Solidão*', '*Meu pai sempre me dizia / Meu filho tome*

*cuidado / Quando eu penso no futuro / Não me esqueço do passado* ('My father always told me / My son, be careful / When I think about the future / I don't forget the past').

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## The Last Continent: Prehistoric America in Comparative Perspective

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The prehistory of the Americas was never lost to view: the shell middens, ceremonial mounds, rock art and less conspicuous traces were parts of the landscape long before Europeans arrived in the fifteenth and sixteenth centuries. The 'rediscovery' of the continent is hence a questionable concept. Yet the long separation of the Americas from the rest of the world has given it a special status in the understanding of human social development. For whereas early historians, antiquarians and archaeologists might well question whether parallels between distant ends of the Old World might not, despite their separation, be the result of direct or indirect contact, the likelihood of contact between the Old World and the Americas, while never entirely discounted, has generally been dismissed as unlikely. Thus, the development of human society in the Americas, since the first settlement of the continent in the latter part of the last Ice Age, has been an independent and indigenous process: 'from approximately 15,000 BC, when ancient peoples first entered the Americas, until roughly AD 1500, to speak in round numbers, there were two entirely separate populations on earth, one in the New World, one in the Old, each unaware of the other' (Watson, 2012).

Some earlier scholars considered the Americas a 'laboratory' for the study of evolutionary processes, because of its separate yet in many senses parallel development. This curious perspective bestows apparent primacy on the Old World and treats the Americas as a kind of test bed for anthropological theories that compare and contrast it with the former. The practice goes back to the sixteenth century, when artists such as Jacques Le Moyne de Morgues and John White produced images of ancient Picts and Britons that drew directly upon their own paintings of Native North Americans. Le Moyne had accompanied a French expedition to Florida in 1564, while John White travelled on Sir Walter Raleigh's 1585 expedition to Virginia (Moser, 1998, pp. 71-76). The idea that Native American societies were in some way equivalent to those of earlier periods in Europe was deeply judgmental but persisted into later centuries. It is exemplified for example in the opening chapter of *Ancient Society* by American anthropologist, Lewis Henry Morgan, writing in 1877:

So essentially identical are the arts, institutions and mode of life in the same status upon all the continents, that the archaic form of the principal domestic institutions of the Greeks and Romans must even now be sought in the corresponding institutions of the American aborigines, as will be shown, in the course of this volume. This fact forms a part of the accumulating evidence tending to show that the principal institutions of mankind have been developed from a few primary germs of thought; and that the course and manner of their development was predetermined, as well as restricted within narrow limits of divergence, by the natural logic of the human mind and the necessary limitations of its powers. Progress has been found to be substantially the same in kind in tribes and nations inhabiting different and even disconnected continents, while in the same status, with deviations from uniformity in particular instances produced by special causes. The argument when extended tends to establish the unity of origin of mankind. (Morgan, 1877, pp. 17-18)

Morgan's 'essential unity of mankind' was predicated upon the notion of European and American social development as essentially separate phenomena. Other European settlers maintained alternative theories of cultural contact to explain the pre-Columbian monuments that they believed were beyond the capacity of Native American peoples to create. The most famous of these was the myth of the 'Mound builders', that the large ceremonial mounds built by Hopewell and Mississippian groups in the eastern USA had been the work of a vanished pre-Indian population. It was only towards the end of the nineteenth century that this was decisively disproved (Feder, 1996, pp. 119-40).

The same period saw the rise of diffusionist theories that disregarded the possibility of independent development and argued that the prehistoric and early historic world had been linked by long-distance maritime voyages that had carried Mediterranean and Near Eastern innovations to distant lands. A key proponent was British surgeon, Sir Grafton Elliot Smith, who argued that features as diverse as artificial head deformation and the boomerang had been carried to the New World by maritime voyagers, and that knowledge of Greek art (transmitted by these same interconnections) underpinned the development of Maya art. Egyptian civilization had a primary role within this process (Smith, 1933).

The theory of connectedness has found little support in archaeological thought during the twentieth century, although it has continued to be a focus of interest (for example, Riley et al., 1971; Jones et al., 2011). Ventures such as Thor Heyerdahl's famous Kon-tiki expedition of 1947 that endeavoured to show how South American navigators could have sailed to Easter Island have not generally been found convincing. What the twentieth century has witnessed, however, is a new and improved understanding

of global patterns of prehistory. This has been the result of a dramatic increase in the amount and dispersion of archaeological fieldwork, bringing some regions into perspective for the very first time; and to the development of scientific techniques, notably in the realm of dating, that allow global chronologies to be constructed reaching far back into the prehistoric past. Thus, comparisons between the prehistory of the Americas and other regions, or between different regions within the Americas, can now be assessed in their own terms. It also means that timescales of change can be evaluated and compared.

The parallels between the prehistories of the Americas and Eurasia are well-known and striking. They include general processes such as domestication, urbanism and state formation as well as more specific features such as irrigation, metallurgy and writing. Since all the evidence (as we shall see) suggests that the two hemispheres were isolated from each other, these convergent developments must be explained in terms of common underlying features such as the response of human societies to similar environmental opportunities (the availability of particular plant and animal species, or mineral resources, coupled with climate, soils and topography). Demography is a key factor: growing population sizes in both the Americas and the Old World encouraged the development of novel strategies in subsistence, settlement and social organisation. Each society was of course unique: the many parallel outcomes in the two hemispheres are nonetheless remarkable.

## The first Americans

The date of first settlement of the Americas remains controversial, although the majority view envisages initial colonization some 17,000 years ago, with groups of hunter-fisher-foragers reaching the southern tip of South America by 15,000 years ago (Méndez Melgar, 2013).

The settlement of a land area of 42.5 million km<sup>2</sup> appears to have been achieved relatively rapidly by comparison with the colonization by modern humans of other parts of the habitable world. Recent research suggests, for example, the first movement of modern humans from Africa into the Arabian peninsula during Marine Isotope Stage 5, possibly before 100,000 years ago, reaching south Asia by c. 80,000 years ago, but crossing to Australia no earlier than 60,000 years ago and probably only 45,000 years ago (Boivin et al., 2013). A similar prolonged process of range expansion took modern humans to north-east Siberia and thence across the Bering Straits into North America. Alternative scenarios of a transatlantic colonization across the edge of the Arctic sea-ice have not commanded broad support (Stanford and Bradley, 2012; cf. O'Brien et al., 2014), and are inconsistent with recent aDNA analysis of the Clovis skeleton from Anzick in Montana that indicates a Siberian ancestry for the first North Americans (Rasmussen et al., 2014). The skeleton from Hoyo Negro in Mexico (c. 12,910-11,750 BP) has also been shown by aDNA analysis to represent an early population expansion out of Beringia, not an earlier migration from elsewhere in Eurasia (Chatters et al., 2014; see also Chatters, this volume).

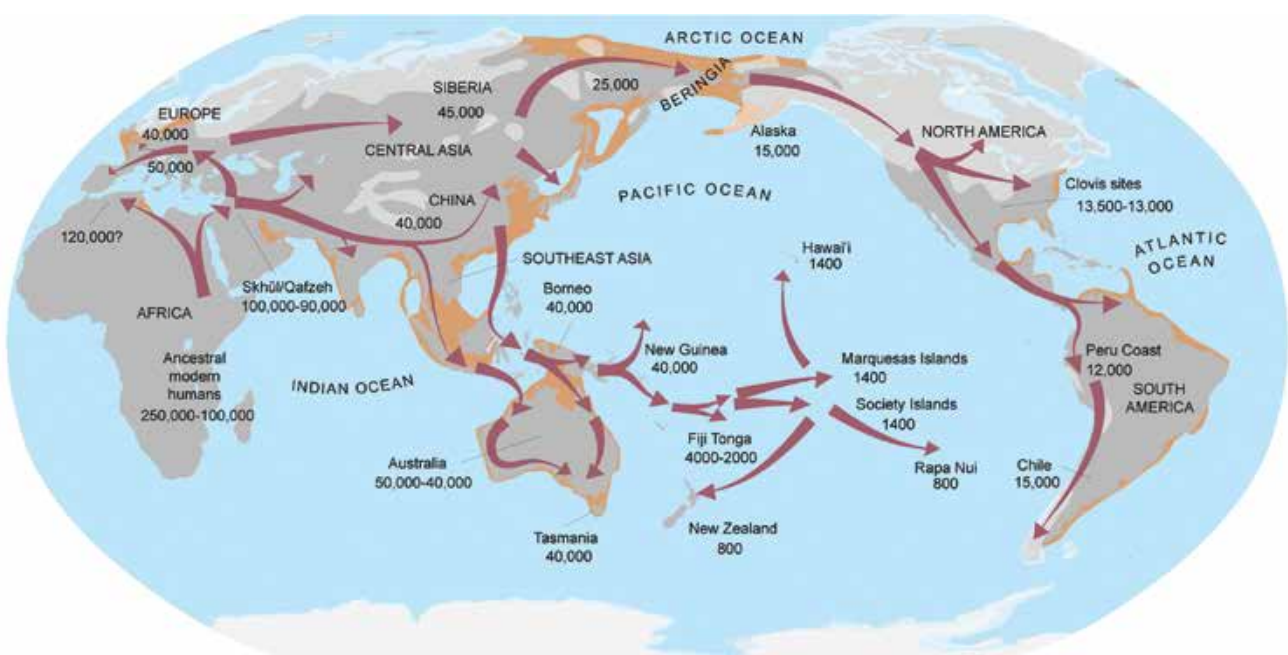


Figure 1. The expansion of anatomically modern humans from their African origins to Europe, Asia, Australasia and the Americas. The colonization of Australasia before 40,000 years ago would have required maritime technology capable of crossing open sea; the colonisation of Polynesia within the last 2000 years required sophisticated maritime technology and navigational skill, though whether Polynesian seafarers reached the coast of South America is still uncertain. Illustrator: ML Design.

Once they had penetrated south of the Laurentide and Cordilleran ice sheets, the human settlers encountered a land of warming climate and abundant resources. In contrast to most of the areas previously colonized by modern humans (with the notable exception of Australasia) there were no established hominid communities (cf. Neanderthal in Europe and western Asia, *Homo erectus* in east Asia); in hominid terms this was pristine terrain. The rapid expansion of settlement was accompanied by the extinction of many of the larger terrestrial mammals that had populated the Americas during the Pleistocene. Recent research concludes that this megafaunal extinction may partly have been a response to climate and habitat change but it was exacerbated and perhaps largely driven by human predation (Prescott et al., 2012; Johnson et al., 2013), even though in specific cases the connection with human action may be unproven (for example, Campos et al., 2010). The fact that the pattern is repeated across several continents is strongly consistent with some measure of human responsibility, and is supported by the impact of more recent human colonization on the flightless moa of New Zealand or the elephant birds of Madagascar.

Both the Americas and Australasia might be considered 'New Worlds': the last continents settled by modern humans, long after Africa, Asia and Europe. But while together they share that distinction, their subsequent social, cultural and demographic development differ in striking respects.

In large measure this can be explained by geography and environment. Nearly 70% of the land area of Australia (3 million km<sup>2</sup>) is desert (Smith, 2013, pp. 1-6), while only limited areas of the north, west and south coasts have more than 100 days of rain per year. The tropical north of Cape York and Arnhem Land give way to subtropical and then temperate zones as one moves south along the east coast, but inland extensive areas of desert are fringed by extensive areas of grassland.

In terms of biomass, Australia is hence much smaller than the Americas than their respective land areas would suggest and pre-contact population levels were much lower. Most estimates suggest fewer than 1 million people (Williams, 2013), as compared with 53.9 million in the Americas (Denevan, 1992). Indeed, populations in the desert areas of Australia may have numbered only 60,000-100,000 (Smith, 2013, p. 10). Despite specific adaptations to plant use and management, cultivation was never adopted, even in the relatively benign and fertile regions of the east coast or the Murray-Darling drainage.

It is striking nonetheless to note the evidence for population increase in Australia and the Americas from the period of first settlement up to European contact. Johnson and Brook (2011) argue from modelling taphonomic processes and abandonment rates at rock shelter sites that Australian population size was broadly stable during the first half of the Holocene but grew significantly from 5,000 years ago up to European contact. Williams (2013) has extended the curve back into the Pleistocene and, with a larger dataset of radiocarbon dates, has largely confirmed the mid-Holocene population growth posited by Johnson and Brook, with pronounced population growth from approximately 4,000 years ago, peaking 1,600 years ago with an estimated population of 1.2 million.

Despite the relatively small population size the clustering of communities in the more habitable areas of the continent and the growing numbers of people during the later Holocene might have been expected to lead to sociocultural complexity. There were indeed innovations in technology, economy and social interaction (Hiscock, 2009). The arrival of the dog and the presence in northern Australia of wild populations of bananas, taro and greater yam, three important food plants of New Guinea, may suggest contact across the Torres Strait and limited or experimental cultivation during the later Holocene, but if so it was a practice that did not spread or become firmly established (Denham et al., 2009).

All that is in sharp contrast to the pattern of development in the Americas. A similar methodology to that employed for Australia has used changing overall frequencies of radiocarbon dates from a hypothesised colonization date of 13,000 BC to the present to construct a proxy demographic curve for prehistoric North America. This concludes that population levels grew slowly at first, increasing pace after 6,000 BC, with a still further rate of increase after 200 BC. Maximum population density was reached around AD 1150, when the North American population may have numbered some 2.5 million people (Peros et al., 2010). Other recent estimates, based on historical and archaeological sources, suggest an even higher figure of between 1.2 and 6.1 million (Milner and Chaplin, 2010). The increased rate of growth after 200 BC relates to the impact of agriculture. In the south USA, for example, where maize cultivation was introduced around 2,000 BC, the development of more productive landraces and the addition of beans, squash and turkey led to significant population increase around the middle of the first millennium BC (Kohler et al., 2008). Still higher densities of population may have been present in the tropical zone. Total population in the heavily settled Maya lowlands alone during the Late Classic period must have numbered in the millions (Demarest, 2004, p. 294).

These population estimates are far larger than those for pre-contact Australia, but modest by comparison with heavily settled regions of the Old World. The Roman Empire, for example, is estimated to have numbered between 60 and 70 million people in the first century AD (Scheidel, 2007, p. 47); and census returns from the Han Empire of China in AD 2 record over 12 million households and 57.7 million people (Twitchett and Loewe, 1986, p. 206). In the Americas, such high

densities of population may only have been encountered in Mexico, where some estimates have suggested a population of over 25 million people for the Aztec realm at the time of Spanish contact (Cook and Borah, 1948). Against such high figures, however, others have calculated that the total population of the Americas in 1492 may have numbered only 53.9 million people. This would imply that in the late fifteenth century, the Americas held only one seventh of the global human population (Denevan, 1992; Thornton, 1987, p. 37). Nevertheless it is clear that at European contact the Americas were heavily settled: perhaps more so than has sometimes been appreciated given the impact of the European diseases that preceded the first European settlers in some regions.

## First cultivation in the Americas

When the Spanish conquistadores arrived in the New World they found a land populated by farming communities. The crops were different from those grown in the Old World, and there were few of the domestic animals that made such an important contribution in Europe and Asia, but the fundamental subsistence economy that they encountered was based on the cultivation and management of plants. That was not true of the entire continent, and hunting and gathering persisted in areas unsuitable for agriculture, such as the Arctic north, but the bulk of the indigenous American population relied on farming for their food.

Agricultural origins on a global canvas have often been envisaged in terms of core areas, where the wild ancestors of important domesticated species had their origins. The number of core areas has been disputed, and the concept itself has been challenged (for example, Harlan, 1971; Piperno, 2011; Fuller, et al., 2011a). It is clear that early human foraging communities not just in 'core areas' but in many other parts of the world entered into close relationships with the plant and animal species on which they depended. Nonetheless, certain specific plants or groups of plants, sometimes accompanied by animals, assumed a considerable importance in particular regions over the long term, and provided the basis on which settled communities of larger populations could be supported.

A number of key areas can be identified in the Americas: south-western Mexico, central Pacific and western Panama, premontane Colombia, the Colombian Amazon, south-western Ecuador, and northern Peru, and eastern North America (Piperno, 2011; Smith, 2011). At the time of European contact, maize was the key staple in three of those areas, and manioc in the fourth. It is misleading, however, to focus on the origins of these staples, since the earliest cultigens appear to have been the squash *Cucurbita moschata* and the bottle gourd *Lagenaria siceraria*. Remains of both have been found at several sites in northern South America and Panama dated between 8200 and 5600 BC (Piperno, 2011). *Cucurbita* squash yields edible seeds, but it is possible that both it and the bottle gourd were cultivated largely for their use as containers. Hence agricultural origins in the Americas may have been propelled by the need of mobile hunter-gatherer communities for means of carrying things, notably water, which would have been a vital resource in this arid landscape.

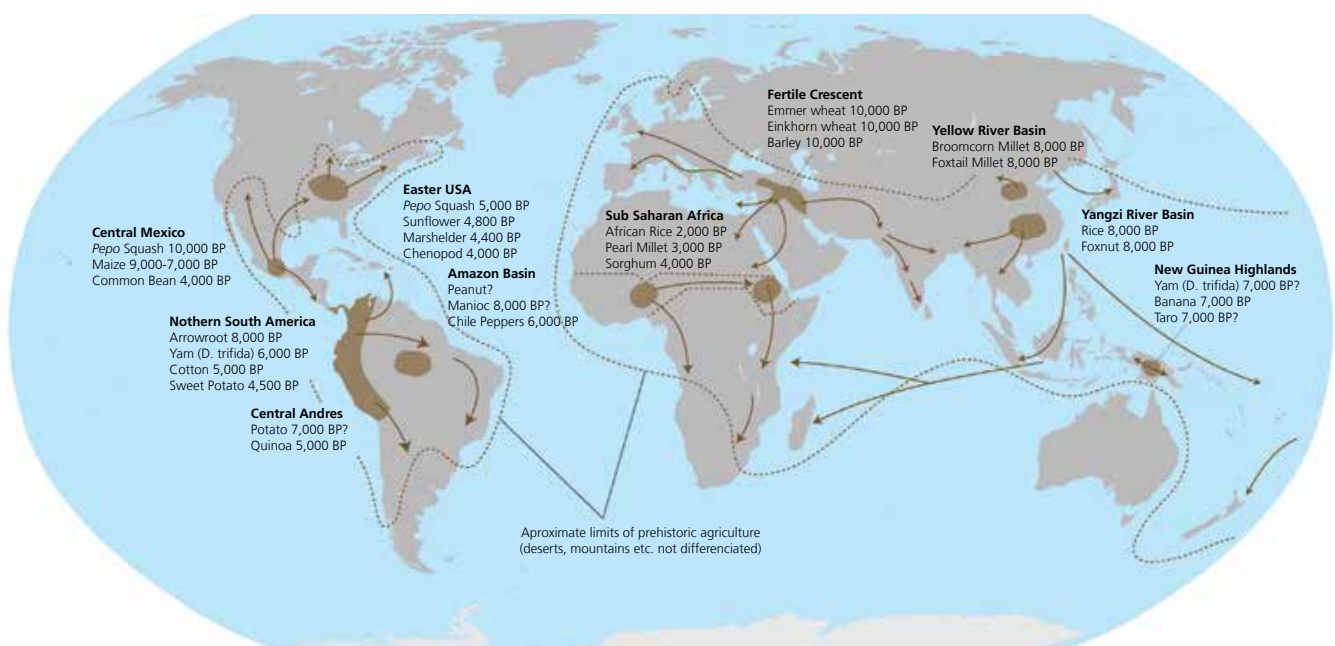


Figure 2. Principal centers of plant cultivation. Note how these are confined to tropical and middle latitudes between 20°S and 40°N, and consist predominantly of large-seeded grasses and tubers. Illustrator: ML Design.



The date of first domestication of the Mesoamerican staple crop, maize, has been much disputed. Excavation in the dry cave deposits of the Tehuacán Valley in the 1960s yielded remains of maize cobs at various stages of domestication and coupled with early C14 dates suggested that the transition from hunting and foraging to farming had been a very gradual process, extending over several thousand years. The first domestic maize, it was claimed, dated to 6,000 BC, and at first played only a minor part in the overall diet, becoming a key staple only in the third millennium BC (MacNeish, 1964).

This early field research in the Tehuacán Valley challenged the prevailing orthodoxy of Old World agricultural origins which since Gordon Childe (1936) had interpreted the beginnings of farming as a 'Neolithic revolution', a radical and relatively sudden shift in human subsistence. The focus in the Old World explanations was on the staple cereals wheat and barley (in south-west Asia) coupled with domestic livestock: sheep, goat, cattle and pig. The Tehuacán evidence poses two separate challenges to this conventional view: first, in demonstrating that the earliest cultigens were not necessarily staple food crops; and second that the path to fully farming communities was not necessarily a sudden shift.

New World farming differs from Old World farming in one other signal respect: the much smaller role accorded to domestic animals. Old World farming communities could call upon a variety of domestic animals, not only as food sources but for dairy products, transport and traction. There was nothing strictly comparable in Mesoamerica and North America, and the camelids domesticated in Andean South America were not exploited extensively for their meat, nor as plough animals, but for transport and wool. Cultivation remained the back-breaking work of human labour.

With the exception of the dog (brought across the Bering Straits by the first settlers: Thalmann et al., 2013) and the bottle gourd (carried from Africa by accidental drifting on South Atlantic Ocean currents during the late Pleistocene: Kistler et al., 2014), all the plants and animals domesticated in the pre-Columbian New World were indigenous to the Americas. The process is testimony to the inherent embeddedness of domestication within human behaviour, at least since the emergence of modern humans. It has been argued, indeed, that under the relatively stable climatic conditions of the Holocene, agriculture was, in the long run, inevitable (Richerson et al., 2001; Bettinger et al., 2009). Such a perspective places New World agriculture alongside that of the Old World regions as parallel processes, driven essentially by (a) the availability of suitable species, capable of thriving under domestication and providing high returns (such as the large seeded grasses: rice, wheat and barley, maize), and (b) demographic growth, encouraging closer interactions between societies and their wild food sources, leading eventually to domestication. Humans were conscious actors in this process, but it might also be envisaged as a form of co-evolution, with people adapting to domesticates just as domesticates adapted to human needs (Rindos, 1984).

In south-west Asia, close relationships between humans and their food sources led to an early exploitation of wild emmer wheat, barley and oats in the Levant. The key site of Ohalo II on the Sea of Galilee has evidence of the systematic exploitation of these resources 23,000 years ago (Nadel et al., 2012). This preceded by over 10,000 years the transition to agriculture. That may be contrasted with the process of subsistence change in the Americas. The settlement history of the Americas was much shorter than that of the Near East. If we assume first colonization of the continent no earlier than 17,000 years ago, and relatively rapid expansion of human communities implied by the available dating evidence from South America, then the period for adjustment of human societies to the regional suites of plant and animal resources had a much later start.

Once again, however, the advent of stable and more benign climatic conditions at the advent of the Holocene appears to have a major role. In South America, a range of Neotropical plant species appear to have been domesticated at the very beginning of the Holocene in Colombia, Ecuador and Peru. In the millennia that followed, human manipulation of gourd, arrowroot, manioc, yam and perhaps maize led to their domestication in this same region. In the Andean zone, there is evidence for the adoption of cultigens in certain upland valleys in the terminal Pleistocene and intensified use in the early to middle Holocene (Dillehay, 2012, p. 43). Yet the impact on communities of these increasingly intertwined plant-human relations appears to have been more gradual than in key regions of the Old World. In the Levant, the size of the largest settlements expanded massively during the early and middle Holocene, from 0.2 hectares in the tenth millennium BC (Late Natufian) to over 10 hectares in the seventh millennium BC (Late PPNB) (Kuijt, 2000). The large settlement of Çatalhöyük in central southern Turkey, founded c. 7100 BC, covered 13 hectares. Within a millennium, furthermore, substantial farming settlements had been established in south-eastern Europe, and by the end of the sixth millennium settlements of large timber longhouses had spread along the river valleys of central Europe to reach the shores of the English Channel. In China, too, the first domesticates quickly became established in the context of large nucleated villages in river valleys. That was not the case in the American Neotropics (Piperno, 2011, S461).

The contrast between the Americas and western Eurasia raises a series of fundamental questions. Why were they so different? One important feature that stands out is the focus in the latter region on the systematic gathering of large-seeded wild grasses – the ancestors of the domestic cereals – for several thousand years. These provided an effective staple foodstuff that could support large sedentary populations, in combination with pulses and domestic livestock. Many of the early New World



cultigens did not have the potential to serve as staples in this way. But others clearly did – notably maize, manioc and potato, and it was those ultimately that provided the means for sociocultural complexity and the development of urban state societies in Andean and Pacific South America, in highland and lowland Mesoamerica and in the Mississippi Valley.

