

PALEODIET MEETS PALEOPATHOLOGY

USING SKELETICAL BIOGEOCHEMISTRY TO
LINK ANCIENT HEALTH, FOOD AND MOBILITY

Santiago de Compostela

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Paleodiet meets Paleopathology. Using Skeletal Biogeochemistry to link ancient health, food and mobility

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The workshop: genesis and aims

This workshop started in between Santiago de Compostela and Reading. We realized that the worlds of paleopathology and paleodiet have been quite long time walking together, but they were never officially introduced. We have the feeling that more and more research groups have started to be interested on the combination of these two topics, but...

How many people are exactly working on this issue nowadays? Are we able to create a synergy between these groups? Why do we have not worked together?

These questions had an easy solution, we needed to put together all these different people in the same room: we need to do a workshop!!! Paleodiet will definitely meet Paleopathology.

And what better place than Santiago de Compostela, the perfect place for all pilgrims along the world, where all the paths ends...

The objective of the workshop is to explore the connections between paleodiet and paleopathology, with special focus on the stable isotopes and bone chemistry applications. The studies of diet and disease in antiquity have always been important areas of research in bioarchaeology and physical anthropology.

With the advent of stable isotope applications more than 40 years ago, our ability to reconstruct the diet of individuals significantly improved; however, despite the fact that numerous diseases have a dietary component, only relatively few studies have combined bone chemistry with palaeopathological analysis. More recently, there has been a surge of interest in integrating the two approaches, not just to explore the synergies between diet and disease but also to understand the relationship between health and mobility and exposure to toxins (e.g. trace metals) and how to tell these effectively from post-mortem contamination.

This workshop will aim to take stock of recent advances and hopes to strengthen collaborations between different research groups on questions related to past diet and health and how these can be approached with bone chemistry applications. Discussions will include not only the differences between “diseased” and “healthy” individuals, but also, among others, which diseases are most suitably investigated by bone chemistry applications, how to deal with inter-population variation and intra-skeletal variability, and the role of environmental factors in disease ecology.

Olalla López-Costas and Gundula Müldner



Summary of attendees and contributions

Ninety one attendees have registered to the workshop. They represent 14 European (Belgium, Croatia, Estonia, Finland, Italy, Poland, Portugal, Serbia, Spain, Sweden and the United Kingdom) and non-European (Argentina, Canada, and Mexico) countries. Most attendees belong to the academia (27 universities) or work in research institutions (5 institutes) related to the fields of Anthropology, History and Archaeology. But Heritage Administration (2), private companies (4 Rescue Archaeology) and one association (1) are represented.

Six invited speakers summarize the state of the art of the research done on palaeodiet and palaeopathology during the last decades. Apart from them, 22 research cases are presented both in podium and poster sessions. These contributions highlight the applications of stable isotopes (C, N, O, S, Sr), aDNA, proteomics and elemental composition (major, minor and trace elements) research in the characterization of ancient human and animal tissues (bone, teeth, hair, etc.), which allows improving our understanding of the relationship between diet and human health in past populations. Indeed, the studies concern individuals/populations from prehistoric (Mesolithic, Neolithic, Bronze Age and Iron Age) and historic (Roman Empire, Middle Age and Modern Age) societies. Inter alia, these studies mostly involve different regions of Europe, but also Mexico and West Indies (Antigua). A paleodiet and paleopathology Ways Forwards will be discussed at the end to synthesize research lines and propose future investigation scenarios.



Map showing the origin regions of the workshop's attendees (Mohamed Traore).

Rede CONSILIENCIA

CONSILIENCIA is a network, funded by the Galician Autonomous Government (Xunta de Galicia, R2014/001), which brings together researchers from Archaeology, History, Social Sciences, Physical Anthropology, Earth Sciences and Information and Communication Technologies of the universities of Santiago de Compostela and A Coruña.

The aim of the network, following the words of E.O. Wilson in the homonymous book, is to develop a transdisciplinary approach to a unified understanding of our environment and the changes it underwent through time –with particular emphasis on transformations due to climate change and human activities.

The network is articulated into three basic lines:

1. Promotion of research actions, as microprojects in the areas of Geoarchaeology, **Palaeodiet** and Environment, Palaeoenvironmental Change and Palaeopollution, and Risks to Coastal Heritage.
2. Network activities: coordination meetings, thematic seminars, open workshops.
3. Dissemination activities: web dissemination, spreading of scientific techniques and results (videos, interactive electronic books, etc.), real time dissemination experiences, and analysis of audience behaviour.

The network also aims to establish strong links with professionals and enterprises/companies involved in the evaluation and preservation of the natural and cultural heritages.

En galego

Os días 15 e 16 de outubro terá lugar o workshop “**Paleodiet meets Paleopathology, using skeletal biochemistry to link ancient health, food and mobility**”, que se centra en explorar as distintas conexións entre a paleodieta e a paleopatoloxía, con especial interese na aplicación dos isótopos estables e a química dos osos. Os obxectivos destas xornadas céntranse en facer un balance dos avances recentes, fortalecer a colaboración dos distintos grupos de investigación sobre cuestións relacionadas coa paleodieta e enfermidade e como estas se poden abordar dende a química do oso. Durante os dous días que terá de duración, debatiremos distintos aspectos da paleodieta e paleopatoloxía como son as diferenzas entre “enfermos” e individuos “saludables”, a importancia das aplicacións químicas óseas para o estudo das enfermidades, como xestionar a variación inter-poboacional e a variabilidade intra-esquelética, e o papel dos factores ambientais na ecoloxía da enfermidade. As xornadas de exposición e presentación de comunicacións alternaranse con seis conferencias dirixidas por expertas de distintos países.

A primeira charal invitada estará a cargo de **Tamsin O’Connell**, da Universidade de Cambridge, quen dará unha visión xeral ao problema con especial énfase nas técnicas empregadas para o coñecemento da dieta no pasado. Despois falará **Julia Beaumont**, da Universidade de Bradford, á cal nos informará das súas investigacións sobre a dieta e as epidemias de fame, fertilidade e os banquetes. Para rematar o día deixaremos un espazo para aqueles que desexen aportar algún traballo ou idea ao workshop, en forma de comunicación oral.

O segundo día comezaremos as sesións con **Andrea Waters-Rist** da Universidade de Leiden, quen nos falará do crecemento infantil, á saúde e os hábitos de alimentación no pasado. A continuación, **Marie Louise Schjellerup Jørkov**, da Universidade de Copenhague, contaranos como era a saúde e a alimentación no período industrial (séculos XIX e XX) en Dinamarca. Despois do café teremos a sesión de pósteres para movernos algo antes de xantar.

Kerstin Lidén, da Universidade de Estocolmo, comezará a última sesión máis enfocada no ADN antigo. Antes do café, **Aurora Grandal d’Anglade**, da Universidade de A Coruña, ampliará o tema de debate introducindo os estudos en outros animais. Despois comezará o último espazo de tempo para presentacións orais antes de iniciar o debate final, que será coordinado por **Olalla López-Costas**, da Universidade de Santiago de Compostela, e **Gundula Müldner**, da Universidade de Reading (Reino Unido).

Este workshop desenvólvese dentro das actividades de divulgación da Rede Consiliencia “*Cambio ambiental e acción humana*” (R2014/001 Xunta de Galicia). Xunto coa Rede Consiliencia, este congreso está ao abeiro da Universidade de Santiago de Compostela e da Universidade da Coruña, sendo a cidade de Santiago (Facultade de Bioloxía) a que acolle dito evento durante este días.

Programme

15th October 2015

14:00–15:00 Registration desk opens (Aula Magna – Santiago Ramón y Cajal, Faculty of Biology)

15.00–15.15 Welcome to “Paleodiet meets Paleopathology”

15.15–16.00 Invited talk 1: Paleodiet and paleopathology: an overview

Elemental approaches to past human lives, combining the overview of paleodiet and paleopathology. T. O’Connell*

16.00–17.00 Invited talk 2: Diet and mortality crisis

Diet and mortality: Famine, feast and fertility. J. Beaumont*.

