ICArEHB
Interdisciplinary Center for Archaeology and Evolution of Human Behaviour

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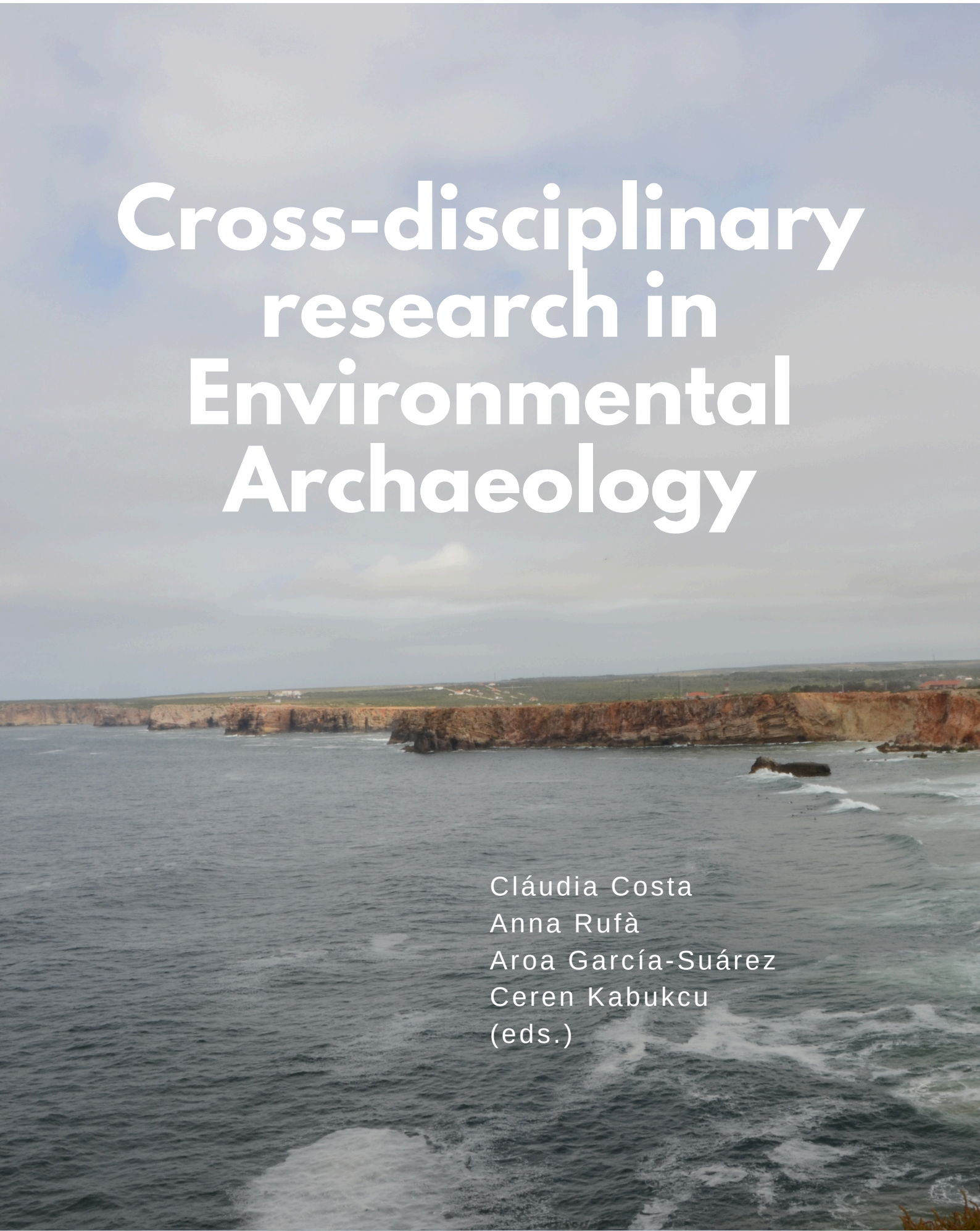
Cross-disciplinary research in Environmental Archaeology



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(eds.)

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This publication compiles some of the extended abstracts presented at the 2024 Spring Conference of the Association for Environmental Archaeology, held at the University of Algarve, Portugal, in May 2024. The conference was organised by ICArEHB - Interdisciplinary Center for Archaeology and Evolution of Human Behaviour and IMF-CSIC - Institución Milá y Fontanals de Investigación en Humanidades, Consejo Superior de Investigaciones Científicas, Spain.

The conference brought together more than forty attendees and featured twenty-three oral presentations and six posters covering a wide range of topics related to Environmental Archaeology. In addition to the sessions held at Campus de Gambelas, University of Algarve, a one-day excursion was organised to visit the Sagres Fortress at Sagres Cape, offering an opportunity to admire the beautiful landscape over the Atlantic. Participants also visited the Vila do Bispo Municipal Museum Celeiro da História, where significant artefacts from the archaeological site of Vale Boi (Upper Palaeolithic) and the Roman mosaic and wall paintings from Boca do Rio (Industrial Roman villa) were on display.

Fig. 1. Group photo at the end of the sessions in from of Faculty of Sciences and Technology in Campus de Gambelas, University of Algarve.

Fig. 2. Group photo in front of the Vila do Bispo Municipal Museum Celeiro da História at the end of the excursion day.

Cross-disciplinary Research in Environmental Archaeology is an online publication edited by ICArEHB and the University of Algarve. It comprises a dozen diversified papers that underscore the collaborative nature of Environmental Archaeology.

This book can be divided into three groups of papers: the first paper is part of the opening session of the conference and provides a synthetic overview of the development of archaeology in Portugal, including archaeosciences and environmental archaeology. It also highlights the significant role of the establishment of ICArEHB in Portugal as a leading institution in research, education, and training both nationally and internationally.

The second group of papers presents results from the application of new techniques to reconstituting the past. Ellen O'Carroll and colleagues introduce a new database, IPeAAT (Irish Peatland Archaeology Across Time), which compiles archaeological information from Ireland, focusing on bogs, wood, and macroplant remains. Mariana Nabais and colleagues present initial results from experimental archaeology, involving the butchering of corvids and columbids with flint tools followed by cooking, to replicate taphonomical patterns on bone surfaces. Judite Artur Nhanombe *et al*. present pioneering results using geometric morphometrics to analyse valve morphology variations in ostracods, investigating how environmental changes affect the morphology of specimens collected from Lake Nyalonzwele in Inhambane, Mozambique.