## Settling the land

As human populations grew in numbers during the Postglacial, human impact on the landscape also increased. This was witnessed in growing levels of deforestation, both in the Americas and Eurasia. Much of that was associated with the clearance of land for agriculture, although hunter-gatherer impacts through burning to encourage new growth may have had unintended and irreversible effects in some areas. In coastal California, for example, the establishment of more sedentary communities of hunter-fisher-gatherers around 1500 BC was associated with increased burning of the local vegetation (Anderson et al., 2013). A general relationship between population size and forest clearance for farming has been documented at both the continental and global scale, and may have contributed to slowly rising levels of atmospheric CO<sub>2</sub> recorded in the Atlantic ice cores (Kaplan et al., 2011).

Human impact was also marked in more symbolic ways. The most widespread took the form of rock art. Palaeolithic rock art (in the form of engraved or painted motifs) is present on every settled continent, including Australia. Evidence from North America suggests that petroglyphs were being carved at Winnemucca Lake, Nevada, as early as 10,000 years ago (Benson et al., 2013). Of similar or slightly earlier age is an engraved anthropomorphic motif from the Lapo do Santo rockshelter in central Brazil (Neves et al., 2012). It is not only the practice of rock painting or carving, but the motifs themselves that find broad international resonance. Images of humans and animals, whether naturalistic or schematic, are widespread on all continents. Still more striking are the middle Holocene hand stencils, present for example at the Cueva de las Manos in Patagonia, inscribed on the World Heritage List in 1999. Hand stencils are also known from North America, North Africa, Australia and Borneo, and from Upper Palaeolithic caves in France and northern Spain, where they constitute some of the earliest dated rock art in the world (Pike et al., 2012; Pettitt et al., 2014). Recent studies of hand stencils in Sulawesi have shown they are of comparable antiquity to the oldest European examples (Aubert et al., 2014). Both the practice of rock art and the individual motifs place the Americas once again within a global context of human behaviour, in this case one where symbolic expression, and the marking of special places within the landscape, occasionally takes very similar forms.

Postglacial societies modified their landscapes in other ways, too. Monuments of earth and stone are a feature of many regions within and outside the Americas. The manipulation of large stones to create pillars, colossal statues or burial chambers (frequently in the form of 'megalithic' monuments) draws upon the need to impress, as power relations became more complex and societies more unequal. Monuments also provided the settings for ceremonial and cult. At Nanchoc in the Andes, platform mounds were built as early as the sixth millennium BC, with steep stone-faced sides (Moseley and Heckenberger, 2013, p. 646). They mark the beginning of a tradition that became widespread in the 3rd millennium BC, as represented by sites such as Aspero on the Pacific coast or La Galgada in the interior. Watson Brake in the Mississippi Valley, a fourth millennium complex consisting of eleven mounds around an oval plaza, provides a North American parallel (Saunders et al., 2005). They invite comparison with west European ceremonial structures of comparable date such as Silbury Hill or Avebury, but such comparisons fail at the detailed level, in terms of form and function. It is the creation of ceremonial settings at monumental scale that is the connecting characteristic.

As communities grew in size and complexity other parallels arose between American and Old World societies. The construction of irrigation canals to bring water to crops, or to natural stands of vegetation (Smith, 2001) is a feature of both hemispheres from at least the sixth millennium BC, although the most elaborate irrigation systems belong to more recent periods. It was only state-level societies that could command the skill and resources to construct such extensive irrigation works as the Nahrwan canal in sixth century AD Mesopotamia (Adams, 2006) or the inter-valley Andean canal systems of the Chimú (Ortloff, 1995). Control of water was a feature of many early and historical societies and once again, there are striking parallels between distant lands and places. The same extends to terracing of mountainous landscapes to create cultivable fields, a feature of Mesoamerica and Andean South America at the time of European contact, as well as in many parts of Asia and southern Europe.

Intensification, in terms of population numbers, settlement density, social inequality and food production, led ultimately to urbanism and state formation in both hemispheres, through a series of separate but parallel processes. The global chronological patterning is very uneven, with the first cities in Mesopotamia during the fourth millennium BC, in the Indus Valley region of South Asia a millennium later and in northern China by the end of the second millennium BC. They are marked by monumental structures, pronounced social hierarchies represented in iconography and burial, and intensified food production. In the Americas, cities form during the late first millennium BC and AD in highland Mesoamerica

(Teotihuacán and Monte Albán) and in the early first millennium in the Maya lowlands. Once again there are striking interregional parallels, between, for example, the low intensity tropical urbanism of the Maya lowlands and the Angkor complex in South-East Asia, or Anuradhapura in Sri Lanka (Isendahl and Smith, 2013; Fletcher, 2012). By the time of European contact, sophisticated urban societies were present, as independent developments, in highland and lowland Mesoamerica and Andean and Pacific South America, just as throughout much of Eurasia and North Africa. Millennia of demographic growth, subsistence change and social inequality had produced a global pattern whose common origin lies in the first settlement of the Americas during the final stages of the last Ice Age, and little or nothing to subsequent contacts.

### The New World in isolation: maritime contact before Columbus

In the context of global prehistory, the Americas present a paradox of early connection followed by later apparent isolation. Modern humans arrived in North America around 15,000 years ago, if not before. There may have been as many as three separate immigrations, probably crossing the Beringian land-bridge from Siberia into Alaska (Greenberg et al., 1986). The alternative, of coastal or maritime migration using boats, opens the alternative possibility of colonization from Europe across the southern edge of the Arctic sea-ice (Stanford and Bradley, 2012), although as we have seen, a north-western point of entry is still generally preferred.

Whichever the point of arrival, the general belief backed by overwhelming evidence (or more accurately absence of evidence) is that the Americas, once settled, were thereafter isolated for over 10,000 years. It is that isolation that gives the parallel nature of many social, cultural and economic developments in Eurasia and the Americas its special significance. Cities, agriculture, metallurgy and writing are among the many key developments that find parallels in both hemispheres, suggesting that in a certain perspective human societies may be considered self-organising systems, tending to find the same solutions, technologies or traditions when faced with similar circumstances and opportunities.

There are, nonetheless, tantalising hints of external connections between the Americas and the Old World over the lengthy period from first settlement to the Spanish conquest. As we saw earlier, domestic dogs were probably brought from Asia by the first settlers, even though the earliest evidence of their presence in the New World is several years later than the presumed period of colonization.

Two specific pieces of archaeological evidence suggest later contact, although they may have been of a relatively ephemeral nature. The first of these is the sweet potato *Ipomoea batatas*. Sweet potato is a domestic plant of tropical America origin, yet it appears in archaeological contexts on a number of Polynesian islands several centuries before European contact (Horrocks and Rechtman, 2009; Montenegro et al., 2008). Recent genetic analysis confirms their pre-Columbian dispersal from the Americas to Polynesia (Roullier et al., 2013). How this came about has been the subject of considerable controversy. The maritime capabilities of Polynesia seafarers are well-established. The settlement of Rapa Nui (Easter Island) involved an open sea crossing of over 2,000 km, its nearest inhabited neighbour being Pitcairn Island, 2250 km to the north-west. Beyond Rapa Nui, the coast of South America lies 3747 km distant (Bahn and Flenley, 1992, p. 22). The possibility that Polynesian voyagers reached South America, whether by accident or design, is entirely plausible. The presence of sweet potato in Polynesia, however, indicates not only landfall in South America but a successful return journey. Westward flowing currents from Guayaquil in Ecuador would have made that possible, if nonetheless challenging (Scaglione, 2005; Scaglione and Cordero, 2011). Other evidence for Polynesian contact has been proposed (Jones et al., 2011), although sweet potato remains the most convincing.

The alternative scenario, that South American coastal peoples themselves undertook maritime voyages in the Pacific, was championed by Thor Heyerdahl in his 1947 Kon-tiki expedition. However, although ceramics found on the Galapagos islands, 926 km from the coast of Ecuador, may indicate maritime contact with South America, earlier claims for their pre-Columbian age have been discounted (Flett and Haberle, 2008; Froyd et al., 2010). There is no other evidence of distant South American seafaring, in contrast to the extensive record of Polynesian voyaging. Alleged parallels between monumental architecture in Polynesia and South America are imprecise and unconvincing, and testify merely to independent regional manifestations of a globally dispersed pattern of ceremonial platforms and standing stones. Accidental drift voyaging from South America to Polynesia remains nonetheless a possibility (Montenegro et al., 2008).

The second is the presence of wheeled toys in Pre-Columbian Mesoamerica. Several terracotta models of wheeled vehicles, with disc-like wheels mounted on wooden axles supporting a terracotta frame sometimes in the form of an animal, have been found mainly in Olmec contexts in the coastal Veracruz region (Ekholm, 1946). It has been suggested that these are evidence of trans-Atlantic contact, perhaps involuntary and spasmodic (e.g., shipwrecked mariners). While that possibility cannot be excluded, an indigenous derivation from spindle whorls offers a more plausible origin (Ekholm, 1946, p. 225).

The absence of any South American domesticates other than sweet potato from Polynesia suggests that such contact as may have existed were ephemeral. Nor is the evidence any stronger for Central or North America. This stands in stark contrast to the movements of crops between different regions of the Old World during the middle and late Holocene. There was active transmission across the Indian Ocean, with Chinese millet reaching Africa, and no fewer than five African crops reaching India soon after 2000 BC (Fuller et al., 2011b). Even the relative isolation of Australia was broken by the introduction of the dingo some 4500 years ago, and already noted, domestic crops may briefly have been introduced from New Guinea to Arnhem Land two millennia or more before European contact (Hiscock, 2009, p. 146; Denham et al., 2009). Given the relatively short sea crossings separating north-east and north-west North America from Europe and Asia respectively, its sustained isolation is all the more remarkable.

The first documented external contact can be dated to around AD 1000 and offers a foretaste of things to come. The Norse (Viking) settlement found at L'Anse aux Meadows on Newfoundland consists of a group of Icelandic-style halls radiocarbon dated to the period AD 980-1020. It is identified as a short-lived exploratory base established by Leif Eriksson in around the year AD 1000 and documented in the later Vinland Sagas. The attempted colony (if such it was) failed, however, owing to the hostility of the local populations and the sheer distance (3200 km) from the small Viking settlements of Greenland (Wallace, 2000). A scatter of Norse artefacts among the Dorset peoples of Arctic Canada testifies to only limited contact between the Greenland Vikings and indigenous North Americas in the two or three centuries that followed (Sutherland, 2000).

Hence by the beginning of the second millennium AD, the isolation of the Americas was under threat from two directions: the Polynesian maritime expansion from island South-East Asia to the west, and the Viking maritime expansion from north-west Europe to the east. The latter succeeded in making landfall, for at least a few short years; the former may also have done so but left no definite trace. In neither case were there long-term impacts. Neither Vikings nor Polynesians reached the Americas in sufficient numbers to pass on the deadly Old World diseases that ravaged indigenous populations following the Spanish conquests of the sixteenth century.

## Epilogue: European conquest and colonialism

The arrival of Spanish and other European adventurers and colonists brutally truncated the indigenous development of Native American societies that had been unfolding since the first settlers crossed the Bering Straits some 15,000 or more years before. In the centuries that followed European contact, warfare, displacement, maltreatment and disease reduced the indigenous population to perhaps 10% or on one estimate as little as 6%, of its original size (Thornton, 1987, p. 42). That cultural dislocation has coloured the subsequent investigation of pre-Columbian societies, as scholars and antiquarians in the western tradition have sought to apply the methods of archaeology to an understanding of American prehistory. European collections of Aztec and Maya antiquities began to be formed during the nineteenth century, but these could not be incorporated into the narrative of the rise of western civilization in the same way as those of Greece and Rome, or Mesopotamia and Egypt (Díaz-Andreu, 2007, p. 172). It was only in the middle decades of the twentieth century that accounts of world prehistory began to be developed in which the early societies of the Americas were accorded a proper and more appropriate standing in the global picture of the human past.

Many of the features of those early societies are widely represented in the Americas and beyond, as we have seen. The underlying trend, of human population increase and adjustment to resources, environments and opportunities, has produced striking parallels which in some respects take us back to Lewis Henry Morgan's 'unity of the origin of mankind' (Morgan, 1877, p. 18). In World Heritage perspective, they have intrinsic value as reminders of the complex patterns of the past that preceded European expansion.

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## Peopling of the Americas: Potential Insights from Modelling

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### Introduction

**This paper offers a comment on the value of modelling, as an aid to explanation of the archaeological record of the first peopling of the Americas. Models are simplifications of reality that enable us to explore alternative processes that may have given rise to the patterns we observe today. They may initially be formulated in qualitative terms as narrative representations of some system of interest (where the axioms – assumptions that are taken as given, to enable hypotheses to be formulated - often remain implicit). But, we suggest, models are more useful if their premises are made explicit, and if their assumptions about the dynamics of the system of interest are formalised as a set of rules or mathematical relationships. In this way the input variables can be quantified, the assumptions about dynamics can be checked, and the archaeological consequences of alternative scenarios can be properly explored.**

Models are fundamental to scientific explanation: at one extreme, science can be defined as

a process of constructing predictive conceptual models. Within this framework, the purpose of research is to produce models which represent consistent, predictive relationships. These models are representations of 'target' systems existing in the ambient world. They are the systems of words, numbers, pictures, programs, actions, and concrete images that constitute scientific communications (Gilbert, 1991: 73).

Fifty years ago, Levins (1966) pointed out that all models involve trade-offs between realism, generality and precision, and that the trade-offs we make in any single instance reflect not just our scientific priorities, but also our own mental limits in grasping cause-effect relationships in complex multicomponent systems and the limitations of the technology we use to model those systems. These observations remain true today. Levins also pointed out that

The validation of a model is not that it is 'true' but that it generates good testable hypotheses relevant to important problems. A model may be discarded in favor of a more powerful one, but it usually is simply outgrown when the live issues are not any longer those for which it was designed' (Levins, 1966, p. 430).

Unless we make model-building part of our plan of scientific activity from the outset, archaeological research is reduced to a process of empirical observation and description in which broader interpretation is constrained by an implicit (and often outdated) conceptual frame of reference. Our predictive conceptual models and their assumptions and frames of reference must therefore always be kept under review.

In this paper, as an illustration of the value of the approach, we will firstly summarise a recent body of work on early Palaeoindian archaeology by one group of archaeological modellers based in the USA. This work focuses on the Early Palaeoindian food economy, and in particular, on the role of proboscideans (mammoth, mastodon) in the subsistence strategies of those early hunter-gatherers who used Clovis spear point technology. We will then, secondly, review the current stage of development of a longer history of modelling the spread of the earliest hunter-gatherer colonists of the Americas (or rather, the spread of the populations that became successfully established; we will not consider the possibility of earlier entries by small populations that subsequently went extinct, although this is an interesting avenue to explore). This second focus of our paper involves work done during the past fifty years by multiple authors, with a variety of modelling techniques and problem focuses. Finally, we will comment on the issue of shelf-life raised by Levins – do existing models of early Palaeoindian subsistence and dispersal adequately address the 'live' issues which we might want to prioritise for investigation today?

## An example of a modelling approach: Surovell, Waguespack *et al.*'s models of a specialized Palaeoindian large game economy

A familiar, but contested, scenario for the economy of early Palaeoindians in North America in the Clovis era associates their spear point technology with specialized hunting of megafauna, including proboscideans (mammoth, mastodon). The arguments in support of this include the co-occurrence of Clovis points with proboscidean remains at many archaeological sites and the chronological coincidence of the Clovis tool horizon with the extinction of these (and other) putative prey species.

However, counterclaims have been made that the early Palaeoindian economy in North America was in fact a generalised foraging adaptation, and that human predation was unlikely to have been a factor in the extinction of these megafaunal species. The arguments in support of this alternative scenario include the relative paucity of sites with Clovis points and proboscidean remains, and the weakness of the chronological association between radiocarbon dates for early Palaeoindians and for the last observed occurrences of the now-extinct species.

Resolving this debate rests on a solid understanding of what patterns we should *expect* to observe in the archaeological record, under one or other scenario. This requires us to construct predictive models both of the original ecological system and of the factors affecting its archaeological visibility today.

A good start at this has been made by Surovell, Waguespack and collaborators. In a series of papers, they have shown (using simple predictive models) that the archaeological record as we know it today is indeed compatible with a hypothesis of Clovis-era economic specialization. In a paper that addresses the record of precursor communities in Siberia, Surovell *et al.* (2009) model the rate at which archaeological sites disappear from the record after deposition, reflecting a range of physical processes of attrition. They point out that that radiocarbon-dated occurrences of proboscidean remains in Siberia ought to increase with recency (at least, prior to the extinction cut-off) and that the fact that they do not implies that the underlying animal populations were in decline during the period of co-existence with Upper Palaeolithic human groups. Their model of the expected increase in survivorship of archaeological remains as a function of recency is an empirically estimated function, derived by analogy with the fall-off in frequency of volcanic events with age in the global archaeological and geological record during the same period (which must reflect taphonomic processes of attrition, since ice core records suggest that the true underlying frequency was uniform).

Elsewhere, Surovell and Waguespack (2008) compare observed frequencies of archaeological sites containing proboscidean remains from Clovis-era North America with those in various periods and regions of the Palaeolithic Old World; they show that after adjusting for time depth and spatial extent, the early Palaeoindian record is indeed characterized by a relatively high density of such sites. Their model consists of a formula for predicting the expected rate of deposition of archaeological sites per unit space and unit time, under different foraging regimes.

In a third paper (Surovell and Waguespack, 2009; cf. Waguespack and Surovell, 2003), the same authors analyse the relative abundance of remains of animals of different size classes in the Clovis-era archaeological record and compare it with the profile of relative abundances of captured animals of these differing size classes in the ethnographic records both of generalists and of large game specialists. Their model describes the expected prey abundance profiles of these two strategies, under the (ecologically valid) assumption that smaller-bodied species can typically be found living at higher densities; in such a world of prey availability, the archaeological sites of generalists should show a preponderance of game of smaller body sizes, while those of large game specialists should show the reverse pattern. It is the latter that is found in the Clovis-era archaeological record.

## Models of early Palaeoindian population increase and spatial range expansion

Surovell, Waguespack and collaborators have been careful to separate their detailed models of an early Palaeoindian big game economy from the larger question of the timing of arrival of the first peoples of the Americas. Nevertheless, they do address this issue. In another recent paper, Surovell and Grund (2012) consider the limited likelihood of finding archaeological sites with remains of extinct fauna, if the period of overlap of humans and their potential prey was short and restricted to an initial phase of human population growth (when total numbers of people and thus their cumulative archaeological impact were low when compared with their successors). Surovell (2003) had earlier modelled the potential population growth rates of hunter-gatherer bands with high rates of relocation of their base camps (high 'residential mobility'), showing that women in such societies – perhaps counterintuitively – would have been capable of high levels of fertility, because such a strategy reduces the distances of daily foraging movements (and therefore their energetic cost). Waguespack (2005), meanwhile,

had argued from ethnographic analogy that in such economies with a heavy meat-dependence, women could be predicted to have taken on a larger share of the non-subsistence tasks.

In a related body of work, several other authors have modelled the spread of an invading population of hunter-gatherers into North America and their possible impact on native prey species. Whereas models of the kind developed by Surovell and collaborators focus on prey choice and on the preservational biases of the archaeological record, this related body of work focuses instead on population expansion (and predator-prey interactions) as a geographically-structured process. Here, a major focus is on the time required to colonize the Americas from an entry point in the north-west, subject to the constraint that groups must multiply by growing and budding off within some neighbourhood; typically, it is not considered realistic to model a new group appearing thousands of kilometres from its parent group, without some intervening chain of links forged by shorter-distance migration and group splitting – a process that is modelled as unfolding over a multi-generational timescale.

An influential early exponent of such models was Paul Martin, who argued in 1973 that the Americas could have been colonized in 1,000 years. He estimated game densities based on modern analogies and analysed a model of an expanding, densely-populated migrating front of hunters who were capable of doubling their number every 20 years and who migrated an average annual distance of up to 30 km per year. If they hunted large game at a rate consistent with the needs of their modelled population densities in the front, but with wasteful use of carcass resources, then the large game species would have been depleted faster than their potential reproductive rates of replacement, leading to local and ultimately species-level extinction. In an extended version of this work, Mosimann and Martin (1975) considered a more detailed predator-prey model, obtaining essentially similar results for the likelihood of extinction of large game species in North America. These results were further confirmed by simulations in a new analysis of the Mosimann and Martin model by Whittington and Dyke (1984).

Alroy (2001) reported a more recent and more detailed exploration of the same issues. He modelled the expansion of an initial hunter-gatherer population entering North America from the north-west and expanding (in number and in space) at a rate determined by ethnographically plausible values for fertility and for mobility. His early Palaeoindian population was modelled as subsisting partly by hunting animal prey, whose distribution, densities and life history strategies were modelled – species by species – from empirical palaeontological data and from modern ecological analogy. Alroy analysed the likely trajectories towards extinction for different prey species under different assumptions about hunting pressure, finding that hunting efficiency (and thus human population density) was the most sensitive predictor of prey extinction rates. His models also predicted a boom-and-bust cycle in initial human population numbers, with a crash following prey extirpation.

Other models have also considered the fact that prey densities vary in space and how this may have affected demography and economic strategy. These models have usually, however, made an additional assumption that early Palaeoindian hunter-gatherers were locally adapted to primary and secondary biomass resource profiles. Thus Belovsky's (1988) optimal foraging models refuted the 'overkill' hypothesis, but only by assuming that human hunters varied their focus on hunted game versus collected plant foods as a function of local net primary productivity, that human population growth rates were sensitive to local food availability, and that prey species recovered from background predation pressure at a constant rate independently of their individual life history characteristics. Steele, Adams and Sluckin (1998) considered the evolution of the population distribution on the North American late glacial landscape as a function of regional variation in ecosystems, but again making unreasonable equilibrium assumptions about the stability of founding populations at carrying capacities that reflect a high degree of local economic adaptation. These assumptions of local cultural and economic adaptation are precisely what the proponents of 'overkill' and of a Clovis-era large game specialization would dispute, arguing instead that a large game focus was an efficient adaptation for an expanding colonizing population (for example, Kelly and Todd, 1988): it would have enabled them to expand into diverse environments where the local resource structure was poorly understood, but the behaviour of the large prey animals could be readily generalised from previous experience elsewhere.

A separate approach to modelling early Palaeoindian demography for the whole of the Americas has been taken by Anderson and Gillam (2000; see also Anderson and Faught, 2000; Banks et al., 2006). Their models explore possible geographical corridors of dispersal (based on GIS least cost path analyses of late glacial topography), with an associated 'leap-frogging' demographic model in which the velocity at which populations expand along a corridor is determined by the dimensions of the typical band's territory, its doubling rate and the distance which a new group is prepared to migrate after fissioning. Other than this tethering to resource corridors (and the assumption that leap-frog migration is an efficient way to colonize a continent of widely-dispersed but food-rich 'megapatches'), their models do not consider predator-prey dynamics or the validity of any associated equilibrium assumptions; but they highlight the possible importance of coastal, riverine and ecotone corridors in channelling movement as the colonizing population expanded.



## Modelling early Palaeoindian range expansion: what are the 'live' issues today?

As we noted above, models are valuable when they generate useful predictions about important, 'live' issues. The models reviewed above remain extremely useful, but they are also - to greater or lesser degrees - linked to the broader assumptions of the 'Clovis first' and 'overkill' scenarios for the peopling in the Americas. We now review some respects in which the live issues have changed in recent times and the implications of these changes for how we should build our models in the future.

*Coastal versus inland dispersal routes.* Most examples from the earlier generation of models of the peopling of the Americas have assumed that the lands south of the ice sheets were reached through an 'ice-free corridor', which opened up between the receding Cordilleran and Laurentide ice sheets some time in the late last glacial. However, recent work suggests that this corridor may not have opened up until well after the Clovis era (Gowan, 2013). If that is the case, then late glacial colonization models should focus instead on the possibility of an initial coastal migration route (for example, Surovell, 2003; Anderson et al., 2010, 2013; Misarti et al., 2012; Clark et al., 2014).