17.00– 17.30 Coffee break

17.30– 19.15 Podium presentation 1. Stable isotopes: human diet, mobility and pathology

17:30–17:45 **Productive strategies and consumption patterns in farms and villages of Early Medieval Spain: the palaeodietary evidence.** M. I. García-Collado

17:45–18:00 **Diet and infant weaning practices in multi-faith medieval Portugal.** A. Toso*, M. Alexander

18:00–18:15 **Investigating the transition from pre-monastic to monastic diet in a postmedieval population.** A. Higuero*, J. Beaumont

18:15–18:30 **The use of $\delta^{13}\text{C}$, $\delta^{15}\text{N}$ and $\delta^{34}\text{S}$ for the reconstruction of diet and migration at Boğazköy, Central Anatolia.** C. Caldeira*, C. Pickard, H. Üstündağ, A. Schachner, U-D. Schoop

18:30–18:45 **Health and society in Northern Mesoamerica; between foragers and agriculturalist in north-eastern Mexico.** J. E. Velasco González*; T. Silva Cárdenas, A. Meza Peñaloza; P. Morales Puente, I. Cassar Aldrete

18:45–19:00 **Ancient proteomics: the simultaneous detection of disease and diet in the archaeological record.** J. Hendy*, C. Speller, C. Warinner, M. Collins

19:00–19:15 **Diet, Mobility and Pathology: Past research and Future Bridges in Portugal.** C. Umbelino*, A. M. Silva, V. Matos



16th October 2015

08:45–08:55 Registration Desk Opens

09.00–10.00 Invited talk 3: Growth, metabolic conditions and stable isotopes

Stable Isotope Analysis of Diet in Past Populations: Delving into the Interplay of Dietary Choices, Growth Patterns, and Health Outcomes.

A. Waters–Rist

10.00–11.00 Invited talk 4: Diet, health and infectious diseases

Diet and health in 19th and 20th century Copenhagen. M. L. Schjellerup Jørkov.

11.00–11.30 Coffee break

11.30–12.30 Poster session

1. Paleodiet meets paleopathology. Is there a link between diet and diseases among individuals in the Early Medieval cemeteries from Lesser Poland?. A. Kubica–Grygiel*

2. Stable isotope analysis of a 17th-century Finnish mummy with DISH. T. Väre, M. Núñez*, O. López–Costas, N. Arosén, G. Eriksson, J–A. Junno, J. Niinimäki , S. Niinimäki, M. Niskanen

3. Exploring the relationship between isotopic composition, age and metabolic conditions in subadults from the Bronze Age population of Motilla del Azuer (Central Iberia). Z. Laffranchi, E. Sánchez Cañadillas*, S. Jiménez Brobeil, A. Delgado Huertas, A. Granados, T. Nájera Colino, F. Molina González.

4. Stable isotopes, diet and territoriality: a new interpretation. I. Sarasketa–Gartzia*

5. Exploring dietary and mobility patterns in medieval monastery of Las Gobas (Spain). I. Guede, L. A. Ortega, M. C.Zuluaga*, A. Alonso–Olazabal, X. Murelaga, J. L.Solaun, I. Sanchez, A. Azkarate

6. Good News for Bad Teeth: Paleodiet Through the Isotopic Analysis of Dental Calculus. C. Davenport*, S. Gonzalez, G. Richard Scott, S. R. Poulson, C. Burrell, E. Dove, I. Towle

7. Diet and social differentiation in medieval Muslim population from Tauste (Zaragoza, NE Spain): Chemical and isotopic evidences. I. Guede, L. A. Ortega*, M. C. Zuluaga, A. Alonso–Olazabal, X. Murelaga, J. Rodriguez Aller, M. Pina, F. J. Gutierrez.

8. Case study: Application of the clinical periodontal diagnostic method in an archaeological sample from a medieval context. S. Llidó Torrent *, F. Alpiste–Llueca, D.C. Salazar–García

9. Breastfeeding strategies and children's health status during Mesolithic–Neolithic. J. Jovanović, C. Becdelievre*, S. Stefanović, M. Le Roy, E. Herrscher, G. Goude.

12.30–15.00 Lunch

15.00–16.00 Invited talk 5: Ancient DNA and stable isotopes

The best of both worlds, when stable isotopes and aDNA meet in an archaeological context. K. Lidén.

16.00–17.00 Invited talk 6: New perspectives from the animal studies

Stable isotopes and DNA in Paleontology: beyond the family diet. A. Grandal d'Anglade.

17.00– 17.30 Coffee break

17.30– 18.30 Podium presentations 2. Trace elements, aDNA and stable isotopes to approach human and animal diet and pathology.

17:30–17:45 Fish-eating sheep at Lake Inari? Stable isotope analysis of animals offered at Sámi sacred sites in Finnish Lapland 1000–1800 AD. M. Núñez*, K. Lidén, G. Eriksson

17:45–18:00 Determination of bone lead in a Roman Period population of Granada (Spain). N. Lupiáñez-Corpas*, M. C. Martín-Domingo, F. Gil-Hernández.

18:00–18:15 New Rum, Old Poison: Lead Exposure and Rum Consumption from Human Remains at the Royal Naval Hospital Cemetery in Antigua, West Indies. D. Wilson*, A. Lieverse, T. Swanston, R. Murphy, I. Coulthard, D. Cooper, T. Varney

18:15–18:30 The Genetics of Leprosy in Medieval Europe. C. Economou

18.30 –19.30 Discussion

Paleodiet and paleopathology: Ways Forward.
G. Müldner and O. López-Costas.

* indicates who is going to present



Abstracts

INVITED TALK 1: Paleodiet and paleopathology: an overview

TITLE: Elemental approaches to past human lives” which will combine the overview of paleodiet and paleopathology

KEYNOTE SPEAKER: Tamsin O’Connell.

AFILIATION: Division of Archaeology University of Cambridge, UK.

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ABSTRACT:

In this talk, I will give an overview of both palaeodiet and palaeopathology, and discuss how these approaches can best be combined to address questions about past human lives, particularly considering issues of scale and resolution.

BIO:

Tamsin O’Connell is a chemist specializing in isotopic analysis for palaeodiet and palaeoclimate. She trained at the University of Oxford, and did her doctoral and postdoctoral research at the Research Laboratory for Archaeology and the History of Art with Prof Robert Hedges. Based at the Department of Archaeology at the University of Cambridge for the last decade, she has worked on all periods from the modern to the Palaeolithic, and on material from all seven continents of the globe. In her work, she has combined isotopic analyses with many other archaeological and archaeological science techniques, including palaeopathology.

A few publications relevant to Dr. O’Connell’s work are listed below:

O’Connell T.C., Kneale C.J., Tasevska N. and Kuhnle G.G.C. 2012. The diet–body offset in human nitrogen isotopic values: a controlled dietary study. *American Journal of Physical Anthropology*, 149(3), 426–434.

Lightfoot E., Šlaus M. and O’Connell T.C. 2012. Changing cultures, changing cuisines: Cultural transitions and dietary change in Iron Age, Roman, and early Medieval Croatia. *American Journal of Physical Anthropology*, 148(4), 543–556.

Crowe F., Sperduti A., O’Connell T.C., Craig O.E., Kirsanow K., Germoni P., Macchiarelli R., Garnsey P. and Bondioli L. 2010. Water–related occupations and diet in two Roman coastal communities (Italy, first to third century AD): Correlation between stable carbon and nitrogen isotope values and auricular exostosis prevalence. *American Journal of Physical Anthropology*, 142(3), 355–366.



INVITED TALK 2: Diet and mortality crisis

TITLE: **Diet and mortality: Famine, feast and fertility**

KEYNOTE SPEAKER: **Julia Beaumont**

AFILIATION: School of Archaeological Sciences, University of Bradford, UK

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ABSTRACT:

In recent years, the link between the *in-utero* environment, the first thousand days of life, and health in later life have become hot research topics. Known as the “developmental origins of adult disease hypothesis (DOHAD)”, studies have used a wide range of techniques, from historical records of birth weight linked to levels of heart disease and type-2 diabetes, through to investigations into the methylation of gene base pairs switching genes on and off (epigenetics).

The evidence is becoming compelling: the health outcomes of an adult are heavily affected by the health of the parents, the environment in which they live and the stresses (nutritional and psychosocial) in their environment. The diet of the mother is an integral part of this: low birthweight and stunting in children have both been strongly linked to the mother’s height (and thus her level of stunting during development), and low birth weight is correlated with obesity and cardiovascular disease in adult life. Infant mortality is also related to breastfeeding and weaning behaviour.

We know that women who are in a nutritionally-stressed state will fail to ovulate (and therefore not conceive), and that women who are pregnant during famine conditions will give birth to children whose development may vary depending on the trimester affected by the lack of maternal nutrition. It has also become apparent that women who are obese may have problems conceiving and that the presence of conditions such as gestational diabetes can result in high birthweight babies and affect the placental blood flow.

Recent developments in the analysis of teeth from archaeological juveniles have shown that short-term changes in diet and physiology can be identified and linked to the age of the individual at the time of formation. As some teeth, particularly deciduous, but also the first permanent molar, develop during pregnancy and early childhood, this has opened a window on the diet of children during the earliest days of life.

It has been established, using micro-CT scans of modern known-age deciduous teeth, the first 1/2mm of dentine forms before birth. Thus, new data from stable isotope analysis of human deciduous dentine collagen has the potential to investigate the diet and physiology of the mother during pregnancy.