The third group of papers relates to research undertaken with archaeological materials. Nompumelelo Maringa and colleagues report on micromammal assemblages from the Neanderthal layers of Lapa do Picareiro in Portugal. Abu B. Siddiq presents an analysis of faunal remains from early sedentary sites of Harvetsuvan Tepe and Sefertepe, dating to the 9th millennium BC in the Middle Euphrates region of Turkey. Monika Jovanović and colleagues offer preliminary results on the use of macrobotanical remains, such as fruits and seeds, and microbotanical remains, including starch grains and phytoliths, from a Mesolithic to Neolithic site in Sudan. Roisin O'Droma reports on a drying kiln site in Ireland, featuring naked barley dated to the Middle Bronze Age and Iron Age periods. João Tereso and Luís Seabra discuss agricultural changes in northwestern Iberia during the 2nd and 1st millennia BC, focusing on seeds and fruits. Aleksa K. Alaica and Luis Manuel González present isotopic analysis of guinea pigs from the Late Nasca period, 1st millennium BC, in Peru, and how these results trace human dietary trends. Antonio Peralta-Gómez examines food and agriculture in Islamic Iberia based on archaeobotanical identification of cereals, legumes, fruits, and garden

plants. Finally, M. Dores Cruz and her colleagues present initial findings on environmental changes in the Gulf of Guinea islands (São Tomé, Príncipe, and Annobón) due to human occupation during historical times.

This volume reveals the diversity of research topics, spanning from Neanderthals to historical/colonial times, in a wide range of territories. It also shows the use of new techniques being used in reconstitution of the intricate relations between humans and their surrounding environments though humanity history.

Fig. 3. Ceren Kabukcu and Cláudia Costa at the Opening Session.

Fig. 4. Closing Session. Aroa García-Suárez announcing the next AEA Conference in Oxford.

The growth of Archaeology in Portugal and ICArEHB's pivotal influence

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Keywords: Archaeology in Portugal, Environmental Archaeology, ICArEHB

In Portugal, professional activity in archaeology before the 1990s was conducted by government agencies and universities, particularly in major research projects and large archaeological sites managed by the state. Smaller interventions were the result of dedicated individuals, most of whom had academic training in history or geology, who used their free time to carry out excavation activities with volunteers. Archaeological activity was not regulated, and permissions to excavate were granted by the Education and Culture services upon request. There was no inspection of archaeological sites, and excavation results were rarely published in local journals and magazines. Being an archaeologist was not considered a profession until the 1990s (Costa *et al.* 2014).

Archaeology was initially offered as a variant of the History course by the Faculties of Letters at the Universities of Porto and Lisbon in the 1980s. With the discovery of the Côa Valley Rock Art site, which was classified as a World Heritage Site in 1998, Portuguese archaeology underwent a radical transformation and gained international prominence. The Côa Valley prehistoric rock art complex was identified during an Environmental Impact Assessment Study conducted before the construction of a hydroelectric project. Due to inadequate mitigation measures imposed by the Portuguese government, the rock art site was condemned to be submerged after all the rock art panels had been documented through photography and drawing.

Archaeologists and civil society united against the construction of the river dam and supported the conservation of the rock art engravings. This movement highlighted archaeology as a scientific activity capable of social intervention and influencing public opinion. The protest even contributed to the downfall of the government at the time.

Following the 1996 parliamentary elections, the newly elected government supported the preservation, study, and dissemination of the Côa Valley prehistoric rock art. In 1997, the Institute for Archaeology (Instituto Português de Arqueologia, IPA) was established, making archaeology an independent discipline from cultural heritage management. From this point on, being an archaeologist in Portugal was no longer an obscure activity.

The preamble of the law that established the new institute called for the construction of laboratories to support archaeological research, including the "use of methods derived from physics and natural sciences" (D-L177/97 of 15 May, Preamble). Consequently, in 2000, the CIPA Programme was created, encompassing zooarchaeology, bioanthropology, geoarchaeology, archaeobotany, and spatial archaeology. The CIPA Programme consisted mainly of foreign researchers contracted by the Portuguese state. Their initial task was to create reference collections and equip facilities and laboratories, laying the foundation for archaeosciences research in Portugal (Zilhão, 2003).

Despite some attempts to integrate these facilities and knowledge into academic courses, such as through master's courses at the University of Lisbon (Faculty of Sciences) or the Erasmus Mundus Master's degree in Archaeology at the Polytechnic Institute of Tomar/Alto Douro University, archaeosciences and environmental archaeology were not widely incorporated into academic curricula.

In 2003, following the resignation of the government elected in 1996, the CIPA Programme began to decline, culminating in the merger of the Portuguese Institute of Archaeology (IPA) with

the Institute of Architecture and Heritage into a single institute responsible for managing all heritage in Portugal, including archaeological heritage: Management Institute for Architectonic and Archaeological Heritage (Instituto de Gestão do Património Arquitectónico e Arqueológico, I.P, IGESPAR, I.P.)[1].

During this period, archaeological research and academic teaching in Portugal remained closely linked to the Faculties of Letters and did not significantly develop archaeoscience research or offer students training in archaeosciences. The field continued to suffer from a lack of specialists and a structure that would foster interdisciplinarity. In this context, the Interdisciplinary Center for Archaeology and Evolution of Human Behaviour (ICArEHB) was established in 2013. This centre was founded by Portuguese researchers from the University of Algarve, which had launched a Master's degree in Archaeology in 2004 that included courses on archaeosciences, as well as researchers based abroad.

ICArEHB introduced a new paradigm in Portugal, focusing on understanding human behaviour in prehistory through innovative, interdisciplinary research that explores the complex interactions between human culture, biology, and the environment (Costa *et al.* 2016). In 2015, ICArEHB was evaluated as "excellent" by the National Science Foundation (Fundação para a Ciência e a Tecnologia I.P., FCT I.P.), a rating it has maintained ever since.

ICArEHB's strong commitment to reconstructing the human past through an interdisciplinary approach has attracted international researchers from various scientific backgrounds and secured international funding, including five European Research Council Projects (ERC). The centre conducts research in Europe, Middle East, Africa, and America, and welcomes students worldwide to pursue their degrees or training programs. It has established laboratories, facilities, and comparative collections, becoming a reference in the study of human evolution and prehistoric archaeology in Portugal.

The integrative approach of archaeological science, the development of partnerships, and the pursuit of research excellence have enabled ICArEHB to rapidly establish itself as a leading international institution dedicated to advancing environmental archaeology. Within this framework, the University of Algarve currently offers a doctoral programme conducted in English, encompassing a wide range of courses in Archaeology, Archaeosciences, Prehistory, Human Evolution, Archaeological Theory and Practice. This doctoral programme now leads in the number of international students in Portugal and facilitates the training of new researchers in Archaeosciences and Environmental Archaeology.

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[1] CIPA Programme was integrated into the new institution (current Instituto Património Cultural I.P. as Archaeosciences Laboratory (LARC).

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IPeAAT; Tracing changes in human interactions in Peatland environments

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Keywords: Raised bogs, Peatland Archaeology, Ireland, Database, Environmental Queries

Four decades of state and commercially funded archaeological excavations in midland industrial raised bogs in Ireland have generated a unique resource of knowledge on the distribution and character of Irish peatland environmental archaeology on a national scale. These datasets have produced a significant corpus of information regarding patterns and processes of Holocene mire development, human impact and landscape change. There have, however, been few attempts to analyse or integrate these datasets on inter-regional or national scales.