*Origins of Clovis technology.* Recent fieldwork suggests (albeit controversially) that Clovis spear point technology may have originated in North America south of the ice sheets (Waters et al., 2011a), implying both an *in situ* precursor population (cf. Gilbert et al., 2008; Walters et al., 2011b) and the rapid diffusion of an advantageous cultural innovation. This scenario therefore now needs to be modelled at the continental scale. One focus for modelling is the demography and spatial expansion of a precursor population: what are the chronological and other empirical constraints? For Anderson and Gillam (2000, p. 60), 'The fluted point distribution [...] probably better represents the process of population in-filling and the spread of a specific adaptation, than the locations where the first peoples settled [...] Clovis could still be a founding population in some areas, although it no longer appears to be the founding population across the hemisphere'; but this does not affect their topographic modelling of possible dispersal corridors, only its timing. Meanwhile, older Clovis-first models can probably be adapted fairly easily to model the spread of Clovis technology (if that innovation was associated with increased hunting efficiency and increased hunter-gatherer population densities). The results might not look that different to those from models of 'Clovis first'. Mosimann and Martin (1975, p. 308), for instance, commented that in their models 'the hunters move south through the region of radiocarbon-dated kill sites in 60 years. It would be very difficult to detect so slight an age difference by radiocarbon dating'; but the same problem arises if the predation wave started from elsewhere within the continent and if the direction of innovation diffusion was reversed.

*Climate change and faunal turnover.* Most earlier models of 'overkill' did not take adequate account of processes of climate change and associated habitat fragmentation and loss, although these were occurring contemporaneously with initial human settlement and with human predation. More recent models suggest that megafaunal extinctions were at least partly driven by such changes in the natural environment, with human hunting simply adding further pressure, although there is still disagreement on the relative importance of the human factor (for example, Lorenzen et al., 2011; MacDonald et al., 2012; Johnson et al., 2013; Lima-Ribeiro et al., 2013a,b; Sandom et al., 2014). New models of predator-prey interactions and the early Palaeoindian archaeological record must therefore take this external, climatically-driven instability into account as well.

*Latin America: radiocarbon chronologies for human occupation and megafaunal extinctions.* In recent years the radiocarbon timescale of early human occupation of the different countries and ecoregions of Latin America has become much more clearly demarcated, due not just to new discoveries, but also to new availability of large-scale archaeological databases and syntheses (for example, papers in Bueno et al., 2013) and of the results of programs of redating of previously excavated archaeological material (for example, Steele and Politis, 2009; Gonzalez et al., 2015). Systematic reviews of the evidence for human involvement in, and for the timing of, South American megafaunal extinctions are also now more widely available (for example, Borrero, 2009; Barnosky and Lindsey, 2010; Prado et al., 2012). New models of human dispersals, prey choice and megafaunal extinctions should therefore be explicitly constrained by (and seek to explain patterns in) these bodies of evidence alongside those from further north.

*Genetic and cultural evolution (and landscape learning).* At a more theoretical level, it is surely now time for archaeologists to address the issue of congruence between their data and models, and the colonization models inferred from ancient and modern human DNA. Archaeology seems to be able to provide more precise chronologies than can archaeogenetics, but has not yet taken its demographic models and used them to predict genetic patterns (even as a by-product of what must remain, for archaeologists, an archaeological record-focused endeavour). But if, for example, our models and observations predict large-scale late glacial booms and busts in Palaeoindian populations, then it must be worth asking whether such fluctuations might be expected also to yield some modern or ancient DNA diversity signature. Meanwhile, it is surely also time for us to address more rigorously the modelling of rates of cultural evolution (and of local or regional ecological adaptation). Different schools of thought in evolutionary anthropology lead to differing expectations for the

trade-off between optimisation of economic strategies in changing environments and the persistence of social traditions (for example, Smith, 2000; Winterhalder and Smith, 2000). These expectations have implications for our understanding of the rate of cultural evolution of local variation in population densities (carrying capacities), as well as of the potential for adaptive responses to rapid climatic and environmental change. A programmatic overview of some of the issues in 'landscape learning' has been set out by Rockman (2003) and by Meltzer (2003), but such models have not yet been explored in a fully quantitative framework.

Finally, it is worth reiterating that models are not typically proposed as 'true' representations of what happened in the past. They articulate explicit assumptions about key aspects of that past reality according to alternative hypotheses, build schematic representations of the dynamics of such past systems, and use these to generate testable archaeological predictions. For this reason, model builders are constrained both by the willingness of others to articulate their speculative hunches explicitly enough to enable them to be formalised and also by the availability of empirical data on a scale and measured to an accuracy and precision sufficient to enable model predictions to be tested. Model-building is most useful, therefore, as part of a dialogue with those engaged most directly in empirical data gathering.

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# Social Evolutionary Dynamics and Property Relations in Primitive Societies

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**This paper looks at social evolutionary dynamics and property relations in primitive societies. It is divided into seven sections that explore different theories posited over time which identify various 'motors' of social evolution and eventually gives way to an articulation of the forces and the social relations of production in the evolutionary dynamic of societies without social classes. To accomplish this, Sahlins's Domestic Mode of Production is analysed and then framed to produce a four-stage model for the development of property relations over the course of prehistory.**

## 1.

Sixty years ago, when Childe (1951), Steward (1955) and White (1949) were practically the only Western scholars in the anthropological disciplines committed to an evolutionist perspective, they adopted a straightforward technological determinism. Human beings were assumed to be rational decision-makers. In the '*bricolage*' (Lévi-Strauss, 1962, p. 26) characteristic of their production, they would come upon useful innovations (ones that increased long-term net energy capture, in White's terms). These would tend to be retained and communicated to other producers, would form the basis for further useful innovations and so forth. Given a few rudimentary assumptions about human nature, the logical unfolding of technology would be the driving force of evolutionary change in human prehistory. Particular ecological circumstances might accelerate the adoption of certain innovations (as in Childe's [1951] 'oasis theory' of domestication), but, as Braidwood (1952) recognized, such circumstances are not necessary to the general theory.

The idea that technological development was the prime mover of human social evolution has come under attack from two quarters. From the cultural ecological perspective of the New Archaeology, the supposed autonomy of technology's development depended on assumptions about a corresponding development of human capabilities and, as such, constituted an unscientific explanation. 'Vitalism ... is unacceptable as an explanation. Trends which are observed in cultural evolution require explanation; they certainly are not explained by postulating emergent human traits which are said to account for the trends' (Binford, 1968, p. 322).

Technological development invokes, furthermore, the conscious decision-making of the producers as a causal force and is, accordingly, an explanation of change that is: 'needlessly teleological (since) many system states and adaptive responses in societies are not conscious to many or most of the people involved -- they are in no useful sense goal oriented' (Hill, 1977, pp. 66-67).

## 2.

What general cause for social evolution does the New Archaeology offer us to replace technological development? Given the New Archaeology's postulate that human cultures are homeostatic regulatory systems, changes in those cultures must come from the outside. Since environmental changes are not directional (while human social evolution has been), the preferred choice for causation external to the system has been population pressure. First put forward in a limited form by Binford (1968), then generalised (following Boserup [1965]) by Cohen (1977), population pressure has become accepted in most overviews of social evolution as its primary motor. For example: 'Over the long course of human cultural development, the archaeological and historical record shows a consistent ... increase in population worldwide. ... As a result of this population increase their subsistence economy must be intensified' (Johnson and Earle, 1987, p. 16). 'Population pressure introduces an element of instability into all human cultures. This instability often interacts with natural sources of instability (called 'perturbations') ... to bring about large scale shifts in modes of production' (Harris, 1991, p. 91).

Now, the difficulties with this approach are well known (Cowgill, 1975). It is a general Darwinian principle, for human households as for any other group of organisms, that reproduction can outstrip production. A universally present cause cannot explain any particular consequence, however. Even if one were to establish that a particularly grave imbalance



exists between a population and its resource base (almost always, 'population pressure arguments assume what they should demonstrate' [Chapman, 1990, p. 147]), there is no reason to suppose that adjustment would be with respect to production (and not reproduction). As Flannery (1986, p. 15) points out, 'in zoology, population increase is generally taken as the sign of a successful adaptation or as evidence that a favourable evolutionary advance has already been made, rather than as a cause for further evolution.' Those who espouse the notion that population pressure is the motor of evolutionary change seek perhaps to escape the optimistic connotations of technological 'progress'. Scholars living at the beginning of a millennium in which interrelated social and technological changes have brought the human species to the verge of extinction have, however, little reason to reject their causal force.

### 3.

The other main alternative to old-fashioned technological determinism has come from the neo-Marxists (Johnson and Earle's [1987, p. 9] 'effete materialists'). Just as capitalism is the cause of industrialism (and not vice versa), just so in the evolution of non-class societies the social arrangements governing production would control technological development. As Godelier (1973, p. 122) puts it:

*'Si l'anthropologie moderne a confirmé la thèse que le rapport entre développement des forces productives et développement des inégalités sociales n'était pas mécanique, elle a dans l'ensemble démontré que la compétition sociale dans les sociétés primitives comme dans les sociétés de classe fournit l'incitation majeure à la production de surplus et, dans le long terme, entraîne indirectement un progrès des forces productives'. (Just as modern anthropology has confirmed the thesis that there is no mechanical relation between the development of the forces of production and the development of social inequalities, it has generally shown that in primitive as in class societies social competition constitutes the most important spur to the generation of surplus and, in the long run, indirectly brings about progress in the forces of production'. [Translation: author])*

Arguments along these lines have been deployed by Bender to account for the development of simple farming from foraging: '... social hierarchization ... may have preceded the change in subsistence base' (Bender, 1978, p. 215), a change orientated to providing leaders with commodities they could control. Such views originate in a certain conception of historical materialism and are (as we shall see below) not incompatible with a Childean evolutionary perspective, but the tendency of those who espouse such positions has been to reject materialism altogether:

*'The explanation of social phenomena, be it the division of labour, age-sets or potential inequalities in both gatherer-hunter and early farming societies, have (sic) tended to be naturalised and made law-like by stressing the dominance of techno-environmental/alias subsistence forces. We legitimise the divisions and inequalities in our own societies by making them the inevitable outcome of inevitable forces' (Bender, 1989, p. 87).*

Bender's particular intellectual trajectory is typical of post-processual archaeology in general: a neo-Marxism that wishes to give greater weight to the social relations of production develops into a neo-Hegelian rejection of materialism in any form (cf. Hodder, 1986).

To be sure, one can give due weight to the importance of the social relations governing production without abandoning materialism altogether. To avoid a position which reduces social organization to homeostatic mechanisms regulating human ecology one does not have to support the idea that social organization is entirely independent of human ecology. Hayden (1990) provides a useful concrete example of how positions such as Bender's (that animal and plant domestication arose in the context of competition associated with incipient social ranking) can be articulated to the antecedent development of foraging techniques. My intention in what follows is to sketch out in general terms the articulation of the forces and the social relations of production in the evolutionary dynamic of societies without social classes.

### 4.

Sahlins's (1972) model of the 'Domestic Mode of Production' provides the definitive account of these relations. The fundamental characteristics of the Domestic Mode of Production are:

1. The dominant division of labour is by age and sex: 'the normal activities of any adult man, taken in conjunction with the normal activities of an adult woman, practically exhaust the customary works of society' (ibid., p. 79).

2. Production and exchange 'are oriented for livelihood, not profits' (*ibid.*, p. 83), so that Chayanov's Rule ('intensity of labor in a system of domestic production for use varies inversely with the relative working capacity of the producing unit' [*ibid.*, p. 91]) applies.
3. The system of land tenure provides to all households equally the resources they need for their autonomous production: 'where these resources are undivided, the domestic group has unimpeded access; where the land is allotted, it has claim to an appropriate share' (*ibid.*, p. 93).
4. What the household produces is pooled among its members.

Necessarily correlated with these features is a simple technology: 'the basic apparatus can usually be handled by household groups; much of it can be wielded autonomously by individuals' (*ibid.*, p. 79). This simplicity makes 'labor ... more significant than tools, the intelligent efforts of the producer more decisive than his simple equipment' (*ibid.*, p. 81). The social relations of the Domestic Mode of Production and their technological correlates may be assumed to be present in all earlier prehistoric societies from the Palaeolithic to the Neolithic, that is to say until the time arrives when social inequalities are so strong that the production of some households is effectively at the command of others.

Now, as Sahlins makes clear (in spite of his somewhat perverse arguments in favour of an 'original affluent society'), it is characteristic of the Domestic Mode of Production that households sooner or later fail in their autonomous production (cf. Colson, 1979). Partly because of the inherently limited goals of domestic production for use (as reflected in Chayanov's Rule), partly because of the vagaries of environmental and other external circumstances, households are always actually or potentially in trouble. The intelligent efforts of the producers must, therefore, be devoted to counteracting potential failure, to reducing the variance in mean subsistence income. Reducing subsistence risk lies, after all, at the very heart of the logic of production for use. This is a point which the proponents of population pressure miss. For Cohen (1977, p. 39), 'the various techniques that constitute agriculture ... provide only one economic benefit: the ability to grow and harvest more food from a unit of space in a unit of time.' The main goal of autonomous domestic units, be they foragers or food producers, is not to maximise but to satisfy, however. (That, after all, is the thrust of Sahlins's notion of primitive affluence.) Rather, it is the potential contribution of food production to expanded storage strategies that should be stressed. A granary or a herd of animals reduces the short- and middle-term production risks associated with most foraging strategies.

Households reduce subsistence risk by a variety of social expedients. Thus, households mitigate their risks by participating in webs of alliance. By sharing (pooling their risks) with others in good times, families can accumulate obligations that may help them in times of shortage (for example, Wiessner, 1982b). Alternatively, households can engage in 'negative risk transfers' (Wiessner, 1982a, p. 173); that is to say, they can organize themselves to expropriate what they need from others (for example, see Sahlins, 1961). Households also reduce subsistence risk by a variety of techno-environmental expedients. Over the course of the Stone Ages, humans were able to develop techniques that broadened the range of resources that they exploited, that preserved resources over longer terms by developing means of storage, that improved control over the exploitation of particular resources (ranging from controlled burning to eventual domestication) and that stabilised resource yields (for example, by developing hydraulic farming). In the ethnographic present, all human societies incorporated some of these risk-reducing practices in their behavioural repertoire.

It is important to note, however, that social and techno-environmental approaches to risk reduction have different potentials for further development. *Ceteris paribus*, households are limited in their capability to expand the scope of their positive risk pooling: their ability to attract sharing partners will be constrained by the amount of surplus they themselves can produce. Likewise, a household's efforts to increase negative risk transfers will be checked by the increasing numbers of enemies its depredations will generate. Techno-environmental approaches to risk reduction are not so immediately limited. In their intelligent, ongoing, autonomous *bricolage*, households can little by little expand their commitment to r-selected species such as wild grasses, develop storage facilities to accommodate the increased harvests, cultivate the grasses so as to control their availability, water their crops so as to stabilise their supply and so on. Given the social relations of the Domestic Mode of Production (the autonomy of the household), risk-reducing technological development is, then, an independent variable that unfolds following its own logic (subject, of course, to environmental opportunities and limitations). To recapitulate, households are in control of their production; they can be assumed (on Darwinian grounds) to have an interest in more secure production strategies; their opportunities for increasing their security by social means are inherently limited; therefore, they will, if they can, take practical steps to increase their security, what steps they can take being constrained by the antecedent nature of their technology and by their natural setting.

## 5.

Within the general framework of the Domestic Mode of Production (that encompasses, in terms of traditional social evolutionary typologies, social formations covering the broad range of bands and tribes), the development of the forces of production carries with it social changes, which in turn stimulate further technological change. Thus, the development of more effective foraging techniques leads over the course of the Upper Palaeolithic to the closing of networks of mutual assistance (to increased territoriality and inter-group competition) (Gilman, 1984). Increased social competition promotes the development of social storage (Ingold, 1986, p. 207) and of production technologies (domestication) that can be oriented to the development of such storage (Hayden, 1990). Farming involves delayed-return production strategies (Woodburn, 1980) and the transformation of land from the 'subject' to the 'instrument' of labour (Meillassoux, 1972; Vicent, 1998). This transformation stimulates long-term investments in the land, diminishing the possibilities of social fission to the point that, eventually, exacerbated social competition results in the permanent subordination of some households to others (Gilman, 1981). With the emergence of class stratification comes what Mann (1986) aptly terms the 'end of general social evolution'.

Throughout the evolutionary cycle which begins in the Palaeolithic and ends with the Bronze Age, household producers were essentially independent. They had access to resources and possessed the skills necessary for production. Their production strategies were sufficiently unintensive to free them to arrange social alliances as they might prefer (that is, to break off unwanted ties). Under these circumstances social and technological decisions concerning household security would be for the household to make. Decisions to improve security through technological means would complicate the achievement of security by social means, however. The development of storage facilities (practical storage, in Ingold's terms), for example, would attract requests for assistance at the same time that it would diminish the need for assistance from others; to enjoy the benefits of practical storage, households would have to exercise exclusive claims over it (transform their practical storage into social storage), undermining sharing (Testart, 1982) and thus increasing competition between households. 'In short, technological improvements in the security of production would lead to potential decreases in social security' (Gilman, 1984, p. 124), decreases to which further technological intensifications would be the most directly available response. Within this cycle, technology appears to unfold logically as an independent variable causing social change, but this appearance is the result of a social organization of production in which the ability of 'thoughtful' foragers (Mithen, 1990, cf. Flannery, 1986, p. 4), farmers, producers of whatever kind to develop or adopt new technologies is not constrained by powerful superiors. In other words, both the forces and the social relations of production constitute the dynamic force behind human cultural evolution. The dynamic of change suggested here is what Stark would term a 'pull model', in which the 'minimal role for population growth is that of a 'gatekeeper' preventing reversal to less productive strategies' (1986, p. 303).

The broad range of times and settings in which transitions from foraging to farming have now been demonstrated to have taken place obviously makes it difficult to accept any single proximate cause, such as population pressure or climate change, as sufficient. As a result, in recent years scholars of the transition to food production have been reluctant to suggest an underlying common process that might account for this nearly universal re-orientation of human production strategies. Thus, according to Bruce Smith: 'agricultural origins' is a convenient umbrella term for what is, in fact, an extensive and complex mosaic of many different and distinct developmental puzzles [2001, p. 202].' Or according to Graeme Barker: 'the extraordinary diversity of the evidence ... sits uncomfortably with any attempt to build a grand cross-cultural theory of universal applicability for why foragers became farmers (2006, p. 411).' I believe it may be helpful to take a step backward so as to bring into focus a broader explanatory dynamic along the lines sketched out above.

## 6.

Be that as it may, I now want to consider how the dialectical development of forces and social relations of production plays out in terms of property relations. The starting point for a social evolutionist analysis of property is Locke's (1960 [1690], pp. 19-20) definition of the term: 'Whatsoever ... [man] removes out of the state that nature hath provided and left it in, he hath mixed his labour with it, and joined to it something that is his own, and thereby makes it his property. It being by him removed from the common state nature placed it in, it hath by this labour something annexed to it that excludes the common right of other men'.

This definition has the virtue that it permits us systematically to link a juridical concept to forms of production. As Robert Netting (1990, p. 47) notes, 'when land is brought into regular use by invested labor (as in heavy, specialized fertilization, terracing, levelling, or irrigation) or when it can produce consistent crops of grain, fruit, nuts, or hay because of special conditions of soil or moisture, there will be a system of enduring claims [to that land] by households or individuals'.

Thus, the material evidence developed by archaeologists for such intensified agricultural production can by extension be used to argue for the existence of demand-rights and/or duties with respect to some tracts of land between members of the society that generated that evidence. To put it another way, two generalisations with systematic implications for property relations can be drawn with reasonable confidence from our historical and ethnographic experience: first, that individuals or groups who have access to or have created a resource that yields a stable income will seek to retain that resource for their own use; second, that individuals or groups committed to the exploitation of such a resource can in turn be exploited (for instance, serve as a source of income for other individuals or groups). The principle of 'sweat equity' permits one to link systems of property (a juridical concept whose reading in the archaeological record is obviously problematic) to systems of production (material facts whose archaeological interpretation is less problematical).

## 7.

Based on this line of thinking one can, I think, develop a four-stage model for the development of property relations over the course of prehistory:

**Stage 1.** Towards the end of the Middle Pleistocene populations of large-brained hominins had successfully occupied a broad range of tropical to temperate environments in the Old World. These populations were committed to mutual provisioning and, given their as yet rudimentary forces of production, they would have had extremely low population densities. The limited foraging proficiency of each of the widely dispersed groups would require them to help one another, a requirement presumably reinforced by an exogamic kinship system rooted in the prohibition of incest. Under such circumstances the self-interest of all these groups would not permit any exclusive property claims whatsoever.

**Stage 2.** Over the course of the Later Pleistocene the gradual development of foraging technologies would permit the capture of a broader range of resources on a more stable basis over the long term. As a result, population densities would rise to the point that a group large enough to reproduce itself could do so within a delimited territory. At this point it would be in a group's self-interest to claim exclusive possession of that territory. The households composing the group would continue to have equal access to resources and to pool their risks by sharing, but collectively they would seek to limit the access of outsiders to their collectively held territory. This initial emergence of ethnicity would, of course, require rituals and paraphernalia to represent and reinforce each group's exclusive identity.

**Stage 3.** The further development of foraging would eventually lead to the exploitation of resources susceptible to storage and encourage the adoption of delayed-return productive practices (such as animal and plant domestication) that would promote such accumulation. At this point, the Lockean notion of property becomes directly relevant. In Ingold's terms, households would seek to convert their practical storage into social storage, that is, to establish exclusive ownership of the fruits of their labour. A storage-oriented production system makes negative risk transfers increasingly feasible. This and the potential for differential accumulation of surplus would stimulate the development of within- and between-group competition and promote the development of social ranking.

**Stage 4.** Households engaged in the internal and external competition inherent in a storage-based economy would have reason to increase and/or stabilise their production. Innovations that produce such increases would often involve investments of labour to create durable facilities (terracing, irrigation, tree crops and so on) that permit greater production on a more stable basis. This primitive accumulation of 'landesque capital' is built up over generations and increases yields over periods much longer than the annual production cycle. Social units that have sunk their labour into such long-term investments will seek to establish trans-generational, inherited ownership of them. Such investments also diminish the possibilities of social fission to the point that, eventually, exacerbated social competition results in the permanent subordination of some households to others. With the emergence of class stratification comes what Michael Mann (1986) aptly terms the end of general social evolution.

Such a model finds broad support in both the ethnological and archaeological records, I believe, but demonstrating that support falls beyond the limits of this article.

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## The Neolithisation Process in the Americas

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### Abstract

All over the world, the Neolithisation process - the shift toward food-producing life-ways - was kicked off at the end of the Late Glacial Maximum and was amplified at different paces in different places during the Holocene. The almost simultaneity of these transformations begs an explanation. The Early Holocene global warming triggered profound environmental changes that offered new resources and subsistence opportunities to the post-Pleistocene hunters-gatherers. Plant and animal domestication took place in different parts of the world resulting from the exploitation and manipulation of selected range of species. Different hypotheses have been formulated to understand the driving forces and mechanisms sustaining these processes. In the Americas, the shift to food-production occurred in three large areas of the continent: in eastern North America in the north, in Mesoamerica in the middle, and in the Andes and part of Amazon basin in South America. The cohorts of domesticates, including maize, squash, manioc, yam, beans, turkey, llama and alpaca, spread through contact and exchange. Population pressure or tipping carrying capacity do not account for the Neolithisation processes in the Americas.

### Introduction

As is the case for the onset of symbolic behaviour and self-awareness, the production of visual art, pottery making, metallurgy and urbanism, the emergence of food-producing economies is a critical milestone that paved the way for the construction of modern humanity. The driving forces behind each of these milestones are fiercely debated by researchers. The issue is both scientific and philosophical in nature and cannot be addressed exclusively from the empirical side of the equation. Empirical data are, however, essential. Facts matter and are crucial even if the same body of empirical data can lend itself to a wide range of interpretations. In general, the rationales adopted to frame a coherent view on any of the important issues mentioned earlier are strongly constrained by the worldviews and academic traditions that shaped the minds of the scientists involved in the debate (Kuhn, 1962).

The debate on the best explanation for the emergence of food-producing economies at the end of the Pleistocene - the Neolithic Revolution or the Neolithisation process as it applies to the American situations – is discussed in this paper, and is an important issue. Two direct and blunt questions can be framed at this juncture; and these simple questions are: **Why the shift from foraging to food - production in the first place? And, where did that happen?**

### I - Neolithisation processes: review of hypotheses

The Neolithisation process resulted in the shift from hunting and gathering to an increasing reliance on food-production. As such, human selective pressures operated on plants and animals, leading to the formation of subsistence-cultural systems based on agriculture, livestock husbandry and/or a varying combination of both.