Stable isotope ratios of dentine collagen taken from individual juveniles from archaeological populations which are known to have suffered nutritional stress have been compared to a small number of modern cases with known medical histories to investigate this hypothesis.

The high variability of values from dentine formed in utero suggests that these may be recording stress levels in mothers during pregnancy.

The analysis of exfoliated deciduous teeth may give a guide to the *in-utero* experience and hence the likely health effects in later life and need for health interventions. These can be applied to modern children, but also applied to archaeological populations to estimate the health of mothers in the past.

KEY WORDS: nutritional stress: stable isotopes: pre-natal dentine

BIO:

For 30 years Julia practised as a dentist with a special interest in orthodontics, and studied part-time at the University of Bradford achieving an MSc in Human Osteology and Palaeopathology, and a PhD in Archaeological Sciences under the supervision of Dr Janet Montgomery. Her area of interest is in the diet of children, specializing in improving the temporal resolution for isotopic analysis of dentine. Since her first appointment as a lecturer at Bradford in 2013, she has been focusing on the earliest periods of life by analysing deciduous teeth from both archaeological and modern children.

A few publications relevant to Dr. Beaumont's work are listed below:

Beaumont, J. & Montgomery, J. (2015) Oral histories: a simple method of assigning chronological age to isotopic values from human dentine collagen. *Annals of Human Biology*.

Beaumont J, Montgomery J, Buckberry J, and Jay M. 2015. Infant mortality and isotopic complexity: New approaches to stress, maternal health, and weaning. *American Journal of Physical Anthropology*.

Beaumont, J., Geber, J., Powers, N., Lee-Thorp, J. and Montgomery, J. 2013. Victims and Survivors: identifying survivors of the Great Famine in 19th century London using carbon and nitrogen isotope ratios. *American Journal of Physical Anthropology* 150(1): 87-98.

Beaumont J, and Montgomery J. 2013. Using stable isotope analysis to identify Irish migrants in the Catholic Mission of St Mary and St Michael, Whitechapel. Miles, A and Bowsher, D 'He being dead yet speaketh' Excavations at three post-medieval burial grounds in Tower Hamlets, East London, 2004-08, MOLA Monograph. London: MOLA.



PODIUM PRESENTATIONS 1.

Stable isotopes: human diet, mobility and pathology

TITLE: Productive strategies and consumption patterns in farms and villages of Early Medieval Spain: the palaeodietary evidence

AUTHOR: Maite Iris García-Collado*

AFILIATION: University of the Basque Country. Department of Geography, Prehistory and Archaeology

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ABSTRACT:

The objective of this presentation is to explore the similarities and differences in diet between the two main types of rural settlements defined for Early Medieval Iberian Peninsula (6th –8th centuries): farms and villages. This classification was originally based on the analysis of the internal organisation of the sites and their social complexity. In addition, it has been proposed these two types of settlements had different economic roles and followed distinct productive strategies. The study of fauna and archaeobotanical remains has already shed some light on this topic and palaeodietary analyses can also contribute to the debate. To do so two village (Gózquez and Boadilla, 68 individuals) and two farm populations (El Soto/El Encadenado and La Huelga, 20 individuals) from the central area of the Iberian Peninsula were analysed for stable carbon and nitrogen isotope composition of bone collagen through IRMS. Results point to diets based on mixed consumption of C3 and C4 plants combined with terrestrial protein sources regardless the type of settlement. $\delta^{13}\text{C}$ values were found surprisingly homogenous in all the four cases ($\delta^{13}\text{C}_{\text{villages}} = -18.6\text{‰} \pm 0.6$, $\delta^{13}\text{C}_{\text{farms}} = -18.8\text{‰} \pm 0.4$) but more variation was detected among $\delta^{15}\text{N}$ values ($\delta^{15}\text{N}_{\text{villages}} = 10.1\text{‰} \pm 1.0$, $\delta^{15}\text{N}_{\text{farms}} = 11.4\text{‰} \pm 1.3$). These figures reveal there were no substantial differences between the productive strategies and consumption patterns of villages and farms, especially regarding vegetal resources, as informed by $\delta^{13}\text{C}$. Further variation among ages, sexed and different types of burials and funerary deposits at the individual level will also be explored during the presentation.

KEY WORDS: Palaeodiet, Early Middle Ages, Visigothic Kingdom of Toledo, villages, farms

GRANT SPONSORSHIP: FPU PhD program (AP2010–5177), funded by the Spanish Ministry of Education, Culture and Sports; Research Group in Heritage and Cultural Landscapes (IT315–10), funded by the Government of the Basque Country; research project ‘Social inequality of Medieval landscapes in the north of the Iberian Peninsula: the archaeological markers’ (HUM2012–32514), funded by the Spanish Ministry of Economy and Competitiveness; ‘History, thought and material culture in Europe and the Atlantic world’ Education and Research Unit (UF111/02), funded by the University of the Basque Country.



TITLE: Diet and infant weaning practices in multi-faith medieval Portugal

AUTHORS: Alice Toso*, Michelle Alexander

AFILIATION: BioArCh, Department of Archaeology, University of York

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ABSTRACT:

The Iberian Peninsula, a crossroads between Africa and Europe and the Atlantic and Mediterranean, harboured one of the multi-faith societies in medieval Europe. Despite the attention given to this socially stratified and multicultural society in modern historiography, little is known on the everyday life of the Iberian population during the Middle Ages. Archaeology has proved to be particularly receptive in this regard, especially in Portugal, leading the revival of the Islamic studies during the last decades of the 21st century. However, at present just a handful of studies have applied stable isotopes to elucidate the dietary practices in medieval Spain, but none to Portugal. This research addresses this gap and explores debates on socio-religious change by applying stable isotope analysis of carbon ($d^{13}C$) and nitrogen ($d^{15}N$) to study the diets of contemporaneous Muslim and Christian communities. This paper presents isotopic data from the Islamic necropolis of Beja, south of Portugal, and São Jorge Castle, Lisbon. The exclusive burial site within Lisbon's castle suggests a high social status for this Islamic population, whose diet and weaning practice is compared to the urban population of Beja, where Christians and Muslims were interred in the same cemetery. Potential dietary variation due to cultural factors such as faith, sex, age and status is also explored. These results represent the first application of stable isotope analysis to study the diet of medieval populations from Portugal.

KEY WORDS: diet, isotope, weaning, Medieval, Portugal.

GRANT SPONSORSHIP: AHRC: White Rose College for Arts and Humanities – WRoCAH



TITLE: Investigating the transition from pre-monastic to monastic diet in a postmedieval population

AUTHORS: Antonio Higuero*¹, Julia Beaumont²

AFILIATIONS: ¹Autonomous University of Madrid, ²The University of Bradford.

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ABSTRACT:

The Christian monasteries played a very important role during the Medieval ages and people of different status entered into the various religious orders. In order to assess the origin and study the diet of the monks who lived in the monastery of San Millán de la Cogolla Yuso (La Rioja, N. Spain), collagen from small incrementally -forming sections of human dentine, and from rib bone was measured to establish the carbon and nitrogen isotope ratios. Here we present the results from ten individuals, providing information about dietary patterns through the childhood of the brethren, whilst the isotope ratios from rib collagen of each individual represent the diet of the inhabitants of the monastery during their last years of life. The isotope data indicate dietary differences between individuals before they became monks, and show changes in diet at the age of entry into the monastic order consistent with the known age of entry of children. This confirms the high status nature of the San Millán monastery, and the varied origins of the individuals who became monks at the site.

KEY WORDS: incremental dentine analysis, monastic diet, Spain.



TITLE: The use of $\delta^{13}\text{C}$, $\delta^{15}\text{N}$ and $\delta^{34}\text{S}$ for the reconstruction of diet and migration at Boğazköy, Central Anatolia

AUTHORS: Claudia Caldeira*, Catriona Pickard, Handan Üstündağ, Andreas Schachner, Ulf- Dietrich Schoop

AFILIATION: University of Edinburgh

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ABSTRACT:

The increased use of sulphur stable isotope analysis in archaeology for the study of paleodiets, migration and weaning patterns has offered a new insight into the life of ancient populations. However due to the relatively recent application in the field of archaeology, sulphur stable isotope analysis still produces many limitations, including the lack of means to accurately validate the wide range of $\delta^{34}\text{S}$ values presented in a number of publications (Craig et al., 2006 & 2010; Nehlich et al., 2010, 2011 & 2012; Privat et al., 2007).