Irish Peatland Archaeology Across Time (IPeAAT) is addressing this knowledge gap and is currently collating information from all excavated peatland structures as well as their associated environmental datasets (wood, insects, and plant macro) into a specifically designed ACCESS database. IPeAAT is a 2-year project, funded by the Irish Research Council COALESCE/INSTAR+ scheme, University College Cork, and involving colleagues from Archaeology and Built Heritage Ltd, University College Dublin, the National Museum of Ireland, Bord na Mόna, National Monuments Service and the Community Wetland Forum. The database is a unique source of knowledge which links data from the excavated structures with the environmental data and chronological frameworks. This talk will introduce the IPeAAT database and its initial results and findings in relation to the environmental proxies (Fig. 1). The talk will also explore how this data can be queried and used to address the interrelationship between past human activity in prehistoric peatlands, how this changed over time and whether this was related to local environmental conditions or societal needs. Early queries and analysis from the database and in particular the plant macro results point towards the availability of Cyperaceae (Sedges) and Phragmites (reeds) in the vicinity of the platforms indicating collection of rushes and reeds for thatching. These environments are also important for wild animals and birds which would have been an important food source. There are over 380 insect species already inputted into the database which makes analysis and habitat categorisation difficult. However initial results from the database and from peat samples taken from around the trackways show the dominance of water and wetland types insect species in the Neolithic periods. Dung beetles are present during all periods of use suggesting the sites were accessible to grazing animals. Insect species also show a loss of woodland in the local area surrounding some of the peatlands and as the bog developed from fen to raised peat. Moving beyond the bog and into the wider landscape, the 20,000 wood identifications inputted into the database from peatland excavations also indicate opening up of the woodlands and clear-felling in the surrounding landscape with the use of higher quantities of ash, a pioneer species, in the Early Bronze Age and into the Iron Age. Graphing of the data also shows that oak is also rarely used in the construction of the peatland sites.

The database, when complete, will be made open access and will be very useful for comparative analysis on a national and international level.

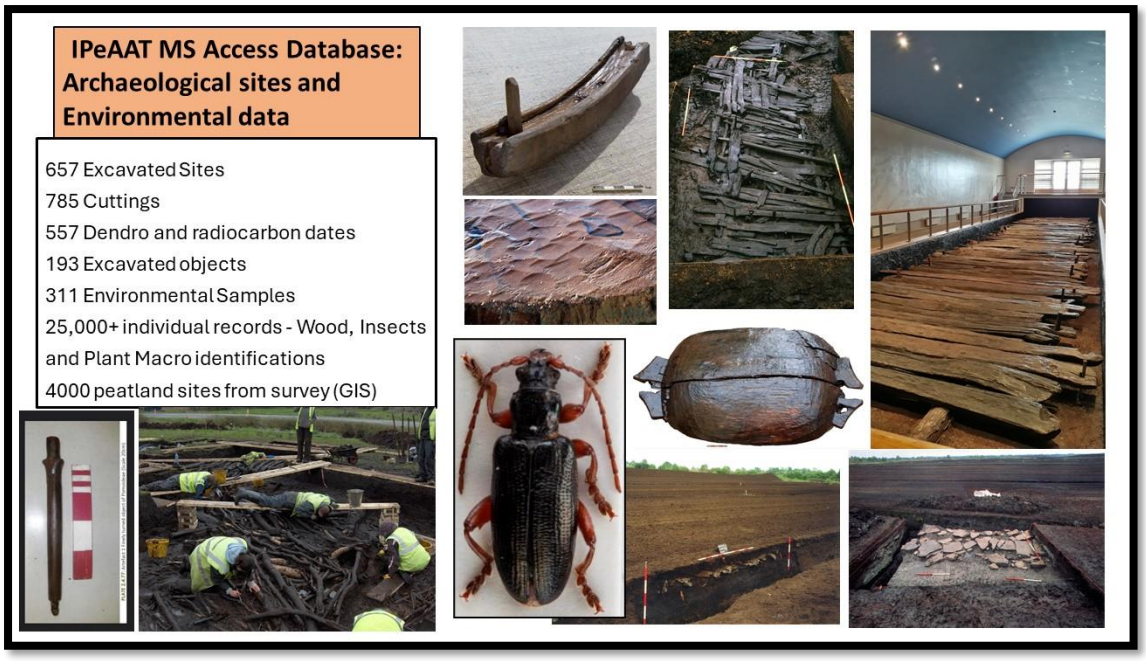

Fig. 1. IPeAAT Database: Facts and Figures.

Replicating early human behaviour in bird preparation: A pilot-study focusing on bone surface modification and breakage patterns

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Keywords: Experimental archaeology, Taphonomy, Cooked meat, Raw meat processing, Avifauna

The consumption of small prey by Neanderthals, including birds, has received increasing attention in recent years. Analysing bird remains poses challenges due to minimal or absent traces of human activity on bones. This study addresses these challenges by experimenting with raw and roasted bird specimens to identify distinctive bone surface modifications and breakage patterns that can be attributed to human processing. The research focuses on two main objectives: identifying cut marks and other modifications resulting from butchering and cooking, and understanding the impact of cooking on bone preservation and visibility in archaeological contexts.

Five bird specimens from bird families commonly associated with Neanderthal diet in the Iberian Peninsula were selected for this study (see Blasco *et al.,* 2022 and references therein). These included the carrion crow (*Corvus corone)*, the common wood-pigeon (*Columba palumbus)*, and the Eurasian collared-dove (*Streptopelia decaocto)*. The birds, which died under natural conditions, were obtained from a wildlife rehabilitation centre, they were frozen for preservation and thawed prior to the experiment to replicate natural handling conditions (e.g., Laroulandie 2001; Osgood 1971). Two birds were processed raw, and three were roasted to replicate Neanderthal cooking techniques. The roasting involved cooking defeathered birds in direct contact with coals at approximately 500ºC.

The butchering of raw birds required the use of a flint flake to sever tendons and disarticulate joints, resulting in visible cut marks on bones. In contrast, roasted birds were manually processed without tools, showing burn marks and higher bone loss. Bones were cleaned post-processing, and surface modifications were analysed using macroscopic and microscopic techniques. Lithic use-wear analysis was also conducted on the flint flake used for bird processing.

Distinct differences were observed between the raw and roasted bird specimens. Raw birds exhibited numerous cut marks primarily on scapulas, coracoids, femurs, and tibiotarsus, indicative of tendon cutting and joint disarticulation (Fig.2 and 3). These marks were absent in roasted birds, which instead showed local burns and significant bone loss due to heat exposure. The roasting process facilitated meat removal but rendered bones fragile and prone to breakage, leading to their underrepresentation in archaeological contexts. Burning patterns included brown and black discolouration consistent with controlled cooking (Fig. 1).

The results underline the importance of cooking methods in bone preservation. Raw bird bones, marked by butchering tools, provide clear evidence of human processing. However, roasted bones' fragility and breakage highlight potential gaps in the archaeological record (e.g., Cassoli, Tagliacozzo 1997; Laroulandie 2005). These results have implications for interpreting Neanderthal subsistence strategies and cooking practices, contributing to a broader understanding of early human dietary behaviours.