The attempts at a general theory of the Neolithisation processes can be arranged into three successive and partially overlapping generations. Gordon Childe (1929, 1951) was the first archaeologist to craft a comprehensive theory of the shift from hunting-gathering to food-production, dubbed 'the Neolithic Revolution', in analogy to the 'Industrial Revolution'. Much has been written about the 'Childean' use of the concept of revolution in this regards, but Gordon Childe was clearly referring to the consequences of this change in subsistence systems; a change that laid the foundations for 'modern' settled village life and the 'Urban Revolution'.

The 'Oasis' or 'propinquity theory' posited climate change as the prime-mover for the dramatic shift from hunting-gathering to food production at the end of the Pleistocene. According to the drafted scenario, the general warming of the earth's

climate resulted in the extension of arid lands and deserts at the end of the Pleistocene/Early Holocene. Plants, animals and humans were confined to a few restricted and favourable oasis-like areas, and in this case along the major rivers of the Fertile Crescent, the Tigris, Euphrates and in a certain sense, the Nile. Humans took advantage of the situation to start the cultivation of some of their favourite plant foods - wheat, barley, emmer, lentils. They also allowed wild herds of animals to feed on their fields after the harvests and from there, initiated livestock husbandry. These initial stages in the practice of agriculture and livestock husbandry led to sedentary villages and the invention of pottery (Demoule, 2009; Price and Bar-Yosef, 2011). Childean theory was unrivalled for several decades up to the late 1950s and early 1960s.

The first systematic objections to Childe's, 'Neolithic Revolution' narrative were raised by Robert Braidwood (Braidwood and Howe, 1960). He questioned Childe's suggestion of the general onset of aridity all over the Near Eastern Fertile Crescent and launched the first coherent multi-disciplinary field research project at Jarmo, in the Zagros Mountains in Iraq. The research team included soil scientists, fauna and plant analysts, as well as experts in different domains of material culture archaeology. The starting point of Braidwood's reasoning was anchored on the environmental diversity of the Fertile Crescent, which includes coastal plains along the Mediterranean, hills, plateaus, mountain ranges, hilly flanks and valleys. This diversity had significant implications for the natural distribution of wild plants and animals, and their pattern of change through time. The record from the Early Neolithic site of Jarmo did not show any evidence of a sustained shift toward increasing aridity at the end of Pleistocene. Small mammals like goats were hunted and later domesticated in that area. A comparative analysis of the material from other sites points to significant regional variation in the shift toward food-production. For Braidwood, this was the indication that each area had its own specific evolutionary trajectory, derived from its peculiarities. He drew on the plant geneticist Nicolai Vavilov's concept of a 'nuclear zone' and dubbed his hypothesis the 'Nuclear Zone Theory'. In contrast to Childe, Braidwood did not address the 'why' question. Instead, he explained the shift to food-producing economies as a timely change in the long-term socio-cultural evolution. In his 'vitalist' approach, that change took place because human societies were ready for this to happen.

These two approaches to the Neolithisation process feature environmental change and its impact on human subsistence and social systems on the one hand (Childe) and human agency on the other (Braidwood). These major dimensions, with different dosages, are included in each of the theories that came to be crafted later, in the second and third generation.

The second generation of explanatory theories is characterized by more elaborate scenarios combining environmental change and population dynamics. There are interesting nuances between authors. Cohen's 'food crisis' hypothesis (1977) and Binford's (1968) 'marginal zone theory' provide a good sample. For Cohen (1977), relying on the number and elaboration of Levantine Epi-palaeolithic sites - or Mesolithic ones elsewhere -, there was a sustained population growth during that period. This dynamic demography threatened the subsistence sustainability of Late Pleistocene hunting-gathering societies. Consequently, they adjusted to the new situation through selective and intensive gathering of a narrow range of plants and animals, triggering their domestication.

Binford's (1968) marginal zone theory is also anchored on population growth, but with a more systematic focus on the spatial - or territorial - dimensions. Accordingly, Late Pleistocene hunter-gatherers' intensification - as indicated by the Natufian case for example - took place in cores of the delineated 'nuclear zone', with the development of bulkier dwelling features, storage facilities, as well as systematic burials within and between habitation units. According to Binford's (1968) model, sustained population growth triggered out-migration from the core areas, along moving-frontiers. It is in this context that the new settlers tried to preserve their original food-ways and initiated what later became the domestication of a range of selected plant and animal species. In other words, the Neolithisation process that resulted in the emergence of agriculture and livestock husbandry took place in the margins of the core-areas instead of their centres.

The third generation theorists were critical about what they saw as an 'environmental deterministic' approach to the Neolithisation process. They pointed to the neglect of the sociocultural mechanisms that may have been part of the process. They consequently suggested alternative approaches with more systematic integration of sociocultural processes with long-term consequences.

Barbara Bender (1975) formulated the 'exchange theory', which was anchored environmentally with a focus on social dynamics and patterns of foraging groups' mobility. There were a series of intriguing archaeological finds, such as sea shells from the Mediterranean found several hundred kilometres in the hinterland, that remained unexplained and were left floating. Bender suggested that they may have been part of exchange systems linking connected late Pleistocene circum-Mediterranean foraging groups. According to Bender's (1975) theory, the intensification and 'routinization' of these social links led to the selection of a narrow range of resources to fuel the round of exchanges. Coastal groups may have selected a certain range of goods including peculiar and colourful sea-shells, while the hinterland groups may have brought cereals and baby mammals. Seasonal gatherings of these foraging groups in their overlapping territorial ranges were a crucial

mechanism of their biological and social reproduction. The Neolithisation process was therefore the consequence of the linkage loops outlined above.

Brian Hayden (1995) aims to explain the puzzling early domestication of pepper, tomatoes and guinea-pigs in South America. These domesticates were clearly not a response to a food-crisis. For Hayden, large social gatherings were part of the social organization of some Late Pleistocene/Early Holocene foragers. Whatever the purposes of these gatherings, the assembled people had to be given food and beverages. In competitive feasting contexts, special food items were distinctive enough to set one group apart relative to the other. The feasting theory (Hayden, 1995) accounts for the selection of special plants and animals that may have been important elements of feasting in which elaborate items of material culture were used and displayed. The domestication of some plants and animal species was consequently an unintended consequence of the generalisation of large social gatherings and feasts.

### 1 - The Neolithic Revolution as a revolution of symbols

Jacques Cauvin's (2000) radical approach to the Neolithisation process deserves special treatment. In his book *The Birth of the Gods and the Origins of Agriculture*, Cauvin (2000) puts a significant distance from all materialistic explanations for the emergence of sedentary village life, the practice of agriculture and livestock husbandry that took place in Southwest Asia from 10,000 to 7,000 BC. Relying on the 'mentalités' rationale, he argues that the onset of Neolithic life-ways was derived, not from population growth, climatic change and forced adaptation of human communities at the end of the Pleistocene, but from a 'revolution of symbols', the invention of deities, that generated new religions and worldviews. Cauvin (2000) relied on a series of zoomorphic and anthropomorphic figurines and statues from different southwest Asian Late Pleistocene and Early Holocene sites interpreted as staging the new religious beliefs. The Mother Goddess, sitting on a leopard throne in a Çatalhöyük Early Neolithic sanctuary, is claimed to document a radical shift in human symbolic behaviour. The presence of a number of female figurines, interpreted as emphasising fertility, is relied upon as additional supporting evidence. According to Cauvin's rendering of the developmental sequence, a new religion articulated on a Mother Goddess and Bulls took shape in the western flank of the Fertile Crescent during the Pre-Pottery Neolithic A (PPNA) and led to the adoption of Neolithic life-ways.

In the introductory part of his book, *Naissance des divinités, naissance de l'agriculture*, Cauvin (1997: 40) asserts that art is the 'main path to access the collective psyche of ancient societies without writing' [*notre principale voie d'accès au psychisme collectif des sociétés anciennes sans écriture*]. This position is predicated on the fact that the representational part of art expression of these remote societies can be preserved in the archaeological record, accessible through archaeological research and analysable through conjecture and refutation. For Cauvin, who rejects all naturalist attempts at explanation of long-term culture change, '*l'imaginaire*', the capacity to construct binding symbols, is the driving force of social evolution. In his perspective, the shift to food-production was the consequence of transformational relationships between humanity and divine entities: the Revolution of symbols came first and the Neolithic Revolution followed.

For Cauvin (1997), the first evidence of the new revolution of symbols can be traced back to the post-Natufian El-Khiam period, around 10,000 - 9,500 BC, prior to the onset of the PPNA. The Natufian art repertoire included representations of gazelle, deer, birds and dogs as shown by finds from Wadi Hammeh and Nahal Oren. The art repertoire from El-Khiam period consists essentially of female figurines, pointing to a radical shift from zoomorphic to anthropomorphic representations. The selection of the woman's body as an icon is claimed to emphasise fertility, and was a conception that led to the later emergence of a Mother Goddess figure. Such figurines were already known and widespread during the Upper Palaeolithic period but for Cauvin they were part of an above all zoomorphic and relatively anarchic system of representation because "most of these animal representations are clustered, without any evidence (...) of a dominant animal that can be considered as a supreme being figure" [*on ne met nulle part en évidence (...) un personnage animal dominant les autres et pouvant faire figure d'être supreme*] (Cauvin, 1997, p.101).

The new religious symbols, especially the carved or painted representations of the Goddess, spread widely in southwest Asia from the end of the El-Khiam period to 7,000 BC. The Early Neolithic site of Çatalhöyük in Anatolia is considered to have provided the most extensive evidence of this new worldview. The representation of the Mother Goddess figure is associated with that of a bull. These images are found in different places, frescoes and sanctuaries, and also as smaller lightly fired portable clay figurines. Accordingly and beside its frequent representation, it is the specific place in which this figure of the Mother Goddess is set at Çatalhöyük that points to its divine character. According to Cauvin, she is 'dominant on the northern and western wall of the domestic sanctuaries', represented in the process of giving birth to bulls. The numerous female figurines from Tell Mureybet, Hacilar and Çatalhöyük point to an overemphasis on fecundity through the exaggeration of the proportions of waists and breasts. The control and domination over leopards is added to motherhood

and fecundity symbols. For Cauvin, this symbolic system persisted during the whole Neolithic period and the Bronze Age up to the emergence of Jewish monotheism.

Despite local variations, the duo 'Goddess Mother/Bull' which emphasised complementarity, but subordination of the latter to the former, points to the secularisation of a new 'worldview', conveying new relationships between humans and nature (Cauvin, 2000). How is the genesis of this new worldview connected to the shift from hunting-gathering to food-production and village life remained unfortunately unaddressed.

Ian Hodder (2006: 195) presents a different view on the art from Çatalhöyük: 'It can be argued that the 9,000 year-old art at Catalhöyük is closer to science than it is to some contemporary art, in the sense that it aims to intervene in the world, to understand how it works, to change it'. This position points to a more dialectic relationship between mind and matter, society and nature. Alain Testart (1998, 2010, 2012) pointed to serious weaknesses of the reasoning crafted in Cauvin's '*Révolution des Symboles, Naissance des Divinités*' and carried out a convincing refutation of the religious assumptions embedded in that model. The Revolution of Symbols thesis ignores all environmental circumstances that are strong constraining forces on human social systems. Cauvin's failure to link human behaviour to processes operating independently in the biosphere is a serious weakness. Paradoxically, and very surprisingly, Testart's vigorous refutation of Cauvin's theses is significantly weakened by his own unwillingness to take seriously into account the biological component of the domestication process (Testart, 2012).

Humans are part of the biosphere that supports and enhance their lives and social reproduction. Plant cultivation and livestock husbandry are clearly predicated on the existence of biological entities that allowed this co-evolutionary conundrum to take place in human history. The emergence of food-producing economies and settled life ways are the result of contingent interaction between independent variables with mutually re-enforcing consequences. Depending on circumstances - it is obvious that many equally interesting attempts have failed - some of these interaction loops became co-evolutionary nodes, shifting the system into a 'directed variation' mode.

## II - Toward a new synthesis: coevolutionary landscape dynamics

The Neolithic Revolution debate is clearly much more subtle and fine-grained today. The two 'explanatory lineages' outlined above are still alive and well (Cauvin, 1997; Rindos, 1984; Zeder, 2009). They are both derived from a gradualist approach to cultural evolution. Punctuated equilibrium models are very likely much more relevant for the understanding of accelerated change that would seem to have popped up all of the sudden (Endersby, 2009; Elredge and Gould, 1972; Gould, 1991). Naturalist-oriented researchers tend to consider the shift to food production that started at the end of the Pleistocene as a series of adaptive adjustments to a wide array of dynamic change. There are nuances between parallel approaches, essentially Human Behavioural Ecology (HBE) through its Optimal Foraging Strategies (OFS) and Diet-Breadth Model (DBM) (Piperno and Pearsall, 1998) and macro-evolutionary perspectives (Smith, 1994, 2011; Zeder, 2009). Seen from such perspectives, the adoption of agriculture and sedentary life-ways as well as livestock husbandry and pastoral nomadism are the results of co-evolving dynamic systems. The driving forces that triggered these contextual adaptive shifts can accordingly be pinned down, analysed and 'falsified' (Popper, 1963). The key variables under scrutiny include landscape, wild life, climate and humans, or more precisely the complex interaction loops between these variables. Some researchers favour climate change as prime-mover. Others single out demography or patterns of social interaction like exchanges, or feasting. For all these researchers, it is important to construct bridging arguments for the explanation to be coherent and testable.

There are different nested levels involved in the 'construction of food ways', all resulting from conscious or unconscious selection processes. The landscape, constantly impacted by humans offers a more or less wide assortment of resources, restricted in this case to plants and animals. Not all edible items are eaten, and the construction of standard cultural food – staple food - is in constant adjustment depending on circumstances. This core category of people's diets includes most of the desirable food items that are generally in large and reliable supply. Without going into the detail of past 'culinary' traditions in different parts of the world, the staple diets were made of key source of carbohydrate plants (wheat, barley, maize, millet, sorghum, rice, yams, bananas, manioc and so forth), plant and animal proteins (beans, lentils, cowpeas, soya, meat, fish, molluscs), and plant and animal fat (palm oil, olive oil, peanut oil, animal fat and so on). Staple food was generally supplemented by occasional food. This category consists of edible items that can be relied upon as substitute or in addition to the basic cultural foods. The third and last category is that of emergency food, made of all edible items that can be relied on in circumstances of food crises.

Knowledge of all these food categories is learned and transmitted from one generation to the next. Consequently, there is a certain inertia in the composition of staple diets that is nonetheless exposed to abrupt changes - punctuated equilibrium.



Cognition is thus crucial in modelling the shift from hunting-gathering to food-production (D'Andrade, 1995; Fauconnier, 1997; Renfrew, 2008). Human conceptual networks are intricately structured by analogical and metaphorical mappings. Mappings between different domains are the heart of the unique human cognitive faculty of producing, transferring and processing meaning. These mappings play a key role in the synchronic construction of meaning and its diachronic evolution (Fauconnier, 1997, p.18). The idea of mapping as a process of transfer from one domain to another is critical for a systematic investigation of past and present food ways as cultural phenomena and knowledge. In the most general mathematical sense, this process is a correspondence between two sets that assign to each element in the first set a counterpart in the second (Fauconnier, 1997). As is the case for art expression, food ways are probably another manifestation of the human ability to create and use symbols. It 'functions at a crucial intersection of mind and body, society and nature' (Hassan, 1993, p. 271). Food ways have to be regarded as cultural constructs embodying thought, communicating information and eliciting action. They involve human minds, motor skills and techniques. The cognitive operations that play a central role in the construction of everyday meaning are the same operations that apply to reasoning, thinking and understanding generally (Fauconnier, 1994, 1997). Food ways thus denote cognition; and cognition is the key parameter holding it all together.

'Human knowledge is much too precious a thing to be carelessly discarded each generation with the hope that it will be rediscovered in the next. Human knowledge is carefully preserved and passed from one generation to another. Most of what any human ever thinks has been thought before, and most of what any human ever thinks has been learned from other humans. Or to put it another way, most of what anyone knows is cultural knowledge ... Knowledge which is embedded in words, in stories, and in artefacts, and which is learned from and shared with other humans' (D'Andrade, 1995, p. xiv).

The sudden bursts of completely novel patterns of behaviour were in all the cases followed by a period of stasis. It is axiomatic that cultural evolution is Lamarckian and epigenetic. Once established, the new behavioural patterns are learned and transmitted through habituation processes. This is generally done through 'parental care', learning, transmission from generation to generation, as well as enforcement of the psycho-behavioural schemes. 'The potential for directed change in cultural systems is greatly, perhaps even exponentially, enhanced over that found in biological systems by the human ability to evaluate outcomes of behaviour and to abandon, adjust, or perpetuate behaviours based on this evaluation' (Zeder, 2009, p. 10).

The Neolithic Revolution took place at different times and places, and within different environmental circumstances all over the world. In the co-evolutionary approach adopted in this paper, human agency is a crucial element of cultural adaptation. 'It allows cultures to respond to pressures more quickly and with greater degree of flexibility and directness' (Zeder, 2009, p. 1). In order to explain culture change, one has to unwrap the processes shaping different levels of the culture under investigation. Human societies are part of an inclusive trophic chain. They are inserted into a population ecology made of constantly interacting multi-components systems. The dynamics of food complexes is driven by selection pressures that are populational and cultural. The operations of all these complex adaptive systems preside over the construction of cultural landscapes, in a dialectic between the 'naturalization of the societies and the socialization of nature' (Chorin and Holl, 2013).

## 1 - Mapping the earliest 'Neolithic' complexes

The shift toward food production took place during the Holocene period, at different times and places (Demoule, 2009). The earliest manifestations are dated to 10,000 BP in the Fertile Crescent in western Asia where domesticated wheat and barley have been recorded. Sheep, goats, cattle and pigs were also domesticated in the same area in the first half of the Holocene (Figure 1). With variation from one area to the next, the western Asia complex consisted of mixed economies, combining mainly cereal agriculture and livestock husbandry (Bellwood, 2005; Cauvin, 1967, 1971; Demoule, 2009). This complex spread later around the Mediterranean and continental Europe (Jones et al., 2013).

Foxtail millet, rice and pigs were domesticated in eastern Asia around 8,000 BP (Li and Xingcan, 2012). Broomcorn millet, foxtail millet and pig remains were found in the Yellow River basin in northern China. Rice, foxnut and pig remains are documented in the Yangtse River basin in central/southern China (fig. 1). Both complexes spread all over eastern Asia to reach Korea, Japan, southwest China and the Himalayas (D'Alpoim Guedes et al., 2013).

The Kuk Swamp in New Guinea provides evidence for the domestication of bananas, plantain and yam (*Dioscorea alata*) around 7,000 BP (Bellwood, 2005) (Figure 1). This complex spread later throughout the Indian Ocean to reach Africa.

The practice of agriculture emerged comparatively late in Africa (Harlan et al., 1979). The remains of cultivated pearl millet (*Pennisetum glaucum*), sorghum (*Sorghum bicolor*) and African rice (*Oryza glaberrima*) are dated to 4,000 - 3,000 BP in the



Figure 1. Main Neolithisation zones worldwide.

Sudano-Saharan belt of the African northern hemisphere (Figure 1). Cultivated non-domesticated sorghum dated to 10,000 - 9,000 BP was found in large quantities in several storage pits from the early Holocene village site of Nabta Playa (Wendorf and Schild, 1998). In contrast, livestock husbandry through the domestication of cattle took place around 10,000 - 9,000 BP in the eastern Sahara and spread from there to the mountain ranges of the central Sahara (Barich, 1998; Cremaschi and Di Lernia, 1999; Di Lernia and Cremaschi, 1996; Holl, 1989, 1994, 1998, 2004).

### III - The Neolithisation processes in the Americas

As is the case for the rest of the world, the shift toward food producing life ways occurred during the Holocene. The end of the Late Glacial Maximum, around 11,600 BP worldwide, set the stage for far-reaching environmental changes that impacted late Pleistocene hunter-gatherers communities (Smith, 2011; Piperno, 2011; Price and Bar-Yosef, 2011). The significant increase in atmospheric CO<sub>2</sub> that was 30% higher than at the height of the Last Glacial Maximum (LGM) ca. 21,000 BP (Ridgwell et al., 2003), higher temperatures and increased rainfall made the shift toward plant cultivation possible. In fact, the key issue is more about the cultivation of plants than the 'origins of agriculture' *stricto sensu*.

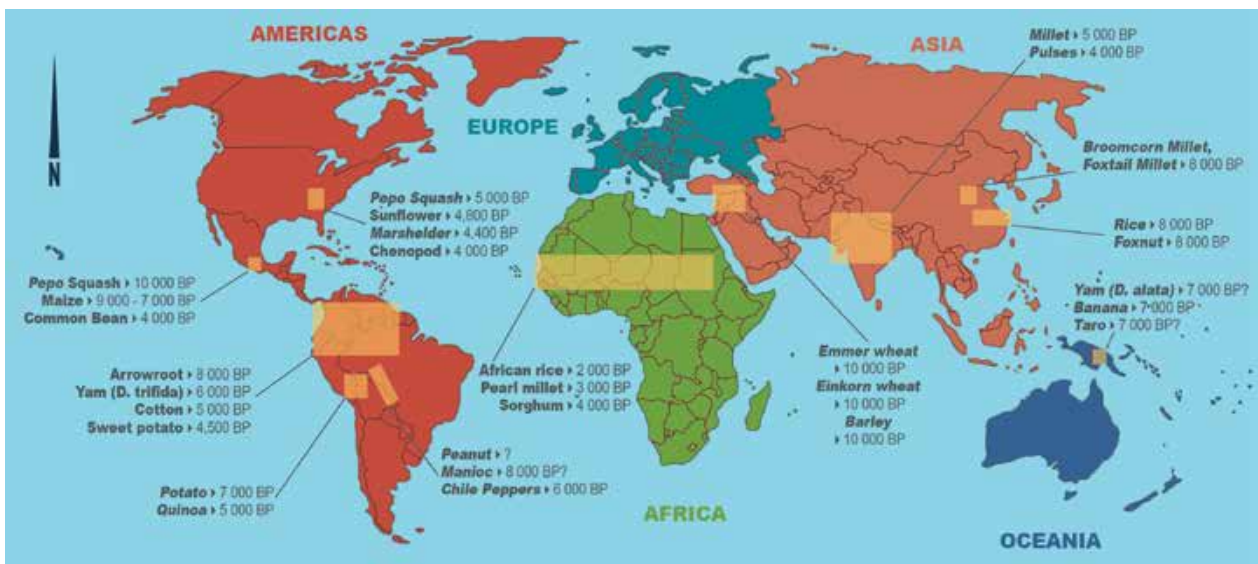


Figure 2. Distribution of initial areas of plant domestication.

The Neolithisation processes began more or less independently in three large geographic areas in the Americas, the south-central Andes in the south, Central America in the middle and eastern North America in the north. Central America and the south-central Andes have many features in common and are part of the Neotropics (Piperno and Pearsall, 1998; Piperno, 2011). In all these large geographic zones, 'external environmental stress, population growth, landscape packing, constricted resources zones, carrying capacity imbalance or resource scarcity' (Smith, 2011, p. 482) do not account for the shift towards food production. As far as the Americas are concerned, this shift occurred within the context of small scattered late Pleistocene mobile hunter-gatherer groups alternating the occupation of rich river valleys and more or less elevated caves and rock shelters. Different plant and animal cohorts were collected and exploited one way or the other, with some relied upon more heavily than others, triggering their shift to the status of domesticates (Larson, 2011).

## 1 - Place and time of earliest domesticates

The significant improvement and increased precision of research methods allow us to track the presence of domesticated plants species, their area of distribution and the chronology of their appearance in human cultural contexts (Larson, 2011; Price and Bar-Yosef, 2011; Smith, 1994, 2006; Zeder et al., 2006).

### The Neotropical zone

The earliest human settlements of the Neotropical forest recorded from Belize to eastern Brazil are dated to 13,000 BP. After 11,400 BP, these hunter-gatherers 'settled into' their landscapes, staying for longer and/or more frequently returning to specific locations, and they frequently manipulated and altered their environments by creating clearings in forest and/or burning them' (Piperno, 2011, pp. 456-7).