This study compares $\delta^{13}\text{C}$, $\delta^{15}\text{N}$ and $\delta^{34}\text{S}$ results of 37 animals and 58 human samples from Boğazköy, Turkey. Consecutive excavations in this city unearthed a multi-period necropolis used during the Iron Age, Hellenistic, Roman and Late Roman periods. The bioarchaeological remains recovered from the site allow a rare glimpse on the lifestyle of Central Anatolian populations throughout several centuries.

Currently, the preliminary results show a lack of correlation between $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ against $\delta^{34}\text{S}$, which demonstrate the difficult interpretation of the results when applying $\delta^{34}\text{S}$ for dietary research. Regarding its application in population movement, and contrarily to initial expectations, Boğazköy revealed highly variable results. A preliminary conclusion suggests that the variation in $\delta^{34}\text{S}$ values is not directly related to diet, but it may be related to population mobility and/or the geological features of the region.

KEY WORDS: Stable isotopes, migration, paleodiet, sulphur



TITLE: Health and society in Northern Mesoamerica; Between foragers and agriculturalist in north-eastern Mexico

AUTHORS: Jesus E. Velasco González*¹; Tonantzin Silva Cárdenas¹, Abigail Meza Peñaloza²; Pedro Morales Puente³, Isabel Cassar Aldrete⁴

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ABSTRACT:

One of the most important aims in the analysis of human ancient remains, especially in relation to environment and culture, is the reconstruction of health and nutritional conditions. Human behaviour in combination with economic strategies, determine the overall organization of a specific society. This is seen, for example, when investigating the emergence of agriculture and its impact on health and nutrition. Osteological analyses (e.g. stress indicators and the type of protein source) maybe crucial to determine the degree of adaptation of human ancient groups. One such case is the interaction between foragers and agriculturalists in north-eastern Mexico, which occurred in different ways and reinforced the idea of a border with northern Mesoamerica. Paleopathological analysis, including dental disease, together with stable isotopes ($\delta^{13}\text{C}$, $\delta^{15}\text{N}$ and $\delta^{18}\text{O}$) enabled to assess the relationship between food and bio-cultural adaptations.

In this work, we present the results of the study of dental pathologies and the analysis of stable isotopes, used to reconstruct paleodiet, in 20 samples from skeletons recovered in La Sepultura cave (Sierra Madre Oriental, SW Tamaulipas). We aimed to address the development of mixed economies in populations from mountain areas and the coastal plain of the Gulf of Mexico during the, so-called, Formative Period in the Huasteca area. These populations are relevant for understanding the origin and spread of corn and its various routes in Mexico. Our data point to an economy based on the exploitation of CAM/C4 plants and, probably, lake resources by 3150 B.P.

KEY WORDS: dental paleopathology, stable isotopes, mixed economy, mobility, northern Mesoamerica

GRANT SPONSORSHIP: Universidad Nacional Autónoma de México; Instituto Nacional de Antropología e Historia



TITLE: Ancient proteomics: the simultaneous detection of disease and diet in the archaeological record

AUTHORS: Jessica Hendy*, Camilla Speller, Christina Warinner, Matthew Collins.

AFILIATION: University of York

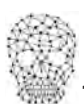
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ABSTRACT:

The study of proteins extracted from archaeological material is increasingly becoming a robust tool to answer a range of questions about the human past. Whilst the analysis of ancient proteins typically focusses on bone collagen (given its abundance in the archaeological record), in the last five years it has become possible to analyse archaeological materials of even greater molecular complexity due to the development of high-sensitivity protein sequencing technologies. In particular, biomolecular investigations into ancient dental plaque (dental calculus) are enabling a novel insight into dietary consumption and disease exposure of past individuals. This paper explores how these recent developments have increased the scope and potential of ancient proteins as a tool for disease and dietary characterisation. To demonstrate this scope, three case studies are discussed; (a) the identification of single, pathogenic bacteria among seven mummified individuals, (b) the characterisation of complex oral microbial communities, and (c) the detection of food consumption with high taxonomic clarity from ancient dental calculus. Sourced directly from the mouths of past individuals, the proteomic analysis of dental calculus enables palaeopathological and dietary information to be simultaneously accessed. Not only is this a robust and efficient tool for exploring disease and diet, this analysis is capable of identifying biological processes occurring in the past, which cannot be determined from genomic data alone.

KEY WORDS: Proteins, Dental calculus, Mass Spectrometry

GRANT SPONSORSHIP: EC Marie Curie ITN EUROTAST



TITLE: Diet, Mobility and Pathology: Past research and Future Bridges in Portugal

AUTHORS: Cláudia Umbelino*, Ana Maria Silva, Vítor Matos

AFILIATION: Research Centre for Anthropology and Health, Department of Life Sciences, University of Coimbra, Coimbra, Portugal

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ABSTRACT:

The Research Centre for Anthropology and Health, founded in 1994, aims to understand health, disease and well-being both in past and living societies from a biocultural perspective. The research group “Past Cultures and Populations” is dedicated to provide a large scale diachronic perspective of human health and disease in the Portuguese territory by analysing skeletal remains from different chronological and geographical contexts over the last 8000 years, from the final Mesolithic to the 20th century. In the last years we started using biochemical and biomolecular approaches, combined with standard bioarchaeological methods, in order to have a broader picture of past human communities. In this work we present the available results about paleodiet and mobility, using respectively C, N and Sr stable isotopes, health status, ancient DNA and paleopathological analyses performed on the Portuguese territory by our team. Carbon and nitrogen stable isotopes analysis were performed on eleven samples from the Muge shell middens dated from the Final Mesolithic, 9 samples from different sites belonging to the Final Neolithic/Chalcolithic and 16 samples from Torre Velha, dated from the 5/6th–12th AD. Strontium analysis was performed on 26 individuals for mobility assessment belonging to the Final Neolithic/Chalcolithic and to the 5/6th – 12th AD. Mitochondrial DNA analysis were performed on individuals dated between the Late Neolithic and Chalcolithic and exhumed from several burials from Perdigões Enclosure, Hipogeu of São Paulo and Dólmen de Ansião and from Torre Velha. Additionally, a skeleton presenting vertebral lesions compatible with tuberculosis from Castelo Branco, dated from 13/14th–19th AD, was analysed for the presence of mycobacterial DNA. Our future strategy includes to enlarge the sample for each chronological period and to integrate all the obtained results in a more regular basis, in particular the biochemical analysis with pathological evidences. Besides it is our aim to increase our external collaborations with other researchers and institutions.

KEY WORDS: Portugal, Paleodiets, Ancient DNA, Paleopathology

GRANT SPONSORSHIP: CIAS (UID/ANT/00283/2013). VM is sponsored by FCT – Fundação para a Ciência e Tecnologia (IF/00186/2014).



INVITED TALK 3: Growth, metabolic conditions and stable isotopes

TITLE: Stable Isotope Analysis of Diet in Past Populations: Delving into the Interplay of Dietary Choices, Growth Patterns, and Health Outcomes

KEYNOTE SPEAKER: Andrea L. Waters–Rist

AFILIATION: Faculty of Archaeology, Leiden University

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ABSTRACT:

Today, as in the past, our dietary choices have a major effect on our growth and health. Stable isotope analysis of bones and teeth from ancient humans allows for the reconstruction of many dietary variables, information which can then be linked to growth outcomes and certain diseases. Research into the effect that growth and disease may have on stable isotope values improves the accuracy with which we can deduce dietary behaviours.

Stable nitrogen isotope ratios ($\delta^{15}\text{N}$), used to reconstruct dietary protein, are altered during states of nitrogen imbalance, such as growth and pregnancy (positive nitrogen balance) and during weight loss due to inadequate protein intake or illness (negative nitrogen balance). Consuming a large amount of protein can also cause altered $\delta^{15}\text{N}$. A few studies have explored the extent to which these phenomena are manifested in bone and tooth dentine protein, and key findings are presented. Results suggest that the effect is minor, if not non-existent, such that our ability to reconstruct diet is not heavily compromised. Yet, key groups such as infants, for whom we reconstruct breastfeeding practices using $\delta^{15}\text{N}$, and populations that experienced regular dietary shortages, need study.

Stable oxygen isotope ratios ($\delta^{18}\text{O}$), used to reconstruct dietary water sources, and also as a source of breastfeeding and weaning data, may be affected by altered red blood cell haemoglobin fractionation such as occurs in the anemic conditions of sickle cell and thalassemia. In paleopathology the skeletal lesions porotic hyperostosis and cribra orbitalia are frequently diagnosed as having arisen from an anemic response, resulting from a variety of causes including an iron-deficient diet, parasitic infection, intestinal malabsorption, blood loss, malaria, and genetic mutations. In the genetic anemias, diseased red blood cells are chronically incapable of assimilating and transporting adequate levels of oxygen, disrupting numerous bodily systems and inducing compensatory and pathological responses. New research into the extent to which these responses alter $\delta^{18}\text{O}$, as measured in tooth enamel, is presented. A sample of purported genetic anemics had significantly lighter $\delta^{18}\text{O}$ values than a non-affected sample, however, further research is needed wherein it is possible to better separate out the effect of breastfeeding.