This pilot study offers insights into the replication of early human behaviours in bird preparation. The distinct bone surface modifications and breakage patterns observed between raw and roasted birds provide a

framework for identifying human-related modifications in archaeological contexts. Future research should expand on this study by including a wider range of bird species and cooking methods to enhance our understanding of Neanderthal dietary practices and their cultural and ecological adaptations.

Funding
Financial support has been provided by MN' contract for project "Neanderthal and Anatomically Modern Human interactions with small prey in Atlantic Iberia throughout the changing environments of the Pleistocene," as part of the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No. 101034349, and from the State Research Agency of the Spanish Ministry of Science and Innovation through the Program Maria de Maeztu Unit of Excellence (CEX2019-000945-M). Additional support has been given by UIDB/00698/2020 and UIDP/00698/2020, Fundação para a Ciência e Tecnologia (FCT I.P.), Portugal. AR is currently a beneficiary of a CEEC - 3rd Edition research contract promoted by FCT I.P. (reference: 2020.00877.CEECIND) and participates in the Spanish MICIIN projects PID2020-114462GB-I00, and the Generalitat de Catalunya projects CLT009/22/00044, CLT009/22/000045, and CLT009/22/00024. MN and AR also participate in the Spanish MICINN project PID2022-138590NB-C41.

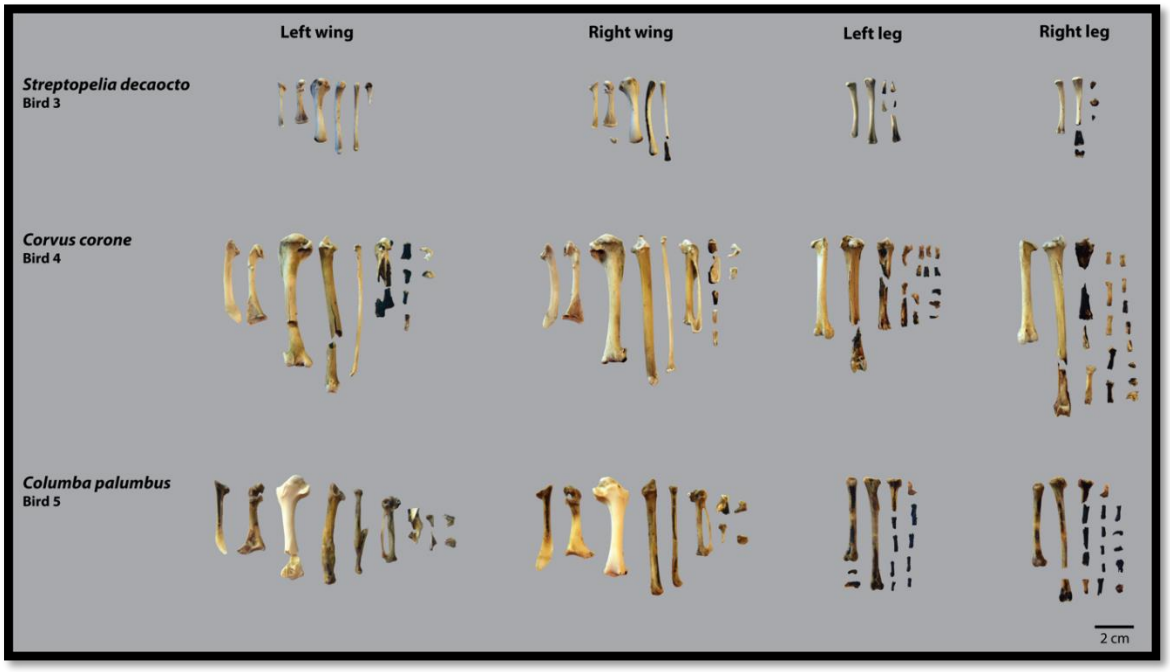

Fig. 1. Thermal alterations and impact of burning on bird bones after experimental exposure to heat of three bird specimens, *Streptopelia decaocto, Corvus corone* and *Columba palumbus*.