In the northern half of the Neotropics, a number of sites and regions like Guila Naquitz Cave (Flannery, 1986), Tehuacan Valley (McNeish, 1975), San Andres, Xihuatoxtla shelter, Rio Balsas, western and central Panama contain evidence of domesticated maize, squash, chile pepper, cotton, sieve bean and jicama. In Mexico, at Xihuatoxtla Shelter in Guerrero state and San Andres in Tabasco state, domesticated maize and cucurbita - squash - are dated to 8,960 - 8,940/8,780 - 8,630 cal. BP and 7,204 - 6,904 cal BP. (Piperno, 2011).

Beside the dog, the turkey is the only animal species domesticated in Mesoamerica and North America. Turkeys were sought after for their feathers and probably their roles in different rituals, and may have as such been targeted by ancient Mesoamerican communities (Thornton et al., 2012). The precise timing and location of American turkey (*Meleagris gallopavo*) domestication are still unknown (Thornton et al., 2012, p. 1). Turkey domestication may have taken place independently in two distinct areas, one in the American south-west and the other in central Mexico. 'In central Mexico, archaeological *M. gallopavo* bones have been identified at sites dating to 800 - 100 BC.... It is [however] unclear whether these early specimens represent wild or domestic individuals, but domestic turkeys were likely established in central Mexico by the first half of the Classic Period (c. AD 200-1,000)' (Thornton et al., 2012, pp. 1-2). The recent discovery of domesticated turkeys in the Late Preclassic context (cal 327 BC-AD 54) at El Mirador in the Yucatan province opens the way to a reconsideration of turkey domestication and dispersal in Mesoamerica and American south-west.

Five interesting sites are found in Panama, three in the central Pacific region and two in the western region. Aguadulce rockshelter, Cueva de los Ladrones and Cerro Mangote in the central Pacific region have evidence of squash, leren, bottle gourd and arrowroot dated to 8,600 cal BP; maize and manioc to 7,922 - 7,734 and 7,740 - 7,640 cal BP; and yam (*Disocorea trifida*), around 5,700 cal BP in the first site. Maize dated to cal 7,804 - 7,584 BP is recorded at the second and third site. Arrowroot, maize and manioc are recorded at Chiriqui rockshelters and Hornito in western Panama, dated to 7,779 - 7,584/ 7,534 - 7,381 cal BP for the first two plants and 5,600 cal BP for the third.

Colombian sites can be arranged into two subsets: the Andean sites on the one hand and the Amazonian ones on the other. The Andean sites stretched from the Middle Porce Valley in the north to the Upper Cauca Valley in the south and include the Porce Valley site, El Jasmin, El Recreo, hacienda Lusitania, Hacienda El Dorado and San Isidro. Maize is dated to 7,321-7,032 and 6,799-6,597 cal BP in the north, 8,000 - 6,000 cal BP at El Jasmin in the middle and finally, 6,138 - 5,721 cal BP and 7,771 - 7,349 cal BP in the Calima region of the Middle Cauca Valley. Yam, squash and bottle gourds are recorded at El Jasmin, dated to 8,493 - 8,313 cal BP, squash at El Recreo, dated to 9,001 - 8,508 cal BP, and finally bottle gourd at San Isidro, dated to 11,058 - 10,706 cal BP in the south. The Colombian Amazon sites, found in the Middle Caqueta region,





Figure 3. Distribution of domesticates from Central and South America.

include Pena Roja and Abeja. Squash, leren and bottle gourd dated to 9,107 - 8,884 cal BP are documented in the former, and maize and manioc dated to 5,539 - 5,351 cal BP attested in the latter.

Ecuadorian sites are found in the southern part of the country. They can also be subdivided into Andean and Amazonian sites. The Andean group is made of four sites, OGSE-80 and OGSE-67 (Las Vegas sites) and Real Alto and Loma Alta (Valdivia sites). The Amazon group includes a single site, Ayauchi. Maize is dated to 6,000 cal BP at Ayauchi in the Amazon, 8,015 - 7,945 and 6,850 - 6,810 cal BP in Las Vegas sites and finally, 5,260 - 5,000 and 5,000 cal BP in Valdivia sites. Squash, leren and bottle gourd are dated to 11,750 - 10,220 cal BP in Las Vegas sites. Leren, achira, arrowroot manioc and jack beans occurred much later in Valdivia sites where they are dated between 6,500 and 5,000 cal BP.

Further south in Peru, there are five sites distributed in two subsets, with two sites: Zana valley sites and Siches in the north, and three, Paloma, Chilca 1, and Quebrada Jaguay in the southern coastal region. Squash in its different varieties is dated to 11,015 - 10,885 / 10,402-10,253 cal BP at Siches and Zana Valley sites. Peanut (*Arachis* sp.) - 8,630 - 8,580 cal BP - manioc - 8,500 cal BP - and cotton - 6,301 - 6,133 cal BP - are confined to northern Peru. Sites from the southern coastal Peru present evidence of bottle gourd - 8,800 - 8,395 cal BP -, squash - 6,500 - 4,500 cal BP-, guava - 6,500-5,700 cal BP at Paloma and finally, achira, jicama (the edible tuberous root of a Mexican vine) and jack bean - 5,400 cal BP at Chilca 1.

Livestock husbandry through the rearing of alpaca (*Lama pacos*) and llama (*Lama glama*) also took place in the Peruvian Andes. As indicated by the faunal evidence of the long occupation sequence of Telarmachay rockshelter in the Puna region at an elevation of 4,000 - 4,900 m above sea level, the first groups of hunter-gatherers settled in the area around 9,000 cal BP. They relied on generalized hunting life-ways, and from 7,200 to 6,000 cal BP they focused on guanaco and vicuna as their main large prey. Domesticated camelids are attested in the archaeological record from 6,000-5,500 cal BP, with a fully-fledged herding economy established at Telarmachay around 5,500 cal BP. The larger guanaco is the wild progenitor of the llama, with the smaller vicuna, the wild progenitor of the alpaca (Barberena et al., 2009; Kadwell et al., 2001; Morales et al., 2009; Pollard and Drew, 1975).

There are two cases of documented cultivated plants in the eastern part of South America. One is found at Geral in eastern Amazon in Brazil and the other at Los Ajos in south-eastern Uruguay. Evidence of maize, dated to 3,800 cal BP, has been recorded at Geral as well as good indicators for the practice of slash and burn cultivation that existed around 6,662 - 6,464 cal BP. Maize, pulses and squash dated to 4,800 - 4,540 cal BP are attested at Los Ajos in Uruguay.

This short review of the chronology and geographic distribution of the earliest domesticated plants in the Americas Neotropics clearly shows that 'the earliest crop complexes were neither seed, tree, nor root crop based but rather mixtures of these different elements' (Piperno, 2011, p. 459). There is strong evidence for the diffusion of crop plants in different directions, probably using rivers as transfer corridors. Peanuts and manioc spread northwards. From the central Balsas River Valley of Mexico, maize spread both north- and southwards, to reach southeast Uruguay around 4,800 - 4,500 cal BP and eastern North America around 400 BC (Smith, 2011). Piperno (2011, p. 461) suggests that simple down-the-line forms of exchange, with cultivars cascading from one group to its nearest neighbour, without population relocation or significant transfers of material culture can well account for the diffusion of early crop plants in the Americas Neotropics. The first food producers of Central and South America were organized into small scattered mobile groups. It is only later, after the widespread adoption of plant cultivation and livestock husbandry of camelids in the Peruvian and Ecuadorian Andes that large permanent settlements developed in Central and southern America.

### Eastern North America

Four seed-bearing plants, the pepo squash (*Cucurbita pepo* ssp.), the sunflower (*Helianthus annuus*), marsh-elder (*Iva annua*) and the chenopod (*Chenopodium berlandieri*) were domesticated in eastern North America in the time interval, also called Late Archaic, ranging from 5,000 to 3,700 BP (Smith, 1994, 2006, 2011). Maize was added to this package later, around 200 BC. Evidence of these domesticates have been recorded at seven archaeological sites, all located in the relatively resource-rich oak-savannah and oak-hickory forest regions. They are scattered over five states, Arkansas and Tennessee in the south, Illinois in the north, with Missouri and Kentucky in between. Additional plant remains dated to the same Late Archaic period are recorded at Jernigan II, Peter Cave and Iddens. They belong either to bottle gourd, - a non-food item but an important container - or do not present significant morphological differences with wild varieties (Smith, 2011: 472).

The archaeological sites with undisputed evidence of Late Archaic domesticated plants are found in two main environmental settings: the rugged uplands and the river valleys.

Marble Bluff, Cloudsplitter and Newt Kash, at both the western and eastern ends of the geographic area under consideration, are rock shelters located next to streams. Marble Bluff above Mill Creek in Arkansas has a 1 m thick cultural deposit with a low density of material culture remains. The remains of domesticated pepo squash, chenopod, sunflower and marsh-elder were found in a well delineated charred storage context 'in a crevice against the back wall of the shelter and could not be easily associated with other cultural features or artefact assemblages' (Smith, 2011, p. 474).

The Cloudsplitter rockshelter, 55 m long and a maximum width of 15 m, is located some 100 m upslope from an intermittent stream in Kentucky. A Late Archaic occupation dated to 4,500 - 3,000 BP was recorded in a small area that may have been enclosed near the rear wall of the overhang. The samples of plant remains from Late Archaic occupation are dominated by nuts, with black walnut and hickory accounting for 90% of the recorded nuts. Domesticated plants are present but marginal. They include chenopod, pepo squash, bottle gourd, sunflower and marsh-elder.

Phillips Spring in the Pomme de Terre River Valley in Hickory County, Missouri, is located on an artesian spring. Six stratified occupation surfaces are documented. The unit K squash and gourd zone is the oldest part of the exposed sequence. It 'contained abundant plant remains (hickory, walnut, abundant acorns, grape, elderberry, ragweed). Bottle gourd rind fragment and 125 uncarbonized *C. pepo* seeds and seed fragments' (Smith, 2011, p. 474). A direct AMS dating of one of the seeds to 5,025 cal BP makes this relatively large sample the earliest indication for the domestication of pepo squash in the area.

Napoleon Hollow in western Illinois is a deeply stratified predominantly Middle-Woodland site with, however, a series of Middle and Late Archaic occupations. An excavated Late Archaic pit contained 'Cucurbita rind fragments, ... *Chenopodium berlandieri*, sunflower and ragweed seeds, along with 44 carbonized marshelder achenes' (Smith, 2011: 475). The recorded marsh-elder achenes, large in size and dated to 4,400 cal BP, are the earliest evidence for the domestication of this plant.

Riverton site, one of the Late Archaic localities of the 'Riverton Culture' is located on the shore of the Wabash River in south-eastern Illinois. It is a large deeply stratified midden, with, in Unit X, a series of Late Archaic rectangular clay



house floors dated to 3,800 – 3,700 cal BP. Soil samples from the clay house floors revealed the presence of two varieties of domesticated chenopod and pepo squash, as well as a small number of wild species like persimmon, elderberry and *Polygonum*. Carbonised fragments of acorns, walnut and hickory nuts were also recorded (Smith, 1994, 2011).

Hayes site is a large multicomponent midden, in the valley of a tributary of the Tennessee River in central Tennessee. Soils samples from a Late Archaic deposit 'contained six complete domestic-size sunflower seeds, one of which yielded an AMS radiocarbon date of 4840 cal BP' (Smith, 2011, p. 476).

All the sites reviewed above were inhabited on a seasonal basis, with the length of individual occupation episodes more important in the river valley settlements. Upland rock shelters, Cloudsplitter and Marble Bluff were short-term seasonal camps, visited frequently and part of a subsistence-settlement system anchored on larger semi-permanent river valley sites. The latter were multi-family core settlements with virtually no inter-family unit differentiation. The river valleys appear to have been the areas of initial domestication of plants in eastern North America (Smith, 1994, 2006, 2011). The marsh-elder, pepo squash and *Chenopodium* are floodplain weeds. They are pioneer species thriving on 'disturbed and exposed soils... created on an annual basis by spring floods ... Their abundant seeds are dispersed by floodwaters, and they colonize the sandy banks and backwater margins exposed each year .. in the shifting landscape of the river floodplains' (Smith, 2011, p. 477).

## Concluding remarks

In the Americas, the Neolithisation processes were driven above all by relatively small fluid and mobile groups of forager-planters. A range of selected species were grown and spread in different ecological micro-zones in the seasonal/annual territorial ranges of these different groups, starting from the end of the Pleistocene. These processes were accelerated during the Middle Holocene and around 5,000 cal BP, the cultivation of selected plant species, and the practice of agriculture relying on slash and burn techniques, were fully adopted in the Neotropics and eastern North America. Crops spread down-the-line, along river systems, in opposite directions. Maize spread south to today's Uruguay and reached today's north to eastern North America around 200 BC.

Neither in the Neotropics nor in eastern North America was the Late Pleistocene population of above-all mobile foragers dense enough to trigger population pressure and resource depletion. With the significant exemption of the American Northwest with its dense population of sedentary hunter-gatherers, it is the generalized adoption of food producing life ways that allowed for the aggregation of a large population in the rest of the continent.

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# Methodological Approach to the Study of Early Cultural Developments and Adaptations in Hunter-gatherer Communities: A Case Study from Keatley Creek on the Canadian Plateau

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## Abstract

The emergence of socioeconomically complex hunter-gatherer communities has been identified as one of the most critical theoretical issues in the study of early cultural evolution. This issue has important implications for understanding the origins of our modern social systems and the relationship between early cultural developments, innovations and human adaptations to ecological changes.

In North America, one of the key geographical areas for studying the emergence of complex hunter-gatherer societies has been the Northwest Coast and Plateau. The village site of Keatley Creek in the Mid-Fraser Region of British Columbia is one of the largest sites of complex hunter-gatherers in western Canada. Ongoing research has been conducted at the site since 1986, representing one of the longest running research programmes for any site in Canada. Over the past three decades it has featured prominently in understanding the emergence and evolution of socioeconomically complex hunter-gatherer cultures. In terms of its size of over one kilometre long and well over 100 semi-subterranean pithouses, its location and impressive natural setting, its preservation of some of the largest corporate group structures in the region, and its early ritual structures with specialized floor deposits (unique to the region and to Canada), Keatley Creek is well positioned in regional and national archaeology to provide critical insights into early cultural developments in the Americas. Only half a dozen large pithouse village sites remain in the Mid-Fraser Region. Others have been fully or partially destroyed.

Models of population dynamics and the evolution of the village site are undergoing re-evaluation in the current research programme at Keatley Creek. Work to date suggests that the height of population and complexity at the site occurred roughly 1,000-2,500 years ago. Some archaeologists have tried to minimise the extent of inequality and complexity represented at this and other similar sites. Yet, given the size of the community, the magnitude of the effort expended in construction, the degree of sedentism displayed, the use of prestige items (including exotic imported materials from the coast, copper and jade), domestication and ritual use of dogs and the evidence of costly feasting and rituals, it is clear that this was a community of complex hunter-gatherers replete with important socioeconomic inequalities.

The *specific timing and conditions surrounding* the emergence, evolution and organization of these cultural developments have been the focus of some debate, which has generated further research at Keatley Creek. This has led to the integration of a new multi-dimensional and detailed methodological approach to advance the recording, documentation, analysis and interpretation of complex stratigraphic sequences that reflect the full occupation period of houses across the site, in addition to the management and analysis of data and collections. This involves a combination of a geospatial database, digital recording and analysis techniques, high definition video and photographic recording, micromorphology, palaeoethnobotanical and other detailed analyses. This paper discusses some key aspects of the updated methods as applied to specific complex and fine-grained stratigraphic contexts and how this is helping to advance understanding of the initial stages of village development including, the co-evolution of ritual structures and social complexity. The results are relevant for investigations of hunter-gatherer adaptations elsewhere in the world

*Key words: Cultural evolution, emergent inequality, complex hunter-gatherers, ritual, resources, climate, GIS, digital methods*



## Introduction

Understanding the processes and conditions surrounding early cultural developments and emergent complexity is of central concern in studies of human and cultural evolution in the Americas and elsewhere. One of the major themes in research on this topic has involved understanding why transitions from more egalitarian organizations to non-egalitarian, hierarchical relations occur and under what conditions socioeconomically complex hunter-gatherer communities develop. This transition is one of the most important issues in hunter-gatherer adaptations on the world stage today since it represents a major threshold in cultural developments leading to contemporary types of societies with all their inequalities and complexities. Thus, understanding why inequalities developed, persisted or diminished has been identified as one of the most critical theoretical issues in the study of human cultural evolution (Price and Brown, 1985; Price and Feinman, 1995, 2010; Arnold, 1996; Boehm, 1999; Wiessner, 2002; Ames, 2010; Dubreuil, 2010; Hayden, 2011; Flannery and Marcus, 2012; Smith, 2012; Carballo et al., 2014; Kintigh et al., 2014). This issue has wider implications for understanding a broad range of issues in human evolution including: human cooperation and competition; the origins of our modern social and economic systems including resource ownership, the development of complex technologies and storage, the development of elaborate art and prestige items; the origins of agriculture; and the influence of environmental changes on cultural developments. Keatley Creek is one of the only sites in North America which has had an intensive research programme addressing such issues for nearly three decades (Hayden, 2000a, b, 2004; Villeneuve, 2010, 2014) encompassing site formation processes, social archaeology, political and ritual organization, economics dynamics and the processes underlying the emergence of inequalities and complexity.

Most prehistorians believe that small groups of simple hunter-gatherers, or foragers, undertook the initial peopling of the Americas and that these groups characterised human adaptations until sometime during the Archaic period. As simple foragers, these PalaeoIndian and possible pre-Clovis groups are generally thought to have consisted of highly mobile, low density, small egalitarian bands, probably with no more than 30 people and often only with 10 to 15 members. It is generally assumed that these groups did not rely on stored foods, they lacked any significant notions of private ownership, they had few or no prestige objects, they had no socioeconomic inequalities and no economically-based competition. This is a particularly apt description of the early occupational history of north-western North America (Matson and Coupland, 1995). The archaeological remains from elsewhere in the Americas for this initial period of occupation also seem to support these interpretations. However, at various times in different regions, fundamental changes began to occur in this simple forager system together with some new fundamental technological innovations (for example, grinding stones, mortars, fish hooks and leisters, weirs and stone boiling). Population densities increased, band sizes increased, some sites were repeatedly occupied or used by semi-sedentary groups, more permanent architecture became established, storage of food was adopted, prestige items began to appear (implying private ownership), cemeteries with notable grave goods occurred together with other evidence that makes it possible to begin thinking about emerging socioeconomic inequalities. Groups with these new adaptations are generally referred to as complex or transegalitarian hunter-gatherers.

There is considerable debate as to the nature, organization, internal dynamics and origin of these groups (for example, Thomas and Sanger, 2010). Earlier generations of archaeologists dealing with these theoretical issues relied extensively on social theories (for instance, the ideas of Jean-Jacques Rousseau, Thomas Malthus, Karl Marx, Émile Durkheim and Friedrich Engels) and anthropological theorists (such as Sahlins and Service, Carnerio and Harris) to establish their models. Early archaeologists tended to use simple prime movers such as ecological circumscription and demographic pressure to explain a wide range of processes involved in the evolution of social complexity (for example, Binford, 1968; Cohen, 1977). Since the 1980s, archaeologists have increasingly developed their own theories, relying on archaeological data and their own analyses of historical records and early ethnographies (for example, Flannery, 1977; Earle, 1989; McGuire and Paynter, 1991; Brumfiel and Fox, 1994; Arnold, 1996). Explanations for the development of complex or transegalitarian hunter-gatherers now frequently appeal to demographic pressures, climate changes, technological changes and ideological shifts. Thus, any study which can shed additional light on these factors is especially valuable in furthering our understanding of cultural evolution.

In the Americas, one of the key geographical areas for studying the emergence of complex hunter-gatherer societies has been the Northwest Coast and Plateau of North America (for example, Ames, 2004; Sassaman, 2004). On the Canadian Plateau, as in other regions of archaeological interest, debates have arisen over the timing and conditions surrounding the emergence of inequalities and whether they are represented by early developments of semi-sedentary large villages. Models focus on whether inequality emerged with early village developments under conditions of resource abundance and changes in procurement or storage technology (Burley, 1980; Matson, 1985; Hayden, 2001, 2005a) or whether inequalities occurred later in village development under resource and demographic pressures during periods of climate change (Prentiss et al., 2007). Research into these issues on the Canadian Plateau is of considerable importance since it has contributed to archaeological models used elsewhere in the world for understanding the adaptation patterns of early complex hunter-gatherers, and the pathways to more complex social and economic organizations including the initial stages

of institutionalised inequalities which has been considered one of the 'dimmest,' least understood areas in the study of cultural evolution (Wiessner, 2002, p. 233).

These models are testable by examining the timing of cultural changes (the beginning of large villages and multi-family structures, specialized ritual structures and wealth-related artefacts reflecting inequality) in relation to coterminous environmental conditions or technological changes and their magnitude. Attempts have been made to use various types of analysis to monitor economic, social and climatic changes over time in Canadian Plateau large pithouse village sites (Hayden, 1997b, 2000a, b, 2004; Prentiss et al., 2003, 2007). However, a number of new techniques provide an improved means of monitoring changes over time, including the use of digital approaches discussed in this paper for the recording and analysis of deposits and artefact distributions, correlating micromorphology and detailed sampling for macro and micro-botanical remains combined with more traditional data such as fauna and lithic analysis and the sequential radiocarbon dating of strata. The research and methods are helping build a more comprehensive dataset and an improved approach to evaluating models (Villeneuve, 2014). This, in turn, is making theoretical progress possible in the discipline, especially for understanding processes surrounding early cultural developments and important adaptive changes of hunter-gatherers.

## 2. The Canadian Plateau

### 2.1. The Mid-Fraser region

The prehistoric pithouse villages of the Mid-Fraser Region on the Canadian Plateau are especially well suited for investigating adaptations and early cultural developments of complex hunter-gatherer communities. The pithouses (semi-subterranean structures) of these villages were occupied in the winter by domestic groups, involving multiple families organized into corporate groups, at least in the case of large houses (Hayden and Cannon, 1982). The structures at these sites are easy to identify and differentiate in comparison to the more heavily vegetated village sites in coastal regions of western North America. Sparse vegetation and semi-arid conditions provided excellent preservation conditions on the Canadian Plateau for archaeological sites. The fine-grained record preserved from the structures permit the study of change over time because of their highly stratified and organic rich refuse deposits on the perimeter of each structure, and the living floors (sometimes layers of floors) inside each structure that were buried by the collapse of soil-covered roofs after their abandonment.

Approximately 1,000 to 2,500 years ago about a dozen unusually large pithouse villages appear to have developed in the region around the modern town of Lillooet, British Columbia, at the confluence of the Seton and Fraser Rivers (Figure 1).

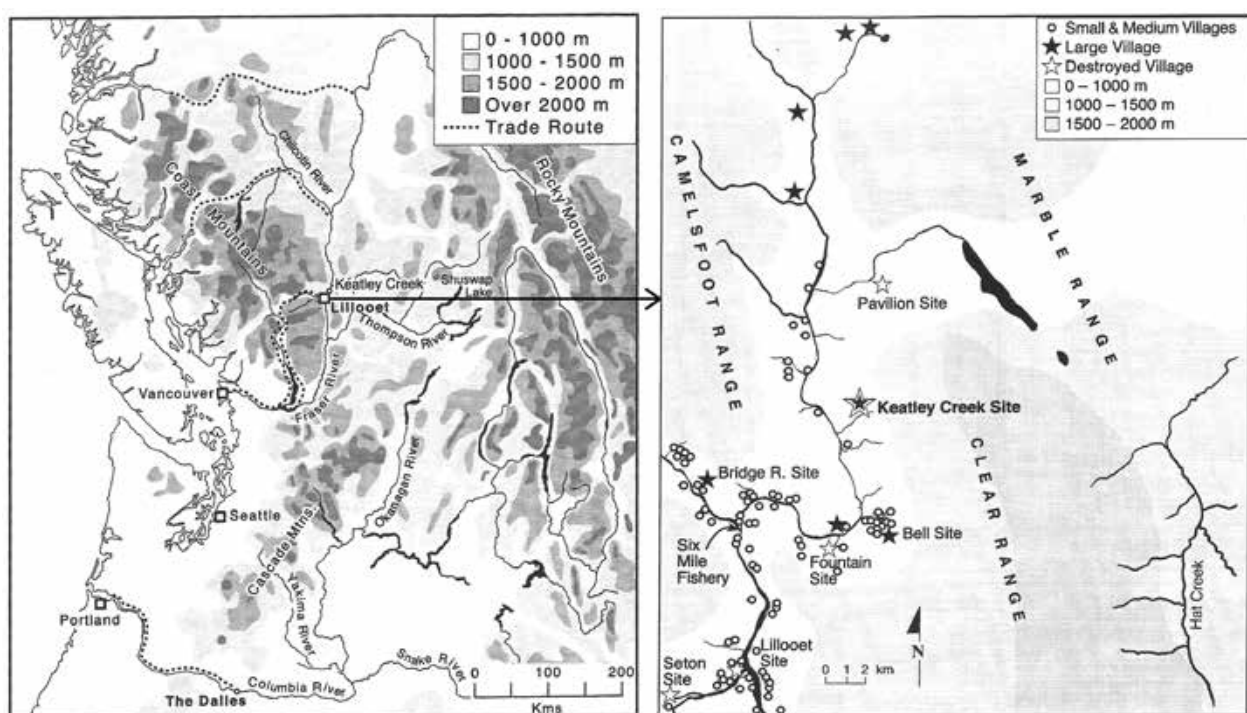


Figure 1. Map of the Mid-Fraser Region on the Canadian Plateau and locations of pithouse village sites including Keatley Creek.