Over twenty–five years of paleodiet stable isotope research has shown us both the great potential of the method and the limitations of our interpretations. The effect of nitrogen balance and oxygen–disruptive metabolic conditions on stable isotope ratios in bone and teeth is garnering increased research attention, as we strive to refine our reconstructions and better understand the isotopic interplay of diet, growth and disease.

KEY WORDS: Stable Nitrogen Isotopes, Nitrogen Balance, Growth, Stable Oxygen Isotopes, Anemia

BIO:

Dr. Andrea Waters–Rist is an osteoarchaeologist specialized in the subfields of paleonutrition, stable isotopes, paleopathology, dental anthropology, and juvenile osteology. She did her MA and PhD degrees in the University of Calgary, Canada. Her research focuses on the interplay of health and diet, particularly in the context of breastfeeding and weaning practices of past populations. She worked on skeletal collections from many areas of the world, including Siberia, The Netherlands, Central America, and Canada.

A few publications relevant to Dr. Waters–Rist’s work are listed below:

Waters–Rist A.L., Faccia K., Lieverse A., Bazaliiskii V.I., Katzenberg M.A., Losey R.J. 2014. Multicomponent analyses of a hydatid cyst from an Early Neolithic hunter–fisher–gatherer from Lake Baikal, Siberia. *Journal of Archaeological Science* 50: 51–62.

Waters–Rist A.L., Hoogland M.L.P. 2013. Osteological evidence of short–limbed dwarfism in a nineteenth century Dutch family: Achondroplasia or hypochondroplasia. *International Journal of Paleopathology* 3(4): 243–256.

Waters–Rist A.L., Bazaliiskii V.I., Weber A., Katzenberg M.A. 2011. Infant and child diet in Neolithic hunter–fisher–gatherers from Cis–Baikal, Siberia: Intra–long bone stable nitrogen and carbon isotope ratios. *American Journal of Physical Anthropology* 146(2): 225–241.

Waters–Rist A.L., Katzenberg M.A. 2010. The effect of growth on stable nitrogen isotopic ratios in subadult bone collagen. *International Journal of Osteoarchaeology* 20: 172–191.



INVITED TALK 4: Diet, health and infectious diseases

TITLE: Diet and health in 19th and 20th century Copenhagen

KEYNOTE SPEAKER: Marie Louise S. Jørkov

AFILIATION: Copenhagen University

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ABSTRACT:

Diet and health in 19th and 20th century Copenhagen was investigated based on skeletal remains from the Assistens cemetery, Section G in Copenhagen, Denmark. Section G of the cemetery was excavated by the Museum of Copenhagen between 2009 and 2011 in connection to the establishment of a new Metro city line. Over the duration of ca. 175 years more than 1700 individuals were buried here. Section G belongs to the Trinitatis Parish which lies in the city center. It housed all social classes, but no paupers were buried at the Assistens cemetery.

Stable isotope analysis of carbon and nitrogen in bone collagen (n=170) and hair keratin (n=40) was carried out on adults and subadults. Here I present the isotopic results and interpret them in relation to the pathological conditions observed and the available historical records of health and diet during the Industrial Period. Diet was not correlated with age and there was no statistical evidence to support the association between diet (as indicated by the isotopes) and pathological chronic conditions. However, bone-hair analysis showed significant depletion in both nitrogen and carbon months prior to death, which in turn may be associated with disease (for some older adults possibly poor dental health). In some cases where there were no pathological indicators on the skeleton, some infants showed isotopic results that could be associated to nutritional stress and for adults dietary change because of illness.

KEY WORDS: Diet, Collagen, Keratin, Disease, Industrial Period

GRANT SPONSORSHIP: Danish Council for Independent Research Humanities grant no.10-094535.

BIO:

Marie Louise S. Jørkov is a physical anthropologist with expertise in isotopic analysis for palaeodiet, funerary archaeology and forensic anthropology. She has a BA in Classic Archaeology from Copenhagen University and Masters in Human Osteology and Palaeopathology from Bradford University. She did her doctoral and postdoctoral research at the Laboratory of Biological Anthropology, the Department of Forensic Medicine at the University of Copenhagen. In between her doctoral and postdoctoral research she has been a lecturer in Forensic Anthropology at Bournemouth University and head of the anthropological analyses conducted for the Museum of Copenhagen in connection to the establishment of a new Metro city.



In her career she has worked on skeletal remains from the Roman period up to modern times. She has been involved in archaeological excavations from South America to the Middle East and as forensic anthropologist she has been deployed by the Danish National Police and the Danish Foreign Ministry working on national and international assignments. In her latest research she focus on the Industrial period in Denmark where she combines palaeopathology and palaeodiet using stable isotope analysis.

A few publications relevant to Dr. Marie Louise's work are listed below:

Jørkov, Marie Louise S. 2015. Stature in 19th and early 20th century Copenhagen. A comparative study based on skeletal remains, *Economics & Human Biology*, Volume 19, Pages 13–26

Jørkov, Marie Louise Schjellerup; Jørgensen, Lars; Lynnerup, Niels. 2010. Uniform diet in a diverse society: Revealing new dietary evidence of the Danish Roman Iron Age based on stable isotope analysis. *American Journal of Physical Anthropology*, Vol. 143, No. 4, 12.2010, p. 523–533.

Jørkov, Marie Louise Schjellerup; Heinemeier, Jan; Lynnerup, Niels. 2009. The petrous bone: a new sampling site for identifying early dietary patterns in stable isotopic studies. *American Journal of Physical Anthropology*, Vol. 138, No. 2, p. 199–209.



POSTER PRESENTATIONS: paleodiet and paleopathology

TITLE: Paleodiet meets paleopathology. Is there a link between diet and diseases among individuals in the Early Medieval cemeteries from Lesser Poland?

AUTHOR: Anna Kubica-Grygiel*

AFILIATION: Institute of Archaeology, Jagiellonian University in Cracow, Poland.

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ABSTRACT:

Since its first applications a few decades ago stable isotope analysis gave us a tool to study human past populations in the wider context. Never before have studies of diet and diseases been more crucial in understanding the relationship between health and nutrition of individuals.

Many bioarchaeological studies have proved that health status changes gradually as urbanization intensifies, which is demonstrated through a greater prevalence of stress indicators and specific infectious diseases as well as the reduction of adult stature in the later period.

The aim of this study is to try to answer the question whether there is a link between diet and diseases in the Early Medieval burials from cemeteries in Lesser Poland. Most of the studied cemeteries were in use from the end of 10th century until the end of the early Middle Ages. The vast majority of them were discovered within or in the immediate vicinity of large strongholds belonging to the Piast period in Kraków and Wiślica.

The material consists of over 200 hundred samples isotopically analysed from a few flat cemeteries in the south-eastern Poland. Biomolecular analyses (carbon and nitrogen isotopes) used for diet reconstruction are combined with the anthropological study of human remains in order to reconstruct general health status of individuals. In assessing health and lifestyle of past populations, dental remains are especially important, because they display evidence of physiological stress (enamel hypoplasias) and diet. Among analysed individuals most frequent dental pathological conditions are: dental caries, antemortem tooth loss, dental wear, plaque and hypoplasia.

Preliminary results suggest that in most cases there is no direct connection between presence of pathological conditions and diet among the analysed individuals.

KEY WORDS: carbon and nitrogen stable isotopes, oral pathology, Middle Ages, Lesser Poland

GRANT SPONSORSHIP: Ministry of Science and Higher Education in Poland



TITLE: Stable isotope analysis of a 17th-century Finnish mummy with DISH.

AUTHORS: T.Väre¹, M. Núñez*¹, O. López-Costas^{2,3}, N. Arosén³, G. Eriksson³, J-A. Junno¹, J. Niinimäki¹, S. Niinimäki¹, M. Niskanen¹

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ABSTRACT:

During the 17th and 18th centuries it was fashionable for northern Finland's upper classes to deposit their dead under the floor of churches, where the cold ventilated environments often led to mummification through natural freeze-drying processes. Most famous among the mummified remains beneath the churches is undoubtedly the fairly-well preserved body of Vicar Nikolaus Rungius (1560–1629) from Keminmaa Parish.