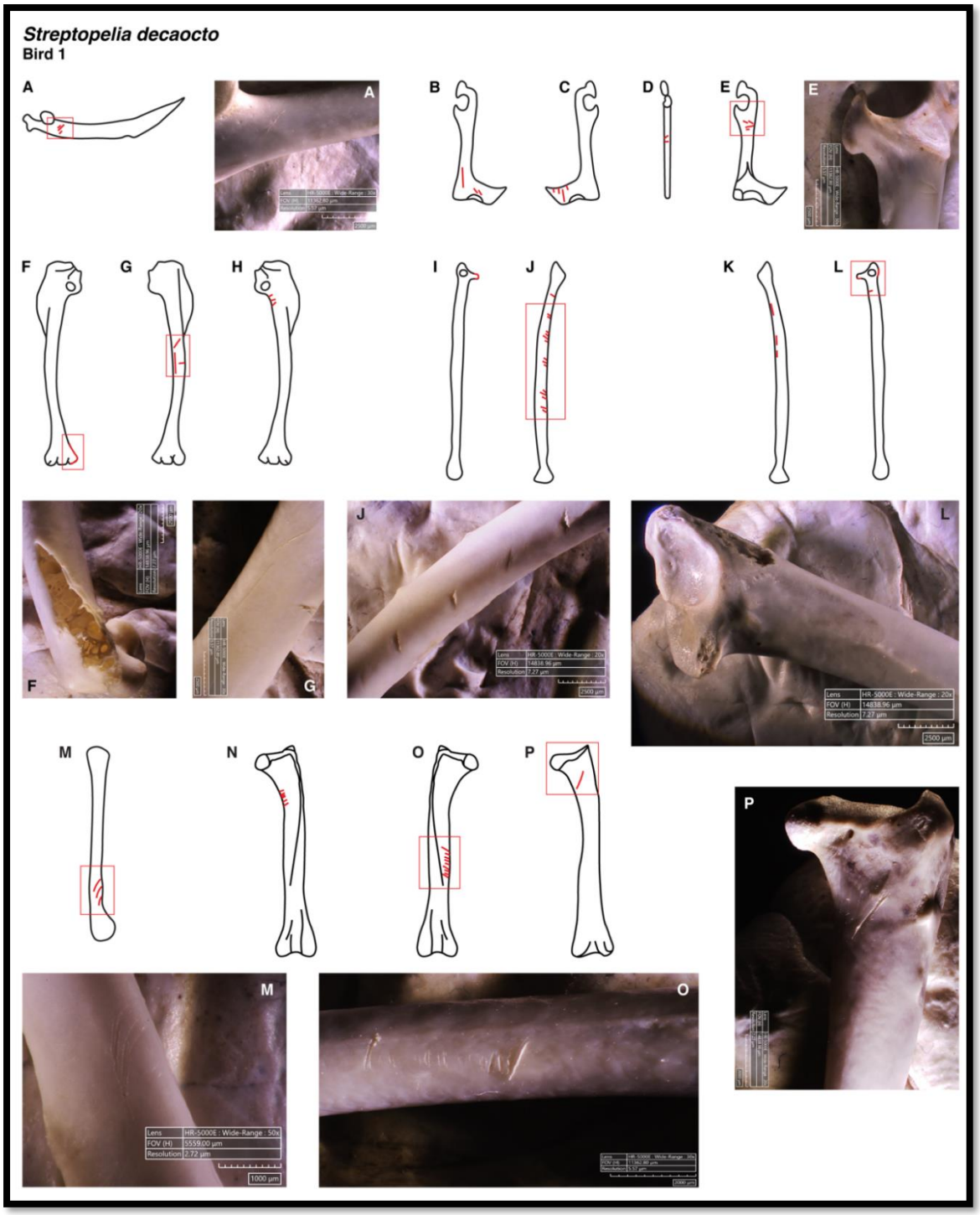

Fig. 2. Bone surface modifications on the appendicular skeleton of *Streptopelia decaocto* after being experimentally processed uncooked. Illustrations are not drawn to scale and should be interpreted as conceptual sketches; they are not suitable for species identification. **A** - Right scapula (lateral side): cut marks. **B** - Left coracoid (dorsal side): cut marks. **C** - Right coracoid (dorsal side): cut marks. **D** - Right coracoid (medial side): cut marks. **E** - Right coracoid (ventral side): cut marks. **F** - Left humerus (posterior side): notching. **G** - Left humerus (anterior side): cut marks. **H** - Right humerus (posterior side): cut marks. **I** - Left ulna (anterior side): wrenching mark. **J** - Left ulna (medial side): cut marks. **K** - Right ulna (medial side): cut marks. **L** - Right ulna (anterior side): wrenching and cut marks. **M** - Left radius (medial side): cut marks. **N** - Left femur (cranial side): cut marks. **O** - Right femur (cranial side): cut marks. **P** - Right femur (caudal side): cut marks.

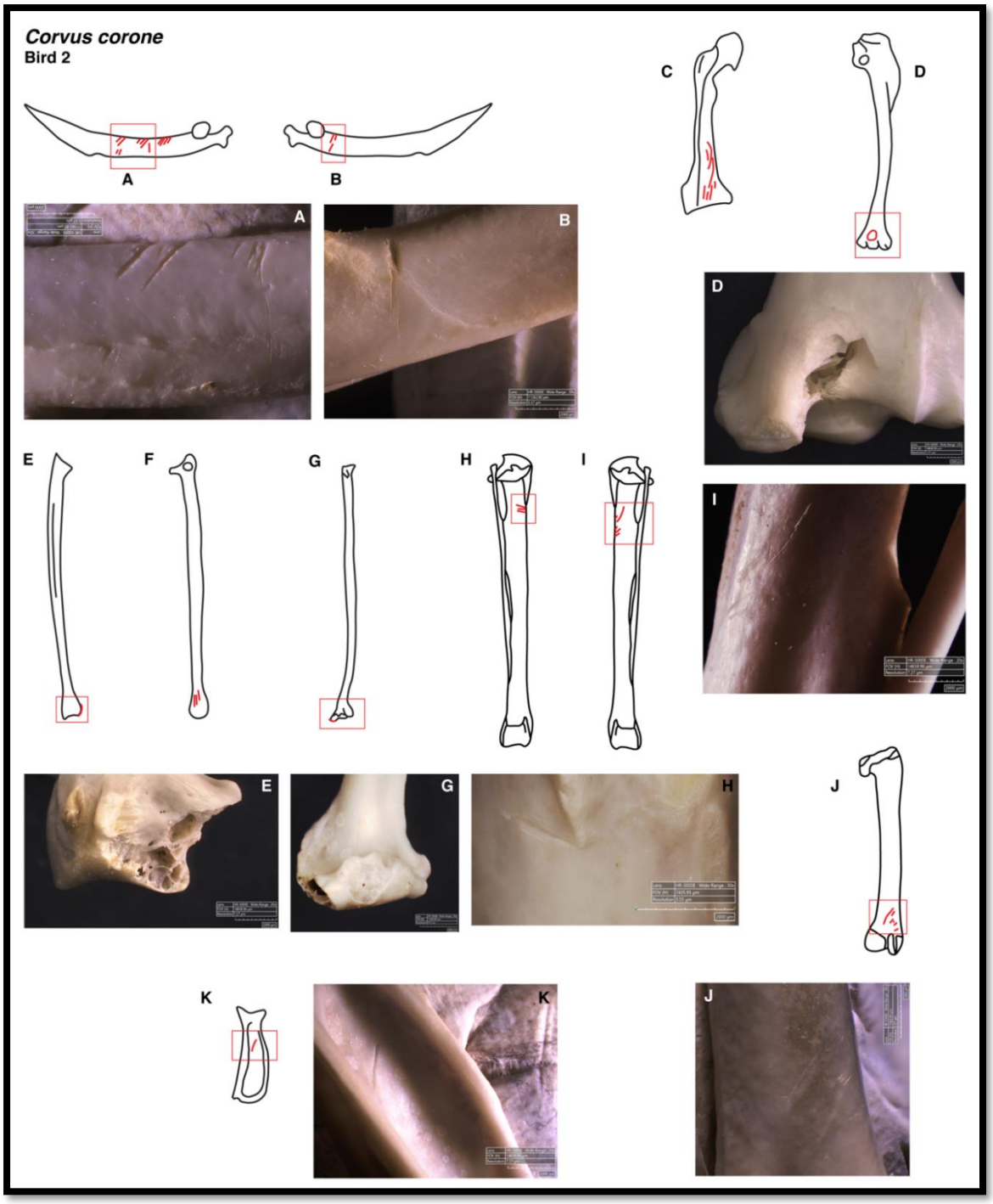

Fig. 3. Bone surface modifications on the appendicular skeleton of *Corvus corone* after being experimentally processed uncooked**.** Illustrations are not drawn to scale and should be interpreted as conceptual sketches; they are not suitable for species identification. **A** - Left scapula (lateral side): cut marks. **B** - Right scapula (lateral side): cut marks. **C** - Right coracoid (dorsal side): cut marks. **D** - Right humerus (posterior side): squashing mark. **E** - Right ulna (lateral side): wrenching mark. **F** - Right ulna (anterior side): cut marks. **G** - Right radius (lateral side): wrenching mark. **H** - Left tibiotarsus (caudal side): cut marks. **I** - Right tibiotarsus (caudal side): cut marks. **J** - Right femur (caudal side): cut marks. **K** - Right major digit phalanx 1: cut mark.