At contact this area was inhabited by Interior Salishan speaking peoples, including the Stl'at'imx (Upper Lillooet, Teit, 1906), Secwepemc (Shuswap) and Nlaka'pamux (Thompson) linguistic groups. The rich ethnographic accounts of these peoples (for example, Teit, 1900, 1906, 1909) and continuous archaeological culture traditions in the area provide an abundant record of information for developing direct historical approaches for archaeological interpretations. The continuing vibrant native cultures of the region also help to link traditional practices with the archaeological past.



Figure 2. Individuals fishing at the Six-Mile Fishery near Lillooet, along the Fraser River. This is the most productive fishery in the Fraser River drainage. (Photo taken with the permission of Xaxli'p First Nation community members).

Traditionally, and still today, the St'at'imc peoples call this area a 'land of plenty' as food resources are abundant, especially salmon, deer, roots (geophytes), berries and other plants (Alexander, 1992; Turner, 1992; Pokotylo and Michell, 1998; Peacock and Lepofsky, 2004; Rousseau, 2004). Pithouse villages were primarily occupied in the winter and involved the intensive use of stored foods that were harvested in the warm season. The combination of rich resource conditions and the development of storage technology have been postulated to be key critical components underlying the shift to semi-sedentary adaptations of early hunter/gathers in this and similar regions (Hayden, 1992, 2000b). These resources could also be used to acquire goods (ornaments, foods, prestige items) from the coast or other adjacent regions (Hayden and Schulting, 1997).

The exceptionally productive salmon fisheries along the stretch of the Fraser River near Lillooet (Figure 2) plausibly underwrote the development of these large communities. The salmon from this region were especially prized since they had lost sufficient fat stores in their migration so as to preserve well, but still retained enough fat to make the dried fish very nutritious and tasty (not too lean and dry, nor too fat). The hot and dry climate of this region during the salmon runs also favoured the preservation of dried salmon. When properly dried, salmon could last in storage for up to two years or more (Kennedy and Bouchard, 1992; Kew, 1992). Isotopic analysis suggests that salmon constituted a large percentage of human protein diets, as much as 60 to 70% in adults (Chisholm, 1986; Lovell et al., 1986).

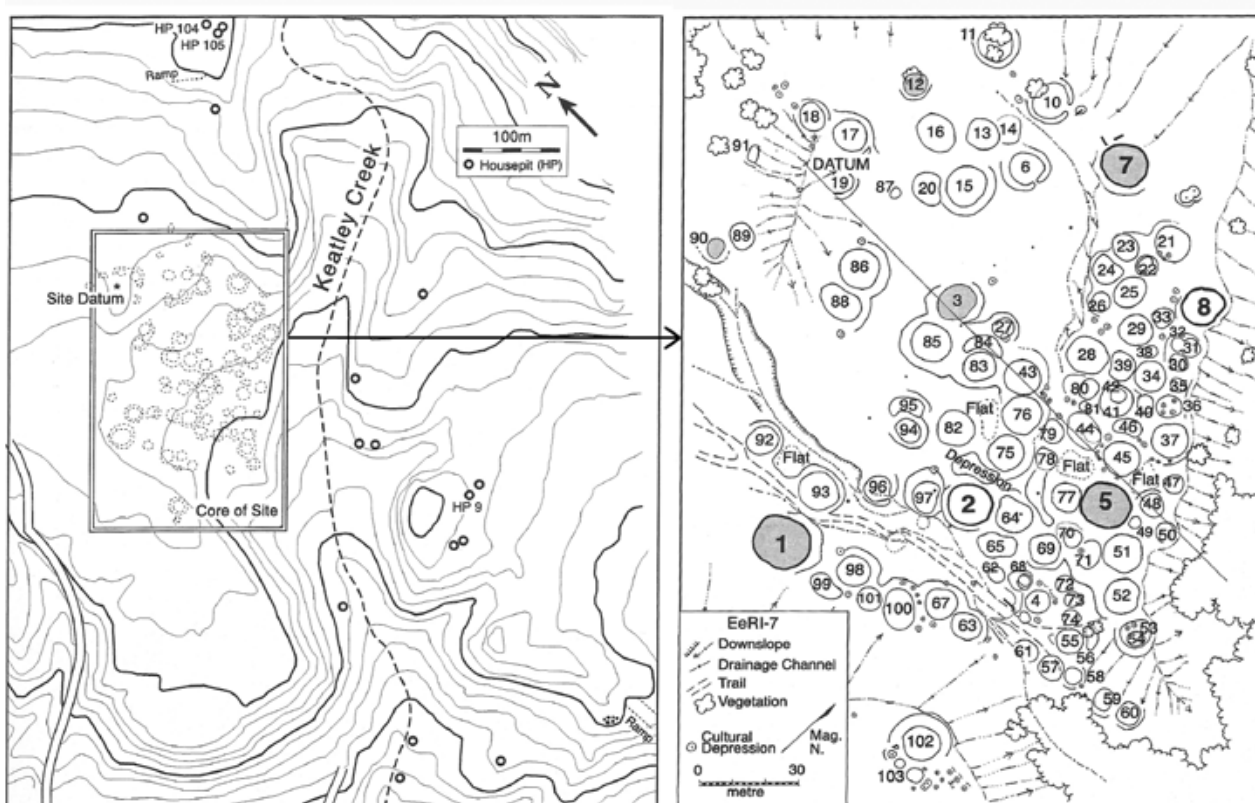


Figure 3. Map of the Keatley Creek site. Entire site area shown on the left. Site core shown on the right.



These resource conditions, together with the major travel corridors along the Seton River and Lake watershed to the coast, made this region favourable for the development of dense hunter-gatherer/fisher populations complexly organized socially, politically, economically and ritually. Unfortunately, only half a dozen of these large pithouse village sites remain relatively intact in the Mid-Fraser region due to land or industrial developments that have fully or partially destroyed some of them. The remaining pithouse village sites constitute true cultural heritage sites of great value.



Figure 4. Photograph of the Keatley Creek site.

## 2.2. The Keatley Creek site

The village site of Keatley Creek is the most intensively studied and important of these remaining sites. It is also one of the largest sites of complex hunter-gatherers in western Canada. Ongoing research has been conducted at the site since 1986, representing one of the longest running research programmes for any site in Canada. Over the past three decades, Keatley Creek has featured prominently in understanding the emergence and evolution of socioeconomically complex hunter-gatherer cultures in both a regional context and in more general models of the dynamics of complex hunter-gatherers in the Americas, and indeed elsewhere the world (Hayden, 1995, 2000a,b, 2001).

Keatley Creek is well positioned in regional and national archaeology to provide critical insights into early cultural developments in the Americas. Located in an impressive natural setting, Keatley Creek is an unusually large site, with the core covering over four hectares and well over 100 semi-subterranean pithouses, and peripheral structures extending over one kilometre along the back of a glacial terrace (Figure 3 and 4). It preserves some of the largest corporate group structures in the region together with early ritual structures (with specialized floor deposits) unique to the region and to Canada.

Models of population dynamics and the evolution of the village site are undergoing re-evaluation in the current research programme at Keatley Creek, however, work to date suggests that the height of population and complexity at the site occurred roughly 1,000-2,500 years ago (Hayden, 1997b, 2000a). Because of the favourable preservation conditions at this site, it is possible to track the development of the village from initial occupations of simple hunter-gatherers (foragers) during Middle Prehistoric Horizons (c. 4000-7000 BP) through the development of more sedentary and more complex hunter-gatherers who constructed more permanent and sometimes imposing domestic structures up to 20 meters in diameter. Some archaeologists have tried to minimise the extent of inequality and complexity represented at this and other similar sites (for instance, Prentiss et al., 2005, 2007). Yet, given the size of the community, the magnitude of the effort expended in construction, the degree of sedentism displayed, the use of prestige items (including exotic imported materials from the coast, copper and jade, Figure 5), the domestication and ritual use of dogs, and the evidence of costly feasting and rituals, it is clear that this was a community of complex hunter-gatherers replete with important socioeconomic inequalities. However, the timing and conditions surrounding these early cultural developments has become the focus of recent intensive investigations at the site (Villeneuve, 2014).

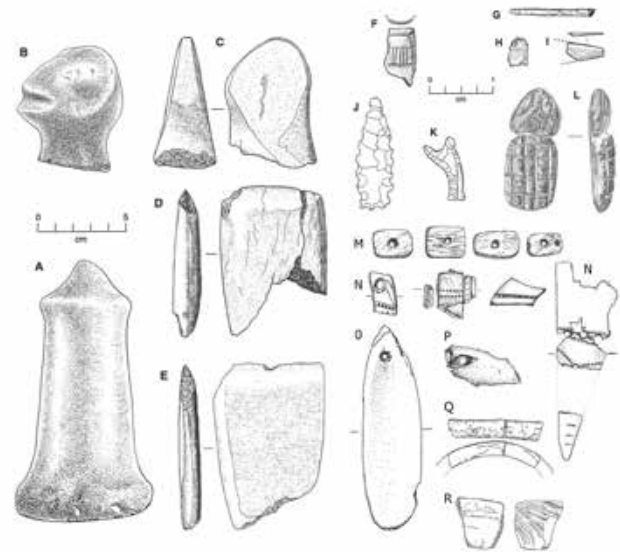


Figure 5. Items of prestige from Keatley Creek, including sculpted mauls and maul heads (A-C), nephrite adzes (D-E), a pipe fragment (F), copper tube bead and sheet (G-H), a sculpted stone reptilian pendant (L), a series of bone buttons (M), incised bone ornaments (N,P), a bone bull roarer (O), a shell bracelet fragment (Q) and a small shell adze (R). © B. Hayden. (Hayden 2005: 71-72, 99).

### 2.3. History of research at Keatley Creek

The majority of research at Keatley Creek has been either undertaken by Brian Hayden directly or through the assistance of his colleagues and former students in collaboration with Hayden. (I have directed excavations at the site since 2006). There have been four major research phases of research at the Keatley Creek site, with a new phase commencing in 2014. The initial phase of research initiated by Hayden between 1986 and 2000/2002 focused on socioeconomic organization (Hayden, 1997b, 2000a,b, 2004). Toward the end of this research phase ritual activity was explored (Hayden, 1998) and then further developed as part of the next phase of research at the site, which began in the early 2000s (Hayden, 2004; Hayden and Adams, 2004) and has been an ongoing focus of research (Villeneuve, 2010). A separate brief period of excavation occurred between 2000-2003 by one of Hayden's former students (Prentiss et al., 2003, 2007) who presented a revised chronology for Housepit 7 and argued for a revised site chronology and changes in resource relationships. Due to discrepancies in dating large housepits and implications for understanding the development of the site, a new research programme was launched by Hayden and me in 2010 with Social Sciences and Humanities Research Council funding to further investigate the timing and resource conditions surrounding the emergence of the village, and especially large houses.

Hayden's earlier socioeconomic research (1986-2000/2002) proved central in laying the foundation for social archaeology in the region by demonstrating how large multi-family corporate residences were organized socially, and in developing socioeconomic models for Keatley Creek as well as complex hunter-gatherers in general (Hayden, 1995, 1997a, 2000b, 2005a). Hayden identified discrete living floors for both large and small structures and mapped their features and contents (Hayden, 2000a,b, 2004 Figure 6). Through full excavation of a number of large, medium and small structures and the testing of additional structures, Hayden demonstrated that different corporate structures exploited or owned different economic resource areas. This was reflected in the different sources of lithic raw materials used by different houses (Hayden et al., 1996; Hayden, 1997a, Figure 7), and in the different ages of salmon procured by residents of larger versus smaller structures (Berry, 2000). The differential procurement of salmon implied ownership rights by large corporate groups over the most important fishing sites while continuity in the differential procurement of lithic sources implied long-term ownership of house sites extending over hundreds of years and perhaps more than a millennium (Hayden et al., 1996). These, and other indications including floor plans demonstrating multi-family organization of large houses with apparent wealth inequalities, led Hayden to propose that substantial inequalities characterized the main occupation at the Keatley Creek site and other large contemporaneous villages in the region (Hayden, 1997a, 2000b). The results from this past research were published in three edited volumes and numerous articles.

This excavation programme provided archaeologists with a much greater understanding of the economic basis and internal social structures of the large corporate groups. The project also raised a number of questions concerning the socioeconomic mechanisms by which such residential corporate groups came into existence. On the basis of ethnographic and archaeological research produced by the Keatley Creek project, Hayden concluded that large corporate groups and villages with pronounced socioeconomic inequalities developed on the British Columbia Interior Plateau under conditions of resource abundance sometime between 2,000 and 4,000 years ago (Hayden, 2000a, b).

More recently other archaeologists have argued for a much more recent development of the large villages and inequalities (for example, Prentiss et al., 2003, 2007), and that these developed under conditions of declining food resources with egalitarian social structures characterizing all but the latest occupations. However, these interpretations were based on a very limited sample from the Keatley Creek site (the northern rim area in Housepit 7) and subsequently limited samples from a nearby site (Bridge River, Prentiss et al., 2008) and limited samples in these contexts to examine resource shifts, especially in early periods of village development. Determining when large residences and indicators of socioeconomic inequality emerged in large communities such as Keatley Creek, and under what resource conditions they developed, has thus become critical to evaluating theoretical models concerning early cultural developments and adaptations of hunter-gatherers on

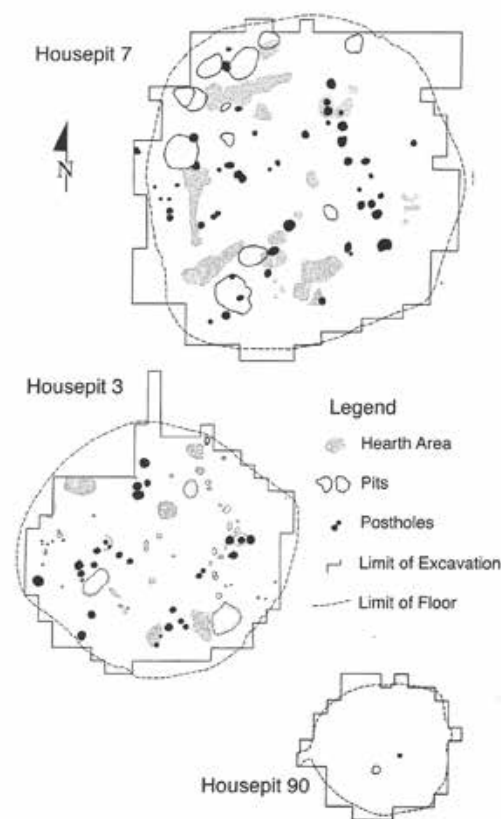


Figure 6. Living floors of small, medium, and large structures at Keatley Creek (Housepits 90, 3, and 7). © B. Hayden (Hayden 2005:50).



the Canadian Plateau (Hayden, 2005b; Hayden and Mathewes, 2009). Current research at the site is testing theoretical models by examining the timing of cultural changes such as the beginning of large villages and multi-family structures, the emergence of specialized ritual structures and the occurrence of wealth-related artefacts reflecting inequality. This research is also trying to monitor subsistence changes over the occupation lifetime of structures, in relation to cultural changes, environmental shifts and technological changes. This programme focuses on the detailed excavation, recording, sampling and analysis of house rims and floors.

To accomplish these research goals, it was first and foremost critical to increase sample sizes across the site. This was greatly facilitated by using advanced methods of data collection, recording and analysis in undertaking larger scale research including the finer details needed to better assess alternative models. Excavation, recording, documentation, analysis and interpretation of complex stratigraphic sequences is now undertaken with a combination of digital, geospatial, high resolution imaging, micromorphology, palaeoethnobotanical and other analyses (Villeneuve, 2014). The following section discusses some key aspects of the updated methods as applied to specific complex and fine-grained stratigraphic contexts, and how results emerging from the integration of new approaches have implications for investigations of hunter-gatherer adaptations in the region and elsewhere in the Americas.

### 3. Advancing methods

#### 3.1. Contexts are key

Contexts are essential elements in evaluating theoretical models. The majority of research undertaken in the pithouse villages of the Mid-Fraser region has focused on house floor contexts. Past research into socioeconomic organization at Keatley Creek, for example, relied primarily on floors for the reconstruction of activity areas and social units or group size estimates (Hayden and Spafford, 1993; Hayden, 1997b; Hayden, 2000a, b, d, 2004). Over twenty radiocarbon dates were produced in this past research, which were used to compare contemporaneous floor assemblages (Hayden, 2000c, p. 36). To position these floor assemblages in a larger general picture of the potential development of the site, some initial radiocarbon samples from house rim midden contexts were also processed. These provided an initial idea of when certain houses (especially large houses) were built and abandoned (Hayden, 2000c, p. 37).

House floors were ideal contexts for investigating activity areas and social organization. However, floors alone are not a reliable or suitable context for addressing larger questions concerning the evolution and organization of a pithouse village site (as some archaeologists have attempted). In terms of the degree to which floor deposits were removed, covered, cleaned, maintained or prepared, there does not appear to be any general pattern to floors over time across a single pithouse village site or between sites. A housepit could be used for many hundreds of years without a major break in occupation, or it could have been used episodically and reoccupied at various times. Multiple floor deposits *might* have been left from some period of use, although floor deposits were frequently removed as part of re-roofing events, leaving only the last occupation deposits *in situ*. Thus, remnant floors (if any exist) would not provide a reliable means of reconstructing the life history of the house. There is simply too much variation in the accumulation or cleaning of floor deposits in the large pithouse village sites so far investigated, to be able to obtain a good understanding of the full potential occupation of a specific house structure, let alone to extend those results to

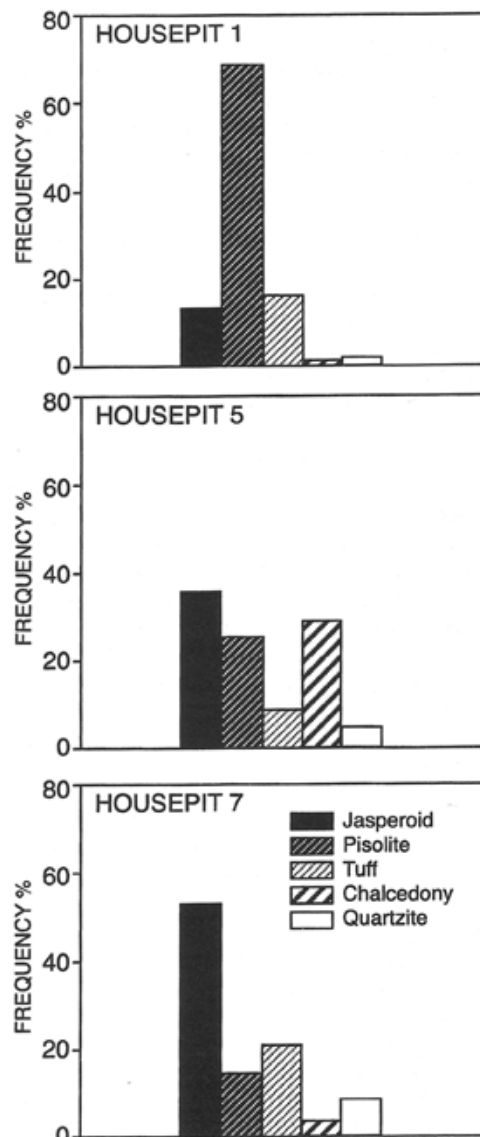


Figure 7. According to the results of past analyses, large corporate households at Keatley Creek had access to, and probably ownership over, different sources of lithic materials (Hayden et al., 1996). These histograms illustrate some of the important differences between three of the largest structures at Keatley Creek. These differences persisted in each housepit rim from the earliest to the latest occupations, spanning about 1,000 years. This indicates that the same corporate group retained ownership of both the residential structure and rights to specific resources throughout the occupation span of the structures. © B. Hayden (Hayden 2005:106).

## Formation Processes for Earth-Roofed Pithouses

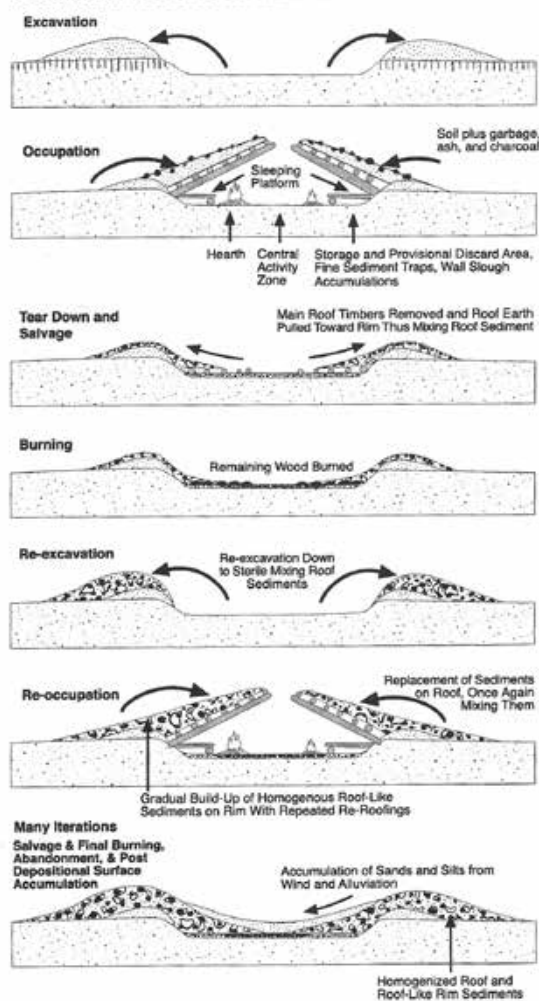


Figure 8. A schematic representation of the formation processes involved in the accumulation of rim deposits and the cleaning out of old floor deposits during the re-roofing process as represented at Keatley Creek. © B. Hayden (Hayden 2005:37)

reconstructing the timing of early cultural developments or the evolution of a pithouse village site. To do this, it is essential to use a combination of floor and house rim midden contexts.

Rims, in particular, represent a large proportion of pithouse village architecture and activity debris (including resource remains) reflecting the history of the site (Figure 8). House rims were the primary location for the discard of household refuse. They are composed of accumulations from the initial building and occupation of a structure throughout its use life and abandonment (Hayden, 1997a). Dumping of house cleaning and construction materials (including the removal of sterile deposits from the excavation of new storage pits or the widening of a wall) can contribute to rim formation, as well as the deposition of materials from activities carried out inside houses or on the outside perimeters of houses. In addition, various natural and cultural taphonomic processes also influence the build-up, erosion or alteration of house rim middens (for example, re-roofing, fires, loessic accumulations). Due to the highly organic layers and dense lithic concentrations that often occur in large housepit rims these contexts provide an abundance of remains for analysis of resource or technological shifts throughout the use life of a house, as well as an understanding of its occupation history.