In the mid-1990s, Oulu University archaeologists made an inventory of the mummified remains beneath the churches of Keminmaa, Haukipudas and Kempele and, after much negotiation, we were allowed to CT-scan Vicar Rungius' body in 2011 and to take minute superficial samples from Rungius and a few other mummies in 2014. The scan showed that the 69-year-old Vicar had suffered from several ailments of varying severity, mainly associated with his relatively advanced age. Among the pathologies revealed by the CT-scan was a well-developed DISH (Diffuse Idiopathic Skeletal Hyperostosis). This condition is often associated with diabetes, obesity and protein/fat-rich diets, which have been linked with the prevalence of DISH in the excavated skeletal material of some monasteries. It is obvious from Rungius' mummy that the Vicar was overweight. Moreover, with a $\delta^{15}\text{N}$ of 14.6‰, Rungius clearly has a higher value than the other mummified individuals and roughly contemporaneous populations in the region. In fact, Rungius' $\delta^{15}\text{N}$ level falls within the lower range of North Baltic seals (13–19‰), which are at the top of the local food chain. Rungius' isotopic results have also been compared with other skeletal remains with DISH.

KEY WORDS: DISH, mummified remains, northern Finland, stable isotopes

GRANT SPONSORSHIP :The Finnish Academy



TITLE: Exploring the relationship between isotopic composition, age and metabolic conditions in subadults from the Bronze Age population of Motilla del Azuer (Central Iberia).

AUTHORS: Zita Laffranchi¹, Elías Sánchez Cañadillas^{*2}, Sylvia Jiménez Brobeil¹, Antonio Delgado Huertas³, Arsenio Granados³, Trinidad Nájera Colino², Fernando Molina González².

AFILIATIONS: ¹Laboratorio de Antropología, Departamento de Medicina Legal, Toxicología y Antropología Física, Facultad de Medicina, Universidad de Granada. ²Departamento de Prehistoria y Arqueología, Facultad de Filosofía y Letras, Campus de Cartuja S/N, Universidad de Granada ³Laboratorio de Biogeoquímica de Isótopos Estables, Instituto Andaluz de Ciencias de la Tierra IACT (CSIC–UGR) Granada.

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ABSTRACT:

We investigate the relationship between $\delta^{15}\text{N}_{\text{coll}}$ ‰ (AIR) and $\delta^{18}\text{O}_p$ ‰ values, and metabolic conditions (i.e. enamel hypoplasia, *cribra orbitalia* and growth delay) in a selected sample of subadults from the Bronze Age site (2200–1350 BC) of La Motilla del Azuer (Daimiel–Ciudad Real).

Our aims were i) to determine the presence of differences in isotopic composition related to age, ii) to explore the connections between paleopathological and isotopic data and iii) to reconstruct the weaning stage by considering health status.

The sample is represented by 15 individuals: 10 with an estimated age of 0–6 years old (*Infans I*) and 5 of 7–12 years old (*Infans II*). An adult female sample of 6 individuals was also included for comparative purposes. The isotopic analyses were performed following the routine procedures of the Stable Isotope Biogeochemistry Laboratory of the IACT–CSIC (Granada).

Average $\delta^{15}\text{N}_{\text{coll}}$ ‰ (AIR) and $\delta^{18}\text{O}_p$ ‰ (V–SMOW) values of the *Infans I* group are higher than those of *Infans II*; even though differences between groups were not significant ($t=1.78$, $P=0.10$ and $t=1.54$, $P=0.15$, respectively). The first group shows an enrichment in $\delta^{15}\text{N}_{\text{coll}}$ (0.64‰ to 2.55‰) and in $\delta^{18}\text{O}_p$ (0.23‰ to 2.13‰) with respect to the adult females.

We did not find any significant differences between the presence/absence of a given metabolic condition, with the exception of growth delay. The group with growth delay showed more negative $\delta^{18}\text{O}_p$ ‰ values ($t=-2.32$, $P=0.04$). Finally, it is likely that the possible weaning falls in the age interval between 2 and 4 years old.

KEY WORDS: stable isotopes; weaning; subadults; Motilla del Azuer; Bronze Age.



TITLE: Stable isotopes, diet and territoriality: a new interpretation

AUTHOR: Izaskun Sarasketa–Gartzia*

AFILIATION: Geography, Prehistory and Archaeology Department, University of the Basque Country

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ABSTRACT:

Stable isotopes, diet and territoriality: a new interpretation Investigations carried out before the decade of 1980 analyzed food habits, mainly, from faunal remains. However, these examinations started from a basis in which the remains of fish, birds or vegetables, often appeared under-represented in relation to the remains of ungulates. From the mentioned decade on, new lines of research were proposed, which provide us data on the reconstruction of the paleodiets, such as the analysis of stable isotopes of $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$.

The main aims of this work are: (1) to present, on the one hand, a compilation of all the stable isotopes results obtained until now from deposits of Mesolithic chronology in the Western Pyrenees (n=13). Additionally, (2) we use the paleodietary information in relation to several social aspects to approach how the resources were exploited in the Mesolithic. Specifically, we test the hypothesis suggested by some authors including P. Arias (1997) about a differential access to marine resources, which were apparently intensively consumed during this period (Sarasketa–Gartzia, 2015).

The results of these analyses distinguish two groups in the base of the diet: (1) individuals with a diet based on marine resources (J3, Colomba and La Poza l'Egua) and (2) individuals with a terrestrial diet (Los Canes).

Following this interpretative line, we show the possibility of using the results of stable isotopes as tool to learn, not just diet, but also mobility patterns. However, the preliminary conclusion of this work is that there are not enough data to confirm the existence of the first territorial patterns. Because of that, it becomes essential to analyze other deposits with the same geographical characteristics to let us know if the territoriality began in this chronology.

KEY WORDS: Isotopes, paleodiet, territorial mobility, Mesolithic, Western Pyrenees.

GRANT SPONSORSHIP : PhD fellow from the Basque Government.



TITLE: Exploring dietary and mobility patterns in medieval monastery of Las Gobas (Spain)

AUTHORS: I. Guede, L.A. Ortega, M.C. Zuluaga*, A. Alonso-Olazabal, X. Murelaga, J.L. Solaun, I. Sánchez, A. Azkarate

AFILIATION: The University of the Basque Country-UPV/EHU. Mineralogy and Petrology Department. Science and Technology Faculty

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ABSTRACT:

The archaeological site of Las Gobas (Burgos, Spain) is a settlement associated with the medieval monastery of same name. The aim of the study is to investigate mobility and dietary patterns among the inhabitants of Las Gobas based on the analysis of strontium and the stable isotopes of carbon and nitrogen. A total of 40 individuals (19 adults, 21 subadults) were analyzed dated from 6th to 11–12th centuries AD. The results indicate a very complex society at Las Gobas where one third of the individuals were of non-local origin. Most of the non-local individuals were young females whereas the non-local men were adults. In the early centuries, the occupation of the site corresponds to the monastery and individuals are mainly local men. The second period corresponds to the establishment of a village associated with the monastery. Most of men are local and the women are foreign and mainly young women. The immigration zones of the non-local individuals cannot be establish with certainty, but the distribution of ⁸⁷Sr/⁸⁶Sr isotope values indicates at two different geographic areas. Women average $\delta^{15}\text{N}$ is lower than that of men but the difference between their mean values is not statistically significant ($p = 0.071$). Nitrogen isotopes show significant differences ($p < 0.01$) in the diet between subadults and adults that can be related to the breastfeeding signal. The stable food was terrestrial, and the majority consisted of plant-based foods. Males, however, consumed a larger proportion of animal protein in their diet. Millet consumption (C_4 plant) was dominating in the 6th –9th centuries, while wheat and barley (C_3 plant) took over in the 10th –11th centuries.

KEY WORDS: Strontium isotopes, C and N isotopes, migration, diet



TITLE: Good News for Bad Teeth: Paleodiet Through the Isotopic Analysis of Dental Calculus

AUTHORS: Carole Davenport*¹, Silvia Gonzalez¹, G. Richard Scott², Simon R. Poulson³, Carla Burrell¹, Eleanor Dove¹, Ian Towle¹.

AFILIATIONS: ¹Research Centre in Evolutionary Anthropology and Palaeoecology, Liverpool John Moores University; ²Department of Anthropology/MS-096, University of Nevada Reno; ³Department of Geological Sciences and Engineering/MS-172, University of Nevada Reno

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ABSTRACT:

When assessing bioarchaeological remains for paleodietary analysis, there is often concern regarding the processes used to attain results. Until recently, destructive sampling to obtain collagen has been the primary option to understand the impact of diet on the biochemical components of the human skeleton. As a potential alternative, researchers have discovered that dental calculus has sufficient carbon and nitrogen to provide estimates of stable isotope compositions largely consistent with those derived from conventional biomaterials.