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Study of ostracod valve morphology as an indicator of paleoenvironmental changes in Lake Nyalonzwele (Inhambane, Mozambique)

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Keywords: Ostracods, Paleoenvironments, Holocene, Geometric Morphometric

Microfossils are tools in the reconstruction of ancient lifeways because they preserve a wealth of information regarding the ancient climate of a given region. One such group of microfossils are the Ostracoda, microcrustaceans sensitive to environmental conditions (Athersuch *et al*. 1989). Here, we test the hypothesis that valve morphology variation in the brackish ostracod *Cyprideis remaneis* will reflect fluctuations in paleoenvironmental conditions. This is a Geometric Morphometrics (GM) based morphological approach with the potential to identify disruptive ecological events, providing a better framework of human occupation when integrating archaeological records over the middle Holocene.

We analysed valves from a section (2.6 meters) of a sediment core collected in an interdunal lake (Nyalonzwele, Inhambane region; Fig. 1) during the 2019 campaign of the project InMoz. The section was dated to the period ~7000 to ~1500 cal. BP, with a total of eight samples studied and a total of 329 adult ostracod valves analysed (of both sexes). GM methods were used to examine valve morphology. TPSDig2 was used to collect landmark (LM) coordinates (4 conventional LMs and 44 curve sliding semi-LMs) (Fig. 2). For the standard geometric analyses, which include a generalised Procrustes analysis (GPA) and a principal component analysis (PCA), the R package Geomorph will be used (Adams, Castilho 2013; Zelditch *et al.* 2012).

We expect morphological changes in the ostracod's valves of the first stratigraphic level compared to the recent levels. The structure of the valves in the recent levels is more robust (as visually assessed) with more individuals, possibly because the lake environment was more stable and with less stress compared to the lower levels.

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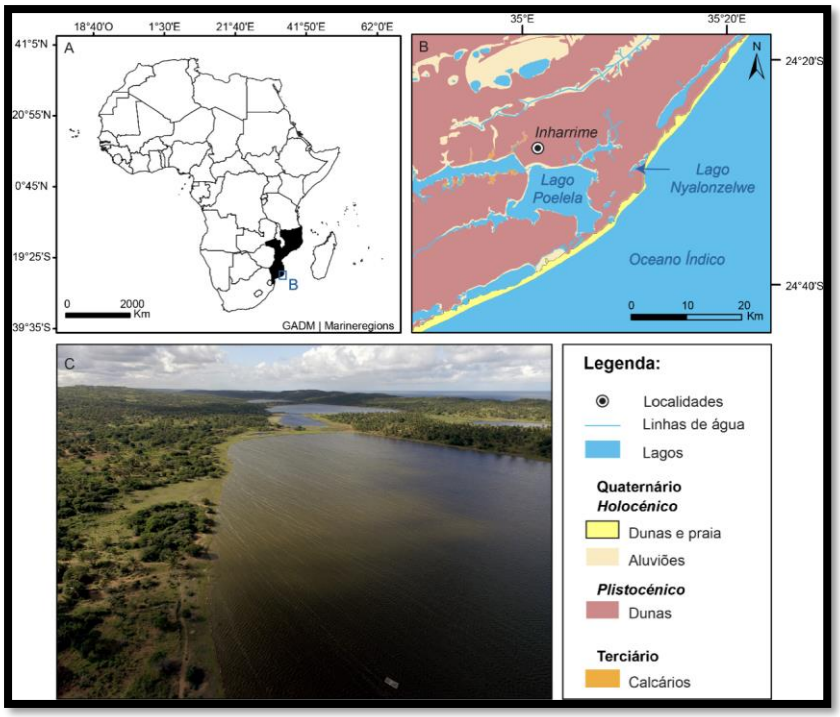

Fig.1. Location of Mozambique and Location of Lake Nyalonzelwe (Gomes *et al.* 2023).

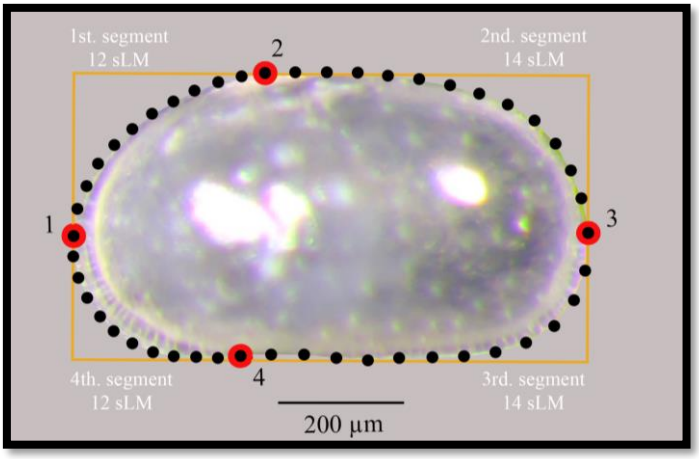

Fig. 2. Representation of the digitisation of the semilandmarks in four segments: first segment with 12 sLMs; second segment with 14 sLMs; third segment with 14 sLMs; fourth segment with 12 sLMs.

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Inferring the palaeo environmental dynamics from Late Pleistocene micromammal fossil assemblages at Lapa do Picareiro, Portugal

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Keywords: Micromammals, Palaeoenvironment, Iberian Peninsula, Neanderthals, Late Pleistocene.

The Iberian Peninsula is considered one of the most significant regions in Europe to study the developments of human adaptions and changes in the environment throughout the Late Pleistocene (Fig. 1) (López-García *et al.* 2011; Haws *et al.* 2020). This region is well known as the location inhabited by Neanderthals during the transitional period between 40-30kya before their disappearance (Smith *et al.* 2005; Finlayson *et al.* 2006; Arsuaga *et al.* 2014). The cause of their disappearance remains debatable, however, changes in the environment may have influenced the availability of resources and made conditions unsuitable for their survival (Finlayson *et al.* 2006). Lapa do Picareiro is a limestone cave site with a thick and continuous archaeological sequence ranging from the Iron Age to the Middle Palaeolithic (Bicho *et al.* 2003, Carvalho *et al.* 2020). This site has evidence of Neanderthal occupation and an abundance of archaeological material (lithics, fauna, shells, and botanical remains) recovered from a 10.6m deep section divided into 36 Pleistocene-aged strata (Carvalho *et al.* 2020).

Lapa do Picareiro yields an abundance of faunal remains (i.e. birds, rabbits, rodents, fish, herpetofauna, ungulates, etc.) dated to MIS 4-2. Previous research at this site has employed multi-proxy analyses of large, small and some micro fauna, stable isotopes, and botanical remains to recognise changes in the palaeoenvironmental conditions covering a time range when the Neanderthal population dwindled. More recently, stable isotopic analysis of ungulate teeth (red deer and ibex) from the site suggests a change from open patches of forest with dry and warm conditions during ~55-57 ka cal BP, to less dense steppe, less dry conditions and fluctuations in warm and cold temperatures during ~51.5-42.5 ka cal BP (Carvalho *et al.* 2022).