Past research has shown that rim middens can be very complex (Hayden, 2000a, 2004). Because of their complex nature, limited work was undertaken in rim deposits in the past by Hayden and his team and it was acknowledged that much more detailed methods and sampling would be required to adequately excavate and interpret rims which were then outside their research focus and funding capacities. Nevertheless, their preliminary work showed that rims are contexts that could be used for understanding the evolution of house structures (Alexander, 2004; Hutchings, 2004; Muir, 2004). These preliminary investigations suggested an early development for some large pithouse structures, but Hayden's exploratory rim investigations were not intended to be thorough or in-depth studies (Hayden, 2004; Hayden, pers. com.). Preliminary

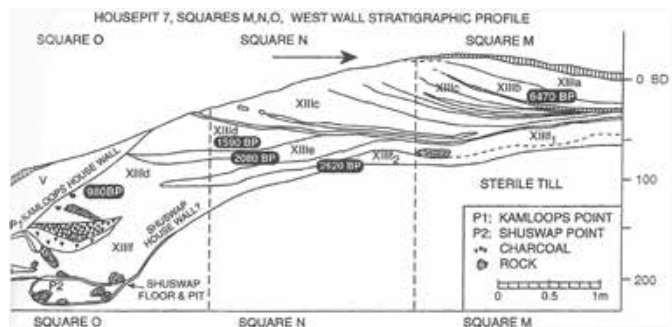


Figure 9. A cross-section profile of the northern rim of Housepit 7 as recorded in Hayden's excavations together with radiocarbon dates he obtained from these strata. © B. Hayden (Hayden 2000:37).

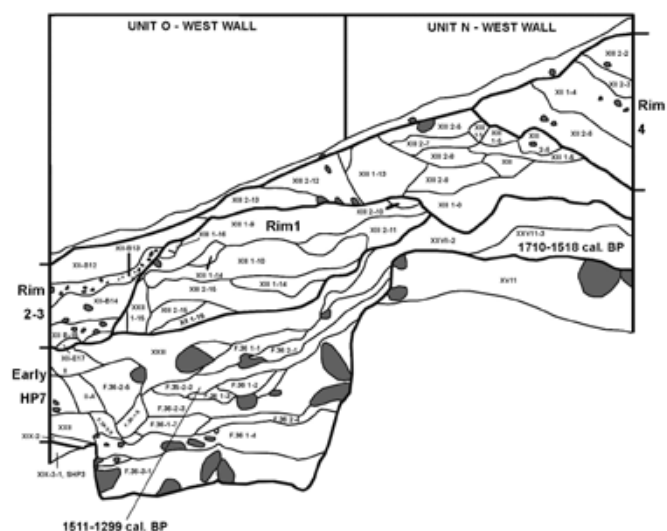


Figure 10. The cross-section profile from the same northern rim as Fig.9 of Housepit 7 as recorded in Prentiss' excavations with accompanying radiocarbon dates. Re-drawn from Prentiss et al., 2007:305.

results from dating Housepit 7 rim deposits, in particular, helped provide an initial bracket for the potential time range of occupation in this structure which had implications for understanding the emergence of socioeconomic complexity at the site (Hayden, 2000c) (Figure 9, see also Figure 10 for another profile of the same wall presented by Prentiss et al. (2007), which is under further revision in the current research programme).

### 3.2. A new approach

To better investigate these stratigraphically complex large housepit rim contexts, and to further evaluate the timing and conditions surrounding early cultural developments at the site, it was advantageous to up-date conceptual and methodological approaches. Digital methods have ultimately led to a new research paradigm in archaeology and have transformed the way in which archaeologists can engage with archaeological contexts or materials and process or analyse information, and ultimately how archaeologists understand the past (for example, Hemsley et al., 2005; Evans and Daly, 2006; Cameron and Kenderdine, 2010; Agbe-Davis et al., 2013). Satellite imagery, for example, was not easy to obtain in the past, but now we view the world this way nearly daily through Google Maps, which has influenced our day-to-day lives as well as our research. The practical and ethical implications of operating in a digital age are perhaps not yet well understood (for example, Colley, 2012), but clearly the use of digital technologies have led to tremendous benefits in life and in the sciences, including archaeology.

This paper discusses a few highlights resulting from implementing digital oriented methods and conceptual approaches to the research at Keatley Creek. Primary focus has been on GIS related techniques as we work toward a larger integrated system for managing data (for example, Katsianis et al., 2008). A wide range of GIS applications have been used in archaeological studies for well over a decade (for example, Westcott and Brandon, 2003; Mehrer and Westcott, 2005; Chapman, 2006; Conolly and Lake, 2006; Robertson, et al., 2006). At Keatley Creek, we have only scratched the surface of the possibilities of digital applications in research, but the new developments are providing significant advantages in how we understand early cultural developments and hunter-gatherer adaptations on the Canadian Plateau.

The Keatley Creek Project has been incorporating digital methods in research since 2006 (Villeneuve, 2007, 2010, 2014) using a number of techniques that had been employed in Europe during the previous decade, and which the author became familiar with beginning in 2000 (for example, McPherron and Dibble, 2002; Sisk, 2010). With the new research programme at Keatley Creek beginning in 2010, great emphasis was placed on adopting a more scientific approach to undertaking excavations of complex stratigraphy and viewing the excavations as repeated experiments for evaluating hypotheses (Villeneuve, 2014). Methods of data collection were routinely refined as part of the experimental process. A major goal of this work was to establish a simple, practical, cost- and time-efficient, digital approach that would increase the amount of data and detail possible to record with consistency and with great accuracy. Methods included using GIS and auxiliary software, video recordings, high resolution imaging, remote sensing, and other techniques. With this new approach it is possible to view and produce or edit results (including graphics) as excavations unfold, and to complete in weeks (with greater detail, accuracy, data, and analysis capability) what used to take multiple research seasons to complete. This has made it possible to increase the number of areas sampled across the site as well as the number of samples taken within those areas, while increasing data consistency.

The original purpose or goal behind the use of advanced methods was to achieve improved resolution and understanding of complex stratigraphy especially in rim deposits. The conceptual approach behind designing and integrating new methods at Keatley Creek emerged from the application of digital techniques to the excavation and recording of complex rock shelter deposits in Europe. The complex stratigraphy of rim middens of large houses was viewed as comparable to that of rock shelters in terms of the potential range of horizontal and vertical stratigraphic variation and complexity, taphonomic processes and anthropogenic influences in mixing or recycling of deposits, and the occurrence of occupation surfaces. Thus, in implementing new methods in the excavation programme at Keatley Creek, emphasis was placed on an approach that would provide maximum interpretive potential and advance the recording and analysis of complex stratigraphy at the site.

### 3.3. Digital recording in excavations

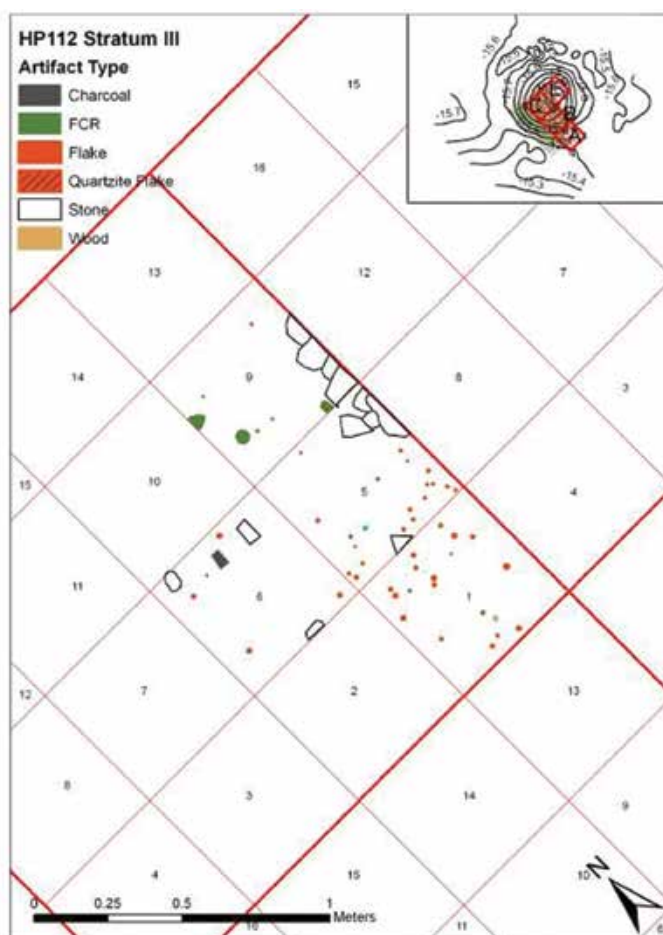
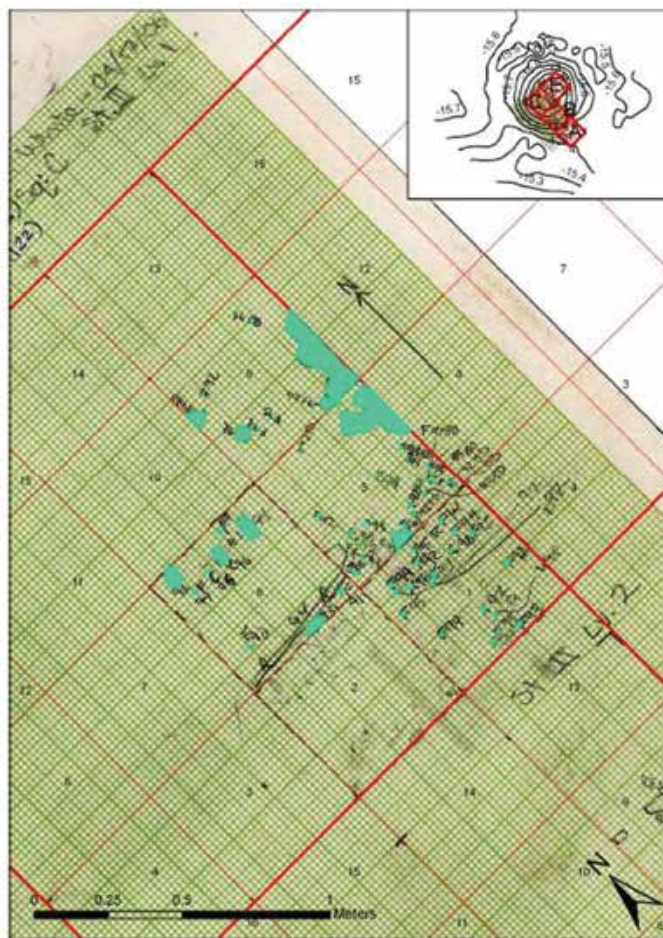
In 2005-2006, when introducing digital approaches in excavations at Keatley Creek, it was necessary to take into consideration the two decades of prior excavations that were recorded using a traditional excavation system. Similar to the process other archaeological sites have gone through, digital methods are helping build an information infrastructure to be able to more successfully and efficiently conserve, access, integrate, mine and analyse data sets with the objective of advancing understanding of human cultural evolution (for example, Kintigh, 2006).



The early Keatley Creek records were archived on paper, as well as stored in Excel files for analysis, and in Photoshop or Illustrator files for simple graphics of maps and stratigraphic sections. A GIS was designed to assist with digitizing old excavation data (for example, excavation plan maps, Figure 11) and to be used in building a centralized geospatial database for the site that could also integrate analysis results and new digitally collected field data (Sisk et al., 2008). Currently, this GIS is also providing a central database for the site collections (including an inventory catalogue of all excavated materials and samples, all analysis results, photographs, paper archive images and other data). One of the primary objectives in utilizing GIS to centralize data management is to help provide more versatility with spatial and intrasite analyses in current and future research.

In 2009 and 2010, a combination of software including GIS, EDM Windows and NewPlot (McPherron and Dibble, 2002) were incorporated into excavations for digital recording, data collection, and processing using a barcode system. One of the major benefits of this system has been the ability to automatically add to (and generate) an excavation database as each item is recorded, including all of the information that was traditionally recorded on excavation cards (for artefacts, samples, and buckets), and a lot of what was traditionally recorded in field notes (such as strata changes, depths, features, burrows, and disturbances), including spatial coordinates of all items recorded (Figure 12). During excavations, this system involves a simple daily set-up requiring only a few minutes at the start of excavations and only seconds of recording as excavations are undertaken (in comparison to the amount of time that graph paper and artefact or sample card recording typically takes). This approach alone has significantly increased speed, efficiency, and organization of work flow, as well as the accuracy and amount of data retrieved in excavations. More importantly, it provides greater ability to focus on the deposits and sampling contexts, thus essentially increasing the quality of interpretations that result from the field. Because there are no artificial quadrat boundaries that constrain excavation, digital grids also facilitate excavators' abilities to follow natural stratigraphy.

*Figure 11. The process of digitising excavation plan maps using GIS. The image to the left shows a scanned excavation sheet (for Housepit 112) referenced to the digital excavation grid and digitisation of artefacts and feature data in progress. On the right are digitised artefacts coloured by type using ArcMap. This digitisation of old excavation data is contributing to a larger geospatial database for excavation data from the site that is also helping also centralise data from various analyses and collections inventories. (Figures taken from Sisk et al., 2008 and also reported as a chapter in Villeneuve 2010).*



This frees the excavator to focus more on following, examining, and interpreting complex stratigraphy in field excavations.

The ability to view and edit spatial data (including re-designating strata numbering or interpretations) in the field during excavations is also of great benefit to improving the quality of data that results from excavations. This includes the ability to examine artefact distributions, clustering, and orientations during excavations for stratigraphic assessments and understanding of formation processes of rim deposits. In addition, strata designations can be made more easily in all areas of excavations with a digital recording approach, providing a significant advantage over the limitations of traditional recording systems. In the past, with traditional methods, field interpretations could sometimes result in the lumping of poorly differentiated strata whereas they could later be determined to be separate deposits. The materials from these layers would thus be lumped together in one level bag (or sample bag) and could not be separated out later for analyses. On the other hand, due to the ease and speed of digital recording systems in excavations, it is possible to increase the number of distinct strata recorded (that can more easily be lumped later). Combined with the individual recording, numbering and bagging of artefacts and samples (all with point proveniences) throughout strata or features, this makes it easier to re-assign artefacts and features to new strata designations and even subdivide strata contents after field excavations and interpretations. Reducing the bulk of paper recording and processing also avoids errors that occur in recording and transferring notes or information. There are many other benefits to the digital excavation approach in excavation, including the ability to view graphics of excavations as the work is undertaken, the conservation of excavation data, and the ease of teaching or training individuals in methods.

### 3.4. Video recording of stratigraphy

Stratigraphic profiles reflect the history of a site and are essentially the story-board of excavations. Understanding the formation processes of complex rim stratigraphy, and being able to communicate that through a stratigraphic profile with results from radiocarbon dating and other analyses, is critically important to a research programme. Traditionally, profile

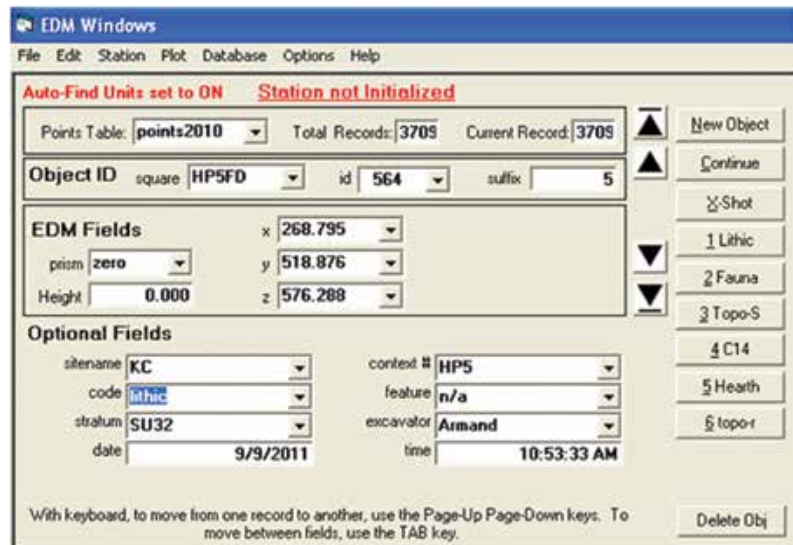


Figure 12. A screen shot of the EDM Windows field recording system for Keatley Creek, as of the 2011 year (some up-dates to recording categories have been made since 2011). Field data is registered with this software that is run on a mini laptop with an XP Windows operating system, utilizing a Leica TS06 (Total Station) to record data points (also see Figure 13). EDM Windows automatically feed data into a central Access database for the entire site (that stores data from multiple excavation areas), which can then be opened and viewed using NewPlot or GIS software in the field to examine data in real time as excavations are ongoing.



Figure 13. Still of the video recording of stratigraphy descriptions in excavations, during 2011 while iPad recording was also explored for combined recording of excavation logs, photos and videos in combination with Total Station and EDM Windows recording. (Video screen shot of Russell Clark in Housepit 5 excavation trench, video recording by S. Villeneuve, video reference KCMVI0001HP52011).



recording has been undertaken with string, line level and measuring tapes, and recorded on graph paper under highly variable daylight conditions. In situations of highly complex strata of large housepit rims, it is seldom that archaeologists take the time to record a very detailed profile on graph paper to accurately represent all aspects of the context, nor is this feasible in most conditions. Any profile drawing on graph paper lacks the wealth of information and accuracy that digital approaches can provide.

Field notes for all stratigraphic units excavated and samples collected are now recorded using high definition video which is then transcribed for reports and high resolution imaging (Figure 13). This visual digital approach to field notes provides far more information and detail from an excavation, in comparison to what was traditionally recorded on paper for strata descriptions and measurements. Video recording tends to be quite thorough since, in our on-site interpretive recording approach, *the camera encourages the excavator to explain their reasoning or justification for strata interpretations* in greater detail than traditionally documented in writing on paper forms. Strata observations (basic colour, texture, compaction, organic content and other information) are documented with video, as well as the thought processes behind the evaluation or judgment of features, artefact patterns, disturbances, or other details that previously would have been recorded in field notes (or, that were even sometimes omitted in past field notes). Video records also provide the ability to review earlier phases of excavations during ongoing field work, and to take screen stills (images) from the video stream, to assist with strata identifications and interpretations, and the assessment of rim formation processes, as well as helping later (in the lab) in the re-examination of strata assessments when finalizing interpretations. Contexts of sampling for radiocarbon dating, for example can be re-examined with far greater information before finalizing a selection of samples for processing.

Video has ultimately become one of the most powerful recording tools in the field for enhancing the process of excavating, the quality of interpretations of complex strata, and the documenting of strata descriptions. It has also advanced learning and teaching experiences which is a benefit recognized by other researchers exploring the use of video in archaeology (for example,

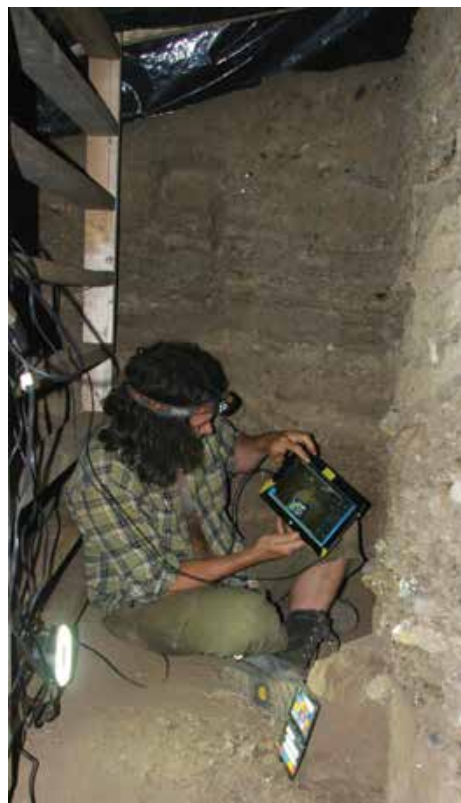


Figure 14. Photograph showing the process of collecting high resolution photographs of the excavation profile west wall in Housepit 5. A Nikon D800 camera is used with a 50mm lens and a 44LED ring light mounted on the camera lens, with a colour chart and light meter reading in LUX present. Images are captured using ControlMyNikon software and processed in Adobe Photoshop Lightroom, then stitched with PhotoScan. (Photo of Remi Farvacque in Housepit 5 excavation trench, taken by S. Villeneuve, August 2013).

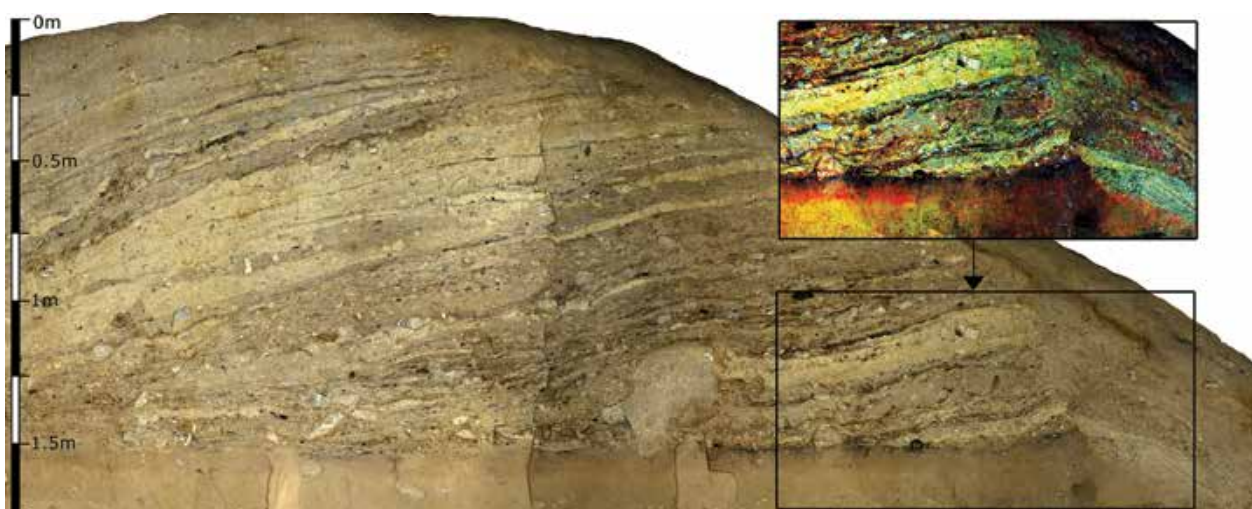


Figure 15. A compressed jpeg image of the final stitched, rectified and colour corrected high resolution photograph of Housepit 5 west wall excavation profile prepared by R. Farvacque, and further prepared by S. Villeneuve for this paper and the Keatley Creek reports (Villeneuve 2014). The box on the right shows a portion of the profile (area shown by the black box) that is enhanced using D-Stretch® software (LAB colorspace that is sensitive to artefacts caused by jpeg compression) to provide a good all-around enhancement. These imaging products are used as visual aids (as well as video records and field measurements) in the process of preparing profile line drawings, and for reference in the field when sampling (e.g. for micromorphology) and in excavation.

Colley and Gibbs, 2013). In our situation, it formerly could take years for new students to build up enough experience to critically assess, think through, evaluate, and document strata well enough to be able to deal with contexts that involve highly complex stratigraphy. Video recording, including the process of engaging students to explain observations and justify interpretations in front of a camera, and the process of transcribing video recording of stratigraphic descriptions, is helping speed up the student training and learning process so that more students can contribute to advancing research in the field. This ultimately translates to the ability to undertake more research with higher quality results.

Visualization techniques have become an important and sometimes central part of archaeological investigations (Llobera, 2010). We are finding that video recording ultimately provides (for our research) what is essentially the best form of 3-D audio and visual documentation of excavations. These documents can also be compiled into movies showing the entire excavation process for every excavation area. Other 3-D imaging techniques, such as those that utilize GIS or photogrammetry in displays of plan (top-down) views of excavations (versus profiles) (for example, Sisk, 2010) are also applied to new research at Keatley Creek for house interiors, especially for ritual contexts.

### 3.5. Photography and digital image processing

To further assist with stratigraphic analysis and interpretations, high resolution digital photography and photogrammetry were also incorporated into profile recording. Our starting objectives in past work (2010-2013) was simply to explore the potential of different lighting conditions and digital image resolution to help capture details of stratigraphic profiles that would aid in profile mapping of stratigraphic boundaries. Daylight conditions for example, even with shade, tend to wash out stratigraphic distinctions making certain boundaries barely noticeable. Some natural lighting can also cause shadows that reduce visibility of strata boundaries which impacts the ability to identify continuity of colours and textures within the strata. The use of LED lighting (versus standard halogen lighting) under dark conditions (at night or under dark tarps) significantly enhances strata visibility. To avoid shadows and distortion, photographs of the profile wall were taken with using direct LED lighting (5500k) ring mounted on a 50mm lens of a DSLR camera under conditions where natural light was blocked out by dark tarps. Colour charts and light meter readings (in LUX) were incorporated (Figure 14). Photographs were taken in vertical sequences across the profile wall and were cropped and stitched, then rectified using correct measurements from the profile wall with the aid of GIS. The resulting image provides far greater strata visibility than what was visible or could be recorded under normal daylight conditions (Figure 15).