To further test dental calculus as a non-destructive proxy for paleodietary analysis, fifty-nine dental calculus samples obtained from two medieval sites in the United Kingdom were tested for stable carbon and nitrogen isotope compositions. A rural sample from Poulton, Chester (n=28), an agricultural village close to the England-Wales border and an urban sample from St Owen's Church, Gloucester (n=31), a medieval port in southwest England were assessed.

Stable isotope results show a significantly higher nitrogen value for the samples from Gloucester (p= 0.006), suggesting slightly higher protein intake than in the rural sample. There was no significant difference in stable carbon values between the two sites, with both yielding $\delta^{13}\text{C}$ values around -21‰, consistent with a diet focused on C₃ plants. This study shows that calculus, as a secondary biomaterial, should be considered as a potential alternative for paleodietary analysis when it is not possible to carry out destructive testing. Comparison with the pathological analyses for each site suggests that differences in food intake could impact health, producing differing disease prevalence rates and profiles.

KEY WORDS: non-destructive, dental calculus, carbon and nitrogen stable isotopes, paleopathology, paleodiet

GRANT SPONSORSHIP: This project has been funded in part by a National Science Foundation grant for 'Testing Stable Isotopes of Human Dental Calculus as a Non-destructive Proxy for paleodiet' (NSF PLR-1335302).



TITLE: Diet and social differentiation in medieval Muslim population from Tauste (Zaragoza, NE Spain): Chemical and isotopic evidences.

AUTHORS : I. Guede, L.A. Ortega*, M.C. Zuluaga, A. Alonso-Olazabal, X. Murelaga, J. Rodríguez Aller, M. Pina, F.J. Gutiérrez.

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ABSTRACT:

Carbon and nitrogen isotope of bone collagen, strontium isotope of teeth enamel and trace element composition of dentin and teeth enamel has been studied. 18 male, 12 female and 10 individuals with indeterminate-sex from the medieval Muslim necropolis of Tauste has been analysed. Low contents of rare earth in enamel and dentin indicate the virtual absence of diagenesis. Similar values of $^{87}\text{Sr}/^{86}\text{Sr}$ isotope ratio in enamel teeth indicates local provenance for all of individual. The $\delta^{15}\text{N}$ enrichment (mean values +15.0‰) is related more to environmental, both geological and climatic, conditions than to dietary patterns such as freshwater fish consumption. Differences in chemical (Sr, Ba, Cu, Zn, Mg, Li) and isotope (C and N) composition are observed with respect to age and sex of individuals. The results indicate adult men had a diet rich in animal protein diet comparing to women and young men. Such differences in diet provide valuable information about the social structure of the medieval Muslim society of Tauste.

KEY WORDS: bone collagen, teeth, LA-ICP-MS, trace elements, carbon, nitrogen and strontium isotopes.



TITLE: Case study: Application of the clinical periodontal diagnostic method in an archaeological sample from a medieval context.

AUTHORS: S. Llidó Torrent* ^{1,2} F. Alpiste-Llueca ¹, D.C. Salazar-García ^{3,4,5}

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ABSTRACT:

The aim of this study is to apply the methodology used in dental clinical diagnosis to archaeological remains. This methodology is based on the periodontal status of the individual: general diagnosis, each specific tooth's situation and its individual diagnosis. It detects, evaluates and classifies the periodontitis morphopathologies by describing the damage produced on bone tissue, its location, extension and degree of affectation. Establish the prevalence, severity of periodontal disease and analyze the correlation with nutritional factors such as diet, can also help us understand the specific circumstances surrounding human communities in the past. From the standpoint of nutrition and health status of individuals, our study may account for the profound economic and cultural changes.

We present here the study of skeletal remains of Medieval chronology (12th–14th centuries) found during rescue excavations in the city of Novelda (Valencian Country) carried out between 1999 and 2000. The sample consists of 6 adult individuals (3 females and 3 males), from which a total of 67 upper dental pieces, 68 maxillary alveoli, 76 lower dental pieces and 78 mandibular alveoli have been studied. The American Academy of Periodontology (1999) classification has been used for describing periodontal disease.

Our results show that the application of the clinical diagnostic method, assessing damage both quantitatively and qualitatively, provides a more accurate information of the disease. It also helps in studying the disease in case of *postmortem* tooth loss, something usual when dealing with material from archaeological and forensic contexts.

KEY WORDS: Paleodontology, Periodontal disease, alveolar bone loss, diagnostic method, dry skull



TITLE: Breastfeeding strategies and children's health status during Mesolithic–Neolithic

AUTHORS: Jelena Jovanović¹, Camille de Becdelievre*¹, Sofija Stefanović¹, Mélie Le Roy², Estelle Herrscher³, Gwenaëlle Goude³

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ABSTRACT:

The Neolithic transition, the passage from mobile foraging to sedentary farming, was a major shift during human prehistory. This change significantly influenced human biology and led to an increase of “stress”, defined as a series of interconnected pathological conditions related to the changes in nutrition and subsistence strategies. Mesolithic–Neolithic populations simultaneously experienced a major increase in female fertility and infant mortality. The Danube Gorges Mesolithic–Neolithic sites (ca. 9500–5500 BC, Balkans) offer a unique osteological sample including well preserved skeletons of children discovered in a specific archaeological context.

In this work, we intend to understand the relationship between new agricultural children feeding practices and human biology. In order to do that, we analyzed nine Mesolithic children and eight Early Neolithic children from the inner Danube Gorges, compared with eight Early Neolithic children from a site located downstream, at the exit of the Danube Gorges ($\delta^{15}\text{N}_{\text{coll}}$, $\delta^{13}\text{C}_{\text{coll}}$, and $\delta^{34}\text{S}_{\text{coll}}$). Isotopic data was complemented with macroscopical observations on porotic hyperostosis, cribra orbitalia, teeth wear, dental caries and calculus, presence and timing of linear enamel hypoplasia. Stable isotope results suggest important differences in term of infant feeding strategies between Mesolithic foragers living within the Gorges and the Neolithic community settled downstream. Interestingly indicators of biological stress, dental caries and calculus also discriminate children from these two populations. These bio–cultural differences may have contributed to the important demographic changes documented at the Mesolithic–Neolithic transition.

KEY WORDS: Mesolithic–Neolithic Transition, Danube Gorges, stable isotope analysis, weaning practices, health status



INVITED TALK 5: Ancient DNA and stable isotopes.

TITLE: The best of both worlds, when stable isotopes and aDNA meet in an archaeological context

KEYNOTE SPEAKER: Kerstin Lidén

AFILIATION: Archaeological Research Laboratory, Stockholm University

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ABSTRACT:

In this presentation I will discuss the research possibilities with a joint stable isotope and aDNA analyses approach to dietary and paleopathological studies. I will also discuss why it is so important to integrate these analyses in a properly defined archaeological context, and why it is important to also take into account antiquarian aspects when doing these analyses. Finally I will provide some examples and discuss the possibilities for a future integrated, interdisciplinary research.

BIO:

Kerstin Lidén is Professor in Archaeometry at Stockholm University and head of the Department of Archaeology and Classical Studies. Presently she is also acting as Professor II at Tromsø University in Norway. She is member of the Royal Swedish Academy and the Humanities Committee of Science Europe.

Prof. Kerstin has published more than 100 scientific articles and her research focus is on food and food culture, studied by means of stable isotopes. She started working with stable isotopes in Archaeology during her PhD thesis, which has been published in 1995 under the supervision of Professor Birgit Arrhenius. She also works on the application of aDNA analysis addressing archaeological questions concerning descent and diseases.

In her quest on interdisciplinary work she tries to combine different methods answering major archaeological questions concerning diet, mobility and cultural evolution.

A few relevant publications of Prof. Lidén's work are listed below:

Gunilla Eriksson and Kerstin Lidén. 2014. Dietary life histories in Stone Age Northern Europe. *Journal of Anthropological Archaeology* 32 (3):288–302.

Christos Economou, Anna Kjellström, Kerstin Lidén, Ioannis Panagopoulos. 2013. Ancient-DNA reveals an Asian type of *Mycobacterium leprae* in medieval Scandinavia. *Journal of Archaeological Science* 40 (1):465–470.

Anna Linderholm, Charlotte Hedenstierna. Olle Svensk and Kerstin Lidén. 2008. Diet and status in Birka: stable isotopes and grave goods compared. *Antiquity* 82 (316): 446–461.



Kerstin Lidén, Gunilla Eriksson, Bengt Nordqvist, Anders Götherström and Erik Bendixen. 2004. The wet and the wild followed by the dry and the tame” – or did they occur at the same time? Diet in Mesolithic – Neolithic southern Sweden. *Antiquity* 78 (299): 23–33



INVITED TALK 6: New perspectives from the animal studies.