Our new study at Lapa do Picareiro (Fig. 1) will be the first micromammal focused project which aims to achieve detailed insights into the palaeoenvironmental changes. The micromammal assemblage consists of material from two levels namely Level JJ (51.5-44.4 ka cal BP, Middle Palaeolithic) and Level GG (39.6-38.7 ka cal BP, Upper Palaeolithic) (Fig. 2), both yielding dates within MIS 3 (Haws *et al.* 2020). Some of the objectives of the study include: identifying the taxonomic composition and recording taphonomic modifications in the assemblage and applying the Bioclimatic and Habitat Weighting methods to determine the habitat structures, vegetative landscape and resource availability (Nesbit-Evans *et al.* 1981; Andrews 1990; Hernández Fernández 2001; Hernández Fernández & Peláez-Campomanes 2005). We use diversity indices (i.e. Shannon-Weiner and Simpsons) to gain insights into the ecological relationships in the micromammal community and vegetation landscape.

Lastly, we discuss the potential of advanced techniques to extract data and propose standardised methodological approaches based on those used at contemporaneous sites to ensure

comparability. The outcome of this research will be compared to multiproxy records from Lapa do Picareiro to interpret past environmental conditions around the site. Therefore, providing a high-resolution, and sequenced understanding of the palaeoenvironmental context and expanding our knowledge of Neanderthals' resilience to periods of climate and resource instability.

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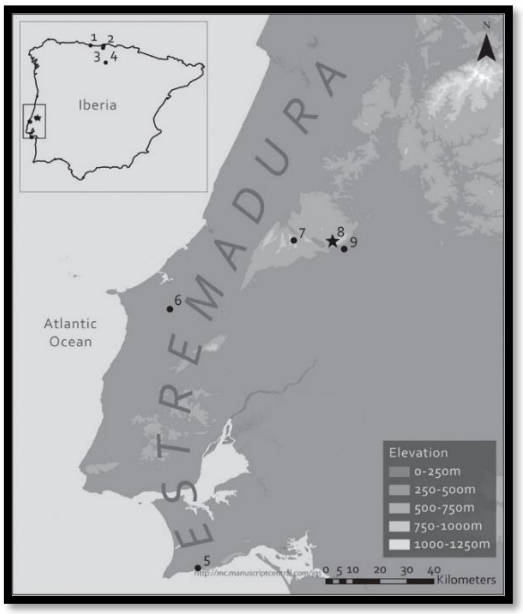

Fig. 1. Map the Iberian Peninsula. Lapa do Picareiro (number 8) and other cave sites in the Estremadura region (Carvalho *et al.* 2020: 305).

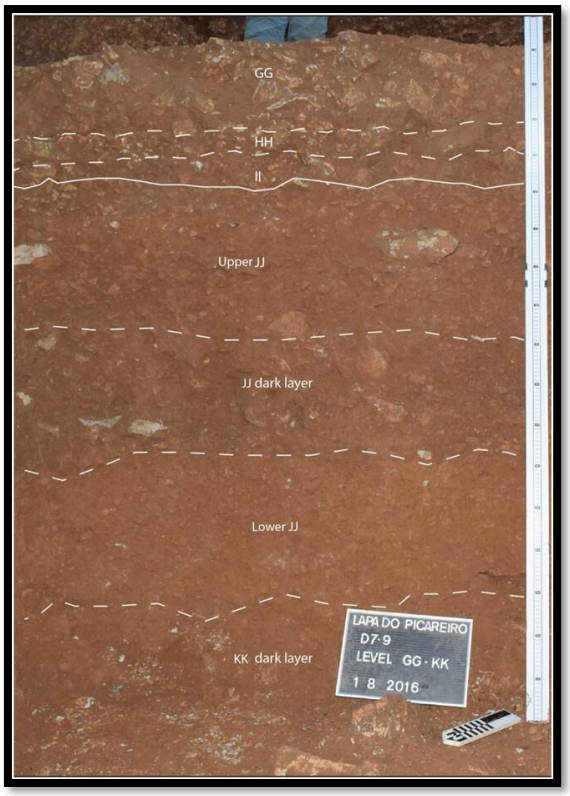

Fig. 2: The stratigraphic profile of Levels GG to KK (Carvalho *et al.* 2022: 307).

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Early sedentary environment-cultural dynamics in the 9th millennium BCE Middle Euphrates Basin

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Keywords: 9th millennium BCE, Zooarchaeology, Harvetsuvan Tepe, Sefertepe, Middle Euphrates, Southeastern Turkey

At the dawn of sedentary life, early human societies in southeastern Turkey experienced dynamic variations in subsistence strategies and resource exploitation across their distinct local ecological niches (Emra *et al.* 2022; Peters, Schmidt 2004). Beyond mere sustenance, resource availability significantly influenced the local cultural characteristics of these early sedentary communities (Peters, Schmidt, 2004; Siddiq *et al.*, 2021). Shortly after the emergence of the earliest sedentary villages in Upper Mesopotamia, particularly in the Middle Euphrates basin, the landscape saw the establishment of large-scale cult centers. These centers served as focal points for inter-communal ritual activities and held significant symbolic importance (Peters, Schmidt 2004; Schmidt 2010).

In this context, zooarchaeological datasets derived from two newly excavated Pre-Pottery Neolithic sites, Harvetsuvan Tepe and Sefertepe, provide new insights into human responses to the evolving cultural dynamics and sedentary landscapes in the early Neolithic Middle Euphrates region. Architectural remains and various cultural items indicate that both sites were Pre-Pottery Neolithic B (PPNB) megalithic cult centers, occupied during the 9th millennium BCE (Çelik 2019; Güldoğan, Uludağ 2022). The dataset reveals an extreme overrepresentation of gazelle, with limited occurrences of sheep, goat, boar, and cattle, suggesting that all animals exploited at these cult centers were obtained through hunting practices.

The presence of a diverse range of wild animals at these cult centers prompts inquiries into human adaptation to the new sedentary environment, the extent of resource exploitation, and their potential implications for animal domestication. It appears that due to intensive resource exploitation, people may have faced challenges that compelled them toward the domestication of caprines and cattle-species that initially had limited subsistence importance-or gradually adapted to the domesticated versions of these animals. This shift likely served as a means of mitigating subsistence insecurities and adapting to changing ecological conditions.

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Tracing the transition: Plant exploitation strategies in Mesolithic and Neolithic Al-Khiday, Sudan (7000 - 4500 cal BC)

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Keywords: Macrobotanical remains, Starch, Hunter-gatherers, Plant use, Sudan

The transition from Mesolithic to Neolithic is often regarded as a pivotal period marked by the shift from foraging to cultivation and domestication of plants and animals. While this transition is well-documented in parts of the world, such as Southwest Asia, it remains poorly understood in North Africa (Winchell *et al.* 2018: 500). Understanding plant exploitation strategies through the study of archaeobotanical material from hunter-gatherer contexts is often inherently challenging due to preservation issues. This challenge is even greater in Sudan, where the lack of systematic recovery of archaeobotanical remains and poorly stratified sites pose significant obstacles (Usai, Salvatori 2019: 447). A well-defined cluster of sites at Al-Khiday (in the Western bank of the White Nile) has yielded extensive archaeological material dated to the Mesolithic and the Neolithic, including macrobotanical remains (fruits and seeds), recovered through flotation, and stone tools (grinding bases and hand grinders), which were analyzed for microbotanical remains (starch grains and phytoliths). The main aim of the archaeobotanical analyses was to understand what were the plants that the inhabitants of Al-Khiday used/consumed and how they processed them. Given that these two periods are associated with social and environmental changes at the site (Maritan *et al.* 2018: 50), it will be possible to determine whether these changes impacted the subsistence strategies of human communities.

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Unveiling prehistoric agricultural practices: Naked Barley discoveries at a kiln site in Ireland

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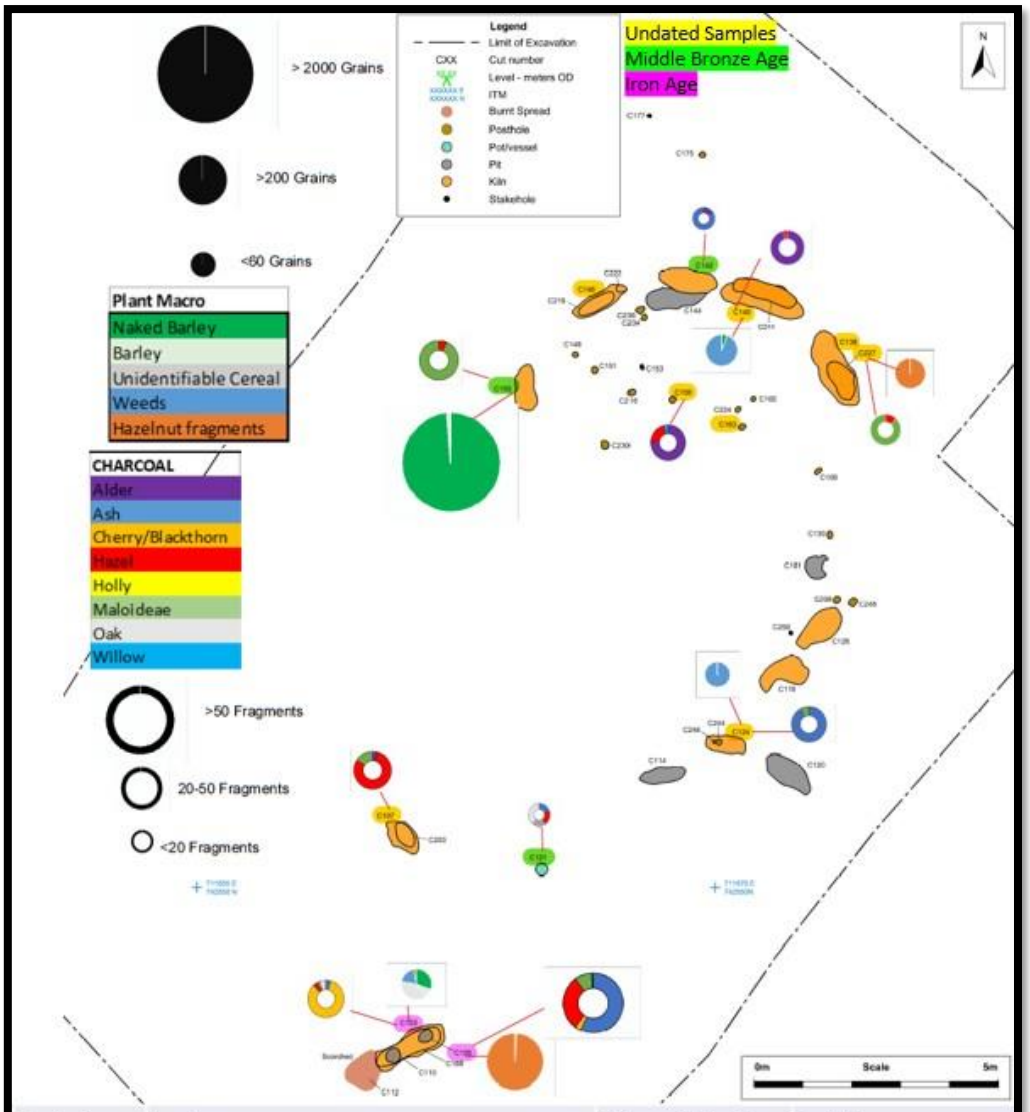
Keywords: Naked Barley, Cereal-Drying Kiln, Middle Bronze Age, Plant Macro Analysis, Charcoal Analysis

This paper presents exciting new environmental results from the analysis of cereal drying kilns excavated in North Dublin, Ireland at a site called Quantum. The kilns were arranged in a semi-circular fashion. Two of the kilns and one vessel containing charcoal were dated to the Middle Bronze Age, while one kiln, located south of the semi-circle was dated to the Iron Age. Cereal-drying kilns were used primarily to dry large quantities of cereals before storage and were common in Ireland from the Late Iron Age as Irelands weather was wet and damp. There are very few Bronze Age examples which made this site very unique to Ireland where so many kilns together were found dating from this period.

Plant macrobotanical analysis revealed that naked barley (*Hordeum vulgare spp. vulgare*) was the only cultivated crop found at the site, dating to both the Middle Bronze Age and Iron Age periods. A subsample of 2,000 grains were identified from one Middle Bronze Age kiln, though there are potentially over 30,000 grains in that kiln. The other kilns yielded much lower quantities of remains. Naked barley was commonly found in Ireland during the Bronze Age, with large caches (27,000-50,0000 grains) also identified at Gransha, Northern Ireland, dating to c. 1410 BC (McClatchie 2010) and Ballymona in the south of Ireland, dating to 1386 - 1029 BC (Johnston 2015). This North Dublin site is the only example of naked barley identified in a Bronze Age kiln.

Charcoal analysis revealed an assemblage typical of a cleared landscape, with mainly ash (*Fraxinus excelsior*), light-dependent trees (*Maloideae, Prunus* spp.) and alder (*Alnus glutinosa*) present. There were no chronological or spatial patterns of fuel types in the kilns. The growing of cereals surrounding this site would have necessitated the clearing of the local woodlands. The processing of large quantities of cereals suggests a substantial local population, though no evidence of a settlement has been found. Bronze Age burial sites have been found in the local landscape, visible on the Historic Environment Viewer, also confirming the presence of a significant population in this area during the periods that the kilns were in use. The importance of multi-proxy environmental analysis alongside historical and archaeological mapping data is highlighted in this talk.



Context	Species	2 Sigma Calibration	Period
Vessel C121	Cherry/Blackthorn (Prunus spp.)	1420 - 1265 BC	Middle Bronze Age
Kiln C155	Naked Barley (Hordeum vulgare ssp. nudum)	1415 - 1260 BC 1241 - 1235 BC	Middle Bronze Age
Kiln C142	Ash (Fraxinus excelsior) Twig	1401 - 1217 BC	Middle Bronze Age
Kiln C103	Naked Barley (Hordeum vulgare ssp