Our high-resolution photographs of the stratigraphy can then be run through image enhancing software to examine stratigraphic patterns in even greater depth. At a low cost, non-specialist level, D-Stretch® was used to explore the use of such software. D-Stretch is based on remote sensing principles and was developed for, and normally applied to, rock art studies (for example, Harman, 2008; Gunn et al., 2010). However, this software can also assist with exploring digital images for enhancing strata visibility (Figure 15). Certain strata characteristics (colour, texture, organic content, sterile layers and other variations) can be made much more visible using this kind of image enhancement software, thus providing advantages to mapping strata boundaries in profile recording. Video records and GIS data are also consulted in the process of creating profile line drawing. The profile maps resulting from this approach are far more accurate, detailed and informative than profiles recorded using traditional graph paper methods under variable daylight conditions. Other data can then be incorporated into profiles drawings (utilizing GIS), including the artefact distributions and strata boundaries recorded digitally in excavations, as well as locations of various kinds of samples and the details of their results (for example, numbers, counts or percentages, and types) including radiocarbon dating, micromorphology, chemical and macro or microbotanical analyses. These digital visual aids increase abilities to examine relationships between deposits and anthropogenic contents at various scales to better assess formation processes and the significance of individual strata. These digital images alone (or enhanced with D-stretch®) can also be used during excavations to assist with following and examining strata as excavations unfold.

This approach has thus far been used strictly for visually enhancing strata boundaries and details. It is not currently used at the interpretive level since that would require much more advanced methods. However, since the basic techniques we have employed thus far have demonstrated that this approach has significant advantages over traditional profile recording, more advanced imaging is now being developed with specialists to help improve this area of research and to integrate results into analyses. Nonetheless, the results emerging from this approach demonstrate how significantly different field interpretations can be for complex stratigraphy when only traditional approaches are applied. This has important implications for understanding the formation processes of a large housepit rim and thus interpreting the evolution of the house and hence extending this to entire site or regional chronologies. Where methods can be of even greater benefit is in turning from issues of site chronology and resource conditions back to larger social questions for modelling pithouse village dynamics. A combination of detailed stratigraphic recording techniques, analysis and more comprehensive intrasite spatial



*Figure 16. Artefacts recovered from ritual related contexts, including a bone button blanket (top right) and a crescent shaped biface (centre right). A rock lined hearth (bottom left) in Housepit 116 is adjacent to unique specialized floor deposits. Rock lined hearths are a feature type found only in ritual related small housepits on the southern Terrace of the site (Villeneuve, 2010). A dog burial (left) led many archaeologists to believe there was a ritual association (see chapters in Hayden 2000a, and Housepit reports in Hayden 2004). © B. Hayden.*

analysis utilizing various digital methods will ultimately create a firm foundation for reformulating views about the past and processes surrounding early cultural developments involved in hunter-gatherer adaptations on the Canadian Plateau.

#### 4. Ritual investigations

One area where the use of digital techniques can be of great benefit is in the excavation and analysis of ritual contexts. Ritual is a notoriously challenging domain of research in archaeology, in terms of the identification and interpretation of individual structures or events, and the development of ritual contexts over time. At Keatley Creek, the identification and interpretation of ritual has been a central focus of research in recent years, as well as understanding what role ritual played in early cultural developments at the site. The ritual structures identified, and that continue to undergo investigations (Villeneuve, 2008, 2010, 2012, 2014; Villeneuve and Hayden, 2008), are small and simple, but represent the first recognizable nascent development of specialized ritual structures documented archaeologically in the Northwest, and, as far as is known, in Western Canada.

Hayden first began to suspect that a number of small structures on the periphery of the site might have been ritual structures in the mid to late 1990s (Hayden, 1998). Many years of careful excavation then went into their excavation and analysis to further investigate and firmly establish that they were likely ritual structures rather than other kinds of specialized structures or residences (Hayden, 2004). Some of the more important indicators of the ritual nature were then established (Hayden



and Adams, 2004). These included: their isolated location peripheral to residential areas; their distinctive types and locations of hearths (central stone ringed hearths); the unusual volumes of storage capacity; the unique assemblages of stone tools and fauna (including ethnographically documented species used in rituals such as loons); the occurrence of exotic and wealth items in usual quantities (for example, dentalium, jade, gaming bones, a unique collection of 72 bone buttons); the rarity of other artefact types; intentional destruction of structures; spatial association with large roasting pits, and; specially prepared floors (Figure 16). Individually, each of these characteristics might be explicable in other terms. However, when considered together, all of these indications make a rather compelling case for an early development of this type of structure for ritual use.

In our current excavations (Villeneuve, 2014), the digital recording methods in excavations (to record stratigraphy, features, artefact distributions and sampling locations), combined with high resolution imaging of profiles and micromorphology is contributing a more refined and detailed understanding of the development of ritual activities and their change over time as well as the investments in, and construction of, ritual spaces. These methods are especially helpful where finely layered floor deposits occur. The investigation into the material remains of ritual activities is now also benefitting from the compilation of a geospatial database (the GIS digitizing of old excavation plan maps) that can be used in activity area analysis and intrasite analysis. All of these new techniques have been applied to refine criteria used to identify ritual activities and potential ritual zones, and in the analysis of the development of ritual at the site. Video recording and 3-D modelling (with photogrammetry and GIS methods) also provide new forms of documentation of these spaces. The combined visual (and audio) displays are beneficial in the analysis of changes over time in these ritual (and other) contexts. Through these new methods, our understanding of ritual behaviour at the site is being transformed and broadened. With data emerging from detailed house rim excavations combined with results emerging from ritual structures, we are starting to develop an understanding of the co-evolution of ritual and social complexity in pithouse village communities.

Why some of the first specialized types of structures in emergent complex societies should be ritual in nature rather than political, economic, or militaristic, is an intriguing question. The same pattern can be discerned in the early complex hunter-gatherer and horticultural cultures of the Near East (Hayden, 2003). In fact, there are many similarities between the Natufian culture of the Near East and the complex prehistoric cultures of the Mid Fraser River Region. As in the Near East, the first ritual structures at Keatley Creek are relatively small, and capable of accommodating only a small exclusive fraction of the community population. They appear to have been used by a very select group, perhaps linked to important economic and political roles as in the secret society organizations recorded for the Northwest area ethnographically – at least, these are the ideas and suggestions we have been evaluating and investigating at Keatley Creek and in other parts of the world.

Keatley Creek has one of the most fine-grained records in Canada for the study of such ritual structures at the transegalitarian level and we expect that results from the site will provide further important insights for understanding these issues in other parts of the world. The new directions in ritual and other research at the site should lead to revised models for pithouse village dynamics, and the evolution and organization of complex hunter-gatherers and early cultural developments on the Canadian Plateau. This research should help to make a valuable contribution to the process of identifying and interpreting ritual activities represented in the archaeological record elsewhere.

## 5. Conclusions

The Keatley Creek site is critical for understanding the transition from egalitarian foragers to more socially complex adaptations in early hunter-gatherer populations. The current research programme at Keatley Creek has helped to shed light on the conditions preceding and accompanying the establishment of large villages, large corporate groups, and inequalities (Villeneuve, 2014). Ritual, in particular, has been an important part of this research which has been under-theorized in studying these processes, or hardly mentioned at all in the major edited volumes on complexity (for example, Price and Feinman, 1995, 2010, although see Aldenderfer, 2010).

Together with obtaining critical new radiocarbon dates for the earliest manifestations of these traits, our recent research has also been implementing the use of state-of-the-art advanced methods to examine stratigraphic sequences and ritual structures. Digital techniques, video recording, GIS data collection and processing, micromorphology, new photographic approaches, and other features have all combined to produce a broader data set and robust new interpretations that will be used to test alternative models of these important cultural adaptations and evolutionary developments.

In summary, Keatley Creek has been an exceptional site to work at in terms of the ability to identify domestic and corporate groups (directly associated with the refuse that each produced), the preservation of deposits, and a vibrant native culture in the region directly descended from prehistoric populations. In terms of its importance, research at Keatley Creek

has contributed to the development of social, economic, political, and ritual models of complex hunter-gatherers, and it continues to contribute major new insights into understanding the prehistory of the region as well as early cultural developments in general.

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# Conclusions and the Way Forward

# 4

**Nuria Sanz**

*Head and Representative of the UNESCO Office in Mexico*

The international meeting *The First Peopling of the Americas and the World Heritage Convention* was held in Puebla, Mexico, from 2 to 6 September 2013. The meeting marked an important advance of the HEADS Programme towards its mission of defining and establish a strategy of cooperation with the local government of Puebla and of establishing solid actions in order to ensure the future recognition, conservation and research of sites related to the process of human evolution, adaptation, dispersal and social development in the Americas. The Americas hold many sites that have strong links to human origins and many of these are insufficiently represented on the World Heritage List. The value of these sites is underestimated and goes unrecognized, and it is often a challenge for States Parties to conserve this heritage and manage its specific vulnerability.

The meeting was a continuation of a series of World Heritage meetings; it addressed the discussions and recommendations from the international UNESCO meeting *Human Evolution and the World Heritage Convention*, which took place on 21 to 25 March 2009 in Burgos, Spain, the *Meeting to promote African human origin sites and the World Heritage Convention*, held from 8 to 11 February 2011 in Addis Ababa, Ethiopia, *Human Origin Sites in Asia and the World Heritage Convention*, held at the Jeongok Prehistory Museum, Republic of Korea, from 24 to 28 September 2012 and, most recently, *Human Origin Sites and the World Heritage Convention* in Eurasia held at the University of Tübingen, Germany, from 25 February to 1 March 2013. Whilst the meeting in Burgos focused on sites related to Human Evolution from a global perspective and analysis, this meeting provided a regional concentration in support of the future conservation of human dispersal and adaptation sites in the Americas, as was the case following the African, Asian and Eurasian meetings. Additionally, this meeting extended beyond evaluating and defining HEADS related sites and their evolutionary features and addressed the development of the compulsory cooperation between science and conservation.

This essential collaboration was highlighted by the involvement and participation of government officials from the State Government of Puebla, SEMARNAT, CONAMP, INAH and CONABIO.

Most of the meeting's work was achieved through multilateral Working Groups, which were based on information acquired from several days of scientific sessions and site visits<sup>1</sup>. The scientific sessions consisted of presentations by invited experts from Mexico and representing 11 other countries, representing over 30 universities and research centres. The experts gave presentations and engaged in discussions about the arrival and dispersal of hominids to and across the Americas. The presentations approached the first peopling of the Americas from many perspectives; experts specializing in climate analysis, human palaeontology, zooarchaeology, mitochondrial DNA, property relations, neolization, the origins of agriculture and the domestication of maize and the important role of the *cenotes* submerged heritage.

The scientific sessions were enriched by site visits. The experts visited la Reserva de la Biosfera Tehuacan-Cuictlan in Tehuacán, Puebla, Mexico, which was declared a Natural Protected Area by Presidential Decree in 1998. The valley reveals important information regarding the origins of agriculture in Mesoamerica and thus regarding the peopling of the continent. It contains key information for developing an understanding of the domestication of many species of plants (maize, chilli, amaranth, avocado and pumpkin, among others). The bioserve is also home to many endemic species, both floral and faunal. The experts also attended the Museo de la Valle de Tehuacán where the local populations of the area presented the ritual called Popoloca Ceremony.

Narratives discussed in the Working Groups include human dispersion into the continent and subsequent adaptations and social developments, such as adaptations to high altitude environments, the domestication of potatoes, maize and amaranth, the transformation of symbolic landscapes and the transformation of grassland use from megafauna to cattle ranching, time depth in living traditions and technological innovations. Other narratives discussed were human and megafaunal interactions

1 <http://whc.unesco.org/es/eventos/1077/>



and economic alternatives, plant and animal domestication and the transition from hunter-gatherers to agricultural or sedentary societies, as referenced in the last pages of the second volume of this publication.

These narratives were discussed within the contextual framework of the following criteria and concerns: current degrees of conservation, exceptional variety and chronological continuity, cultural and environmental record, and political and environmental risks necessitating international collaboration.

Among the sites discussed was Monte Verde in Chile, noted for its Outstanding Universal Value. Investigations of the site have contributed to insights into a growing body of knowledge based upon several of the aforementioned scientific narratives. The site embodies a huge temporal development, with dates as early as 14,500 years BP. The site also conveys a transcendent and significant quantity of biological, social and cultural processes related to human evolution. Technological advances are evidenced even by double-S-slip knotting. It has also been underlined the importance of the evidence of technological advances at Peru's Huaca Prieta, that includes unifaces dated 14,400 (calibrated) BP. Unifaces from Monte Verde date to 13,500-12,800 (calibrated) BP. This correlation potentially indicates dispersion patterns.

The Working Groups focused on conservation and addressed the need for enlarging sites to include the past and current use of biodiversity in surrounding areas, and also touched upon the subject of expanding conservation procedures to include local populations in the decision-making process. The idea of expanding conservation to include mobile heritage was also discussed, and it was suggested that a Technical Group be created that would look at designing a HEADS approved protocol for designing interpretive criteria for prehistoric sites, guidelines to display collections and delve deeper into the reflection on how to use criteria viii for the benefit of HEADS sites.

Discussions also considered the Mexican Tentative List for World Heritage Sites, and in particular, the case of Tehuacan/ Tehuacan-Cuicatlan Biosphere Reserve. It was suggested that the current model for the nomination process be updated to reflect the following aspects:

Suggestions in order to begin the nomination process of this site within the collaborative nature and framework of the HEADS Thematic Programme include eliciting a meeting between mayors and state governmental entities to generate dialogue as reflected in the participation of members from the SRE, SEMARNAT, CONANP, INAH and the Governor of the State of Puebla of the Presidium of the opening ceremony of the meeting.

It is acknowledged that the HEADS Thematic Programme may provide the knowledge, international experience and resources necessary for the generation of expert technical working committees in order to advance the nomination process. This publication could be used as a tool to provide the elements for the comparative study of sites.

## Results of Working Groups

### GROUP 1: The Americas (I)

The first Working Group's discussion on multidisciplinary Approaches of Colonisation and Dispersal was guided by Dr Robin Dennell. The participants who contributed to the dialogue were Dr Tom Dillehay, Dr James Chatters, Dr Dennis O'Rourke, Dr Nelson Fagundes, Dr Luis Alberto Borrero, Dr James Steele, Dr Eduardo Corona Martinez and Dr Joaquin Arroyo.

#### Main narratives for the Americas

- i. Archaeological studies (i.e. skeletal record)
- ii. Geoarchaeological processes
  - a. Caves
    1. Little Fish
    2. Bute
  - b. Rock shelters
    1. Pedra Fourada 2
  - c. Cenotes in Yucatan
- iii. Genetic-archaeological-geomorph-climatic studies (i.e. identifying landscape usage)



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- iv. Integration of genetic record of modern humans, aDNA and archaeological evidence
  - a. Modelling and reconstruction of past environments in relation to the timing of colonization, namely:
    1. Beringia
    2. Panamanian isthmus
    3. Brazilian rainforest
- v. Isotopic analysis
- vi. Palaeoecological research
  - a. Megafaunal/ human and megafaunal interaction



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#### Subsequent Adaptations

- i. Economic shift from sealing to whaling
  - a. Dorset to Thule (Arctic North America)
- ii. High altitude adaptation
  - a. In the archaeological sites of Peru and Bolivia
- iii. Movements across the Andes
- iv. Modifications of human biology
- v. The domestication of the potato
- vi. Transformation of grassland use by megafauna to cattle ranching as in the cases of Argentina.

#### Social Developments

- i. The evolutionary role of food storage
  - a. Population growth and domestication
    - i. North-west coast
- ii. Symbolic landscapes
  - a. Intercommunity development of public landscapes, geoglyphs
    - i. Pecos River area (USA)/ Coahuila, Nuevo León and Sonora in México.
- iii. Sedentism/villaje emergence, population aggregation
- iv. Evolutionary role of deferred or delayed return in economics
  - i. North-west Plateau
  - ii. Columbia/Fraser River
- v. Time depth of living traditions
  - i. Use of grasslands
  - ii. North-west coast
  - iii. Riverine environments
  - vi. Technological innovations
    - a. Clovis/Folsom
    - b. High altitude corrals (camelids)
    - c. Transition from coastal hunter-gatherers to sealing and to whaling

#### GROUP 2: The Americas (II)

The second Working Group's discussion guided by Dr Francois Sémah. Dr Mark Rohrig Hubbe, Dr Daniel Sandweiss, Dr Christopher Scarre, Dr Theodore Schurr, Dr Rafael Suárez Sainz, Dr Francisco Mena, Dr Augustin Holl, Dr Adriana Schmidt Dias, Dr Fernando Fernandez and Dr Guillermo de Anda Alanis participated.

#### Scientific Narratives related to specific sites:

- i. Human dispersion into the continent
  - a. South-east Alaska, USA
  - b. Monte Verde, Chile
  - c. Nacientes del Río Catalanes-Arapey, Uruguay
  - d. Channel Islands, California
  - e. Clovis Site, New Mexico, USA
  - f. Lagoa Santa, Brazil
  - g. Santa Elina, Brazil

- h. Quebrada Jaguay, Peru
- ii. Human/megafauna interactions and economic alternatives
  - a. Lagoa Santa, Brazil
  - b. Monte Verde, Chile
  - c. Las Breas de San Felipe, Cuba
  - d. Head Smashed In Buffalo kill sites (1981, vi)
  - e. Quebrada Jaguay, Peru
- iii. Plant/Animal domestication/ Transition from Hunter-Gatherers to Agricultural/ Sedentary Societies
  - a. Tehuacán, Mexico
  - b. Huaca Prieta, Peru
  - c. Telarmachay, Peru
  - d. Oaxaca Valley, Mexico
- iv. Adaptation to extreme environmental conditions
  - a. Pucuncho Valley, Peru
- v. Evidence of the rise of social complexity
  - a. Brazilian shell mounds
  - b. Huaca Prieta, Peru



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#### Criterion

- i. Exceptional Conservation
  - a. Monte Verde, Chile
  - b. Peruacu Valley, Brazil
  - c. Cenotes of Yucatan, Mexico
  - d. Lagoa Santa, Brazil
- ii. Exceptional Variety and Chronological Continuity
  - a. Huaca Prieta, Peru
  - b. South-east Alaska, USA
- iii. Cultural and Environmental Record
  - a. Pucuncho Basin, Peru
- iv. Necessity for international collaboration
- v. Environmentally and Developmentally Endangered

#### Some exceptional sites and regions were considered to shape some of the identified cultures:

- i. Pucuncho Basin, Peru
  1. Earliest high altitude site
  2. Significant palaeoclimatic and palaeoenvironmental records (glacial deposits, ice cores)
  3. Traditional but low density occupation (alpaca herders)—low threat
  4. Ongoing interdisciplinary research
  5. Obsidian: exploitation of key natural resources
  6. Linked to Puchuncho Basin by obsidian: Quebrada Jaguay
- ii. Lagoa Santa Region, Central Brazil
  1. Longest history of research
  2. Ongoing interdisciplinary research
  3. Early human collections
  4. Palaeontological quaternary knowledge in the Americas.
  5. Endangered by mining
  6. 1844: First suggestion of human coexistence/ interaction with megafauna
- iii. Uruguay Middle River Basin
  1. Transnational collaboration: Brazil, Uruguay, Argentina
- iv. Mexico, Oaxaca Valley
  1. Neolithic revolution
  2. Settlement type shifts
  3. Well-documented climate sequence
- v. Huaca Prieta, Peru
  1. Longest archaeological sequence

2. Important for the history of plant domestication/ agriculture
3. Fishing practices documented
4. Rise of social complexity (i.e. rituals)
- vi. Cave Sites (Early underwater cultural heritage), Yucatan Peninsula, Mexico
  1. Long human occupation 10/ 12 ky cal
  2. Exceptional preservation
  3. Human and palaeontological record
  4. Extreme environment
  5. Ecologically unique
  6. Potential for transcontinental collaboration
  7. Association with the contemporary Maya culture
  8. Palaeoclimatic changes
  9. International importance of reservoirs of fresh water
- vii. Las Breas de San Felipe, Cuba
  1. Latest megafauna in Americas (associated with archaeological remains)
  2. Geographical dispersions linking Yucatan and Mexico
  3. Insights into palaeoclimate in the Caribbean overlap.
- viii. Brazilian shell mounds (Sambaquis)
  1. Dates 8000-2000 PB (radiocarbon)
  2. Largest shell mounds on planet (over 900 recorded)
  3. The beginnings of ceramics
  4. Coastal development
- ix. South-east Alaska, USA (Tlingit, Haida, Eyak)
  1. Migration knowledge
  2. Living cultures present
  3. Riverine movement, oral histories
  4. Climatic and environmental research
  5. Transcontinental contact
- x. Catalanes Nacientes of Arapey Archaeological region (North Uruguay)
  1. Caves and rockshelter with early occupation (c. 10.000 BP)
  2. Stone structures (cairns and circles)
  3. Lithic resources – quarries and workshops of silicified sandstone, agates, opal and jasper.

### GROUP 3: Conservation

The third Working Group's discussions were guided by Dr Margherita Mussi. Its expert contributors were Dr Fred Smith, Dr José Concepción Jimenez, Ms Suzanne Villeneuve, Dr Brian Matthew Kemp, Dr Jorge Ríos Allier, Dr Marcia Chame, Dr Felisa Aguilar, Dr María de la Luz Gutierrez Martinez and Dr Pilar Luna Erreguerena.

The discussions covered the following subjects:

#### Framing data into policies

- i. Development of international interoperable database system to integrate movable and immovable heritage of the prehistoric sites.
- ii. Increased biodiversity in the surrounding area
  - a. Volcanic area (Tres Vírgenes Volcanic System, Baja California Sur), source of pigment/obsidian (symbolic, ritual and chronological importance), among others
- iii. Methodology to articulate cultural and natural heritage management for rock art sites:
  - a. Baja California Sur
  - b. Sierra de San Francisco, Mexico (already inscribed on the World Heritage List; 1993, (i)(iii))
  - c. Sierra de Guadalupe

#### International reflection on the integrated preservation of bones

- a. Promote deeper reflection on the Anthropocene, as discussed by scientist and reflect on the implications for the HEADS project.
- b. Procure guidelines that are \_\_\_ for genetic analysis



**Group 4: The Mexican Tentative List for World Heritage Sites: the case of Tehuacan/ Tehuacan-Cuicatlan Biosphere Reserve**

The fourth group's discussions were led Dr Nuria Sanz. Participating professionals were Dr Antonio Gilman, Dr Jose Francisco Ortiz Pedraza, Dr Juan Manuel Vicent, Ms Maria Pia Gallina, Mr Fernando Reyes Dlores and Ms Cecelia Hernandez.

**The Recommendations formulated to begin the process were:**

- i. To elicit a meeting with mayors and state governments to generate dialogue
  - a. Tehuacan, Coxcatlán, State of Puebla, State of Oaxaca
  - b. Secretary of SEMARNAT, commissioner CONANP
- ii. To carry out training of technical groups:
  - a. biological
  - b. cultural
- iii. To develop a detailed cultural and natural cartography of the site
- iv. Research should be focused on the archaeology of landscape and cultural occupation in the different stages of the establishment of cultures found in the Valley over 10,000 years
- v. To generate a detailed map using GIS technology including land use, erosion, the distribution of plant species in the soil, groundwater, land, etc.
- vi. To update the MacNeish studies with the implementation of new technologies.
- vii. The first site of the domestication of maize is known; but it is necessary to raise awareness of the importance of the genetic heritage of maize and its related cultural preservation.
- viii. A social development plan is necessary, including the implementation of standards of living according to the combines efforts of the local people to the traditional use of biodiversity.
- ix. To assist the relevant government bodies responsible for agrodiversity in the country, such as CONABIO and SAGARPA.

While this publication is going to press, the candidature of the site has been submitted to the World Heritage Centre for evaluation. We thank the Federal, State and Local Authorities for their commitment and engagement as proof of the outstanding value of this HEADS meeting on the Americas. No better conclusion could be achieved.









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Vers une inscription transnationale en série sur la Liste du patrimoine mondial  
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