TITLE: Stable isotopes and DNA in Paleontology: beyond the family diet

KEYNOTE SPEAKER: Aurora Grandal d'Anglade

AFILIATION: Instituto Universitario de Xeoloxía, Universidade da Coruña

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ABSTRACT:

Studies of stable isotopes in bone collagen of fossil mammals provide data on their position in the food chain, but also reflect the environmental conditions in which the animals lived, recording variations in climate over time and space. The climate can influence the isotopic signals in two ways; either through variations that occur in the isotopic baseline of the ecosystem, either through its influence in the physiology of the animal species.

Thus the values of the isotopic signature of nitrogen in bone collagen not only depend on the position of the animal in the food chain, but can also vary depending on the greater or lesser microbial activity in soils and plants at the base of the food web. Microbial activity is determined by the climate and has a strong geographical component that is reflected in a latitudinal and altitudinal gradient, and also over time, if we compare individuals of different chronology.

The carbon isotopic signature also depends on the food consumed. From the base of the food chain, plants discriminate against the heavier carbon isotope differently depending on their physiology (plants C3, C4 or CAM), but also depending on the altitude, the degree of tree cover, the insolation, etc., so that the isotopic signatures recorded in bone collagen also vary depending on the location and climate in which the animal lived.

Using as an example the isotopic signatures of one of the most abundant mammals in Pleistocene sites throughout Europe, the cave bear, and various ungulates, we will observe differences related to the geographical location and climate fluctuations, both at a continental or regional scale, or even locally.

Moreover, the cave bear is a good example of how fluctuations in climate influence the physiology of the animals. Hibernation is a mechanism to overcome the less favourable months of the year that the bear perform at the expense of stored fat and reuse of urea nitrogen, which is not excreted. Thus, especially long hibernations produce particular isotopic signatures that do not directly reflect the animal's diet.

Thus we see that the single isotopic signature of an animal may not strictly record a certain trophic level. Environmental parameters have a direct influence on the isotopic values. And we must bear in mind that in some

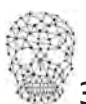


cases the animals move from one area to another, or change their diet throughout their life, or may suffer diseases... so their different tissues can record different conditions.

There is another important implication of the influence of environmental parameters on the isotopic signatures of animals and plants. The human diet is based on a combination of foods of animal and vegetable origin. Therefore in a study of human paleodiet is important to consider the isotope baseline recorded in the fossils (usually animal bones) and interpret their isotopic values taking into account those environmental parameters, at least those that can be reconstructed in the present.

KEY WORDS: stable isotopes, fauna, paleodiet, environmental parameters, physiology

GRANT SPONSORSHIP: Project "Rede Consiliencia" (R2014/001)



PODIUM PRESENTATIONS 2: Trace elements, aDNA and stable isotopes to approach human and animal diet and pathology.

TITLE: Fish-eating sheep at Lake Inari? Stable isotope analysis of animals offered at Sámi sacred sites in Finnish Lapland 1000–1800 AD

AUTHORS: Milton Núñez*¹, Kerstin Lidén², Gunilla Eriksson²

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ABSTRACT:

During 2006–2011 Oulu University researchers in collaboration with the Sámi community investigated several ancient Sámi sacred sites. These *siedi*, as the Sámi call them, were regarded as the abode of deities and powerful spirits, which were propitiated with periodical offerings of animals, coins and other valuables. Excavation produced numerous animal bones, which are the subject of this paper. Forty-two AMS dates placed the offering activities between the 11th and 19th century AD. The remains were dominated by tame/wild reindeer with the occurrence of some wild game (mammals, birds, fish). An interesting exception was observed at two *siedi* on two small islands in southwestern Lake Inari, which yielded a significant amount of sheep bones. AMS dates indicate that sheep were being offered at these two Inari *siedi* by 1400 AD. The stable isotope ratios of the bones from all the studied sites agree with what one would expect from the various species involved, but once again the sheep from Inari make an exception. The $\delta^{15}\text{N}$ values of the 21 analysed adult sheep from Inari are clearly higher than those of other herbivores, and in some cases they reach and even exceed those of predators like bear and pike. This would suggest that the Inari sheep diet contained a certain amount of animal protein, and a search into ethnohistorical records indicates that sheep were commonly fed a fish soup/gruel as winter fodder in 19th-century Finnish Lapland. A likely explanation for the high $\delta^{15}\text{N}$ is that the Sámi were already doing so centuries earlier.

KEY WORDS: Fish-fed sheep, Sámi sacred sites, Finnish Lapland, stable isotopes

GRANT SPONSORSHIP: The Finnish Academy



TITLE: Determination of bone lead in a Roman Period population of Granada (Spain).

AUTHORS: N. Lupiáñez-Corpas*, MC. Martín-Domingo, F. Gil-Hernández

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ABSTRACT:

Bone is considered a dynamic tissue since it undergoes a lifelong remodelling process, with new bone added even after the cessation of growth. This process can result in the accumulation of metals and trace elements, such as lead, in bone. Lead has been used since 4th millennium BC, with a peak in usage in the Roman Age. Lead and calcium have a parallel metabolism, therefore bone tissue is where lead is principally stored. This fact allows bone to be used to determine the level of this toxin. The concentration of lead in bone reflects its prolonged exposure. Thus, bone is considered an appropriate tissue to study chronic exposure to lead. In the present study, we determined the lead levels of 21 individuals using rib samples from archaeological remains belonging to the Roman Period coming from an archaeological excavation which took place in 2011 in Granada (Spain). Lead level was determined by graphite furnace atomic absorption spectrometry. Owing to the cumulative nature of lead, subjects' age was used as an analytical variable. Thus, two groups were established: Group 1 (<40 years) and Group 2 (>40 years). Group 2 showed a higher lead level, which was expected, however there was no statistically significant difference between the two groups. This is due to the fact that the sample size is small and the difference between the number of samples of each group (Group 1: 5; Group 2: 6), a matter arising from the study of archaeological remains.

KEY WORDS: archaeological human remains, biomonitorization, bone, lead, Roman Period.



TITLE: New Rum, Old Poison: Lead Exposure and Rum Consumption from Human Remains at the Royal Naval Hospital Cemetery in Antigua, West Indies

AUTHORS: Danee Wilson*¹, Angela Lieverse¹, Treena Swanston¹, Reg Murphy², Ian Coulthard³, David Cooper⁴, Tamara Varney⁵

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ABSTRACT:

Lead has been known to be toxic to humans since Roman times, yet its use has fluctuated greatly through the centuries. Historical literature has proposed that new rum (the first distillate of rum production), was the main culprit behind the prevalence of lead poisoning in the colonial West Indies. A sample of 24 individuals recovered from the Royal Naval Hospital Cemetery (RNHC) were studied to examine the relationship between diet and lead exposure. This non-segregated cemetery, containing the remains of individuals of both African and European descent, was in use from A.D. 1793–1822. One of the objectives of this research was to determine if a relationship could be discerned between consumption of rum and increased exposure to lead via analysis of stable carbon isotopes and bone lead levels. It was initially hypothesized that rum, a C₄ plant product and part of the daily naval rations, might be detectable in $\delta^{13}\text{C}_{\text{apatite}}$ values and associated with cumulative lead exposure. However, the strongest correlation between stable isotope signatures and bone lead levels was found between $\delta^{13}\text{C}_{\text{collagen}}$ and lead, primarily for those of European ancestry. These findings revealed that there was no straightforward association between $\delta^{13}\text{C}_{\text{apatite}}$ values and bone lead, and that multiple variables, including ancestry, diet, and exposure to lead through means other than rum, were likely to have had an effect on the strength of the relationship between diet and lead.

KEY WORDS: Lead, Stable Isotopes, Navy, Antigua

GRANT SPONSORSHIP: Social Sciences and Humanities Research Council (SSHRC) of Canada



TITLE: The Genetics of Leprosy in Medieval Europe

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ABSTRACT:

Leprosy has been one of the few diseases of the past that have been successfully studied by biomolecular methods. Latest advances in the field of ancient-DNA have made it possible to tackle not only the presence of the disease in archaeological remains, but also the origin, spread and phylogeography of the causative agent (*M. leprae*). The immune system of the host can also be analysed by such means, and provide clues for its evolution through the ages. Of particular interest and importance has been the recent achievement of sequencing the whole genome of Medieval strains of the pathogen, giving insights on its virulence and spread.

Here we present studies that have been done on Scandinavian –as well as Northern European in general– findings, dated to the early Middle Ages (900–1300 AD). In total, 10 skeletons were initially analysed for leprosy identification, whereas 4 more were used for typing the whole microbial genome. The results show that the disease was present in this part of the continent in several ‘types’ and this has triggered discussions on how it has reached several parts of the world.

KEY WORDS: Leprosy, Palaeopathology, Europe, Middle Ages, aDNA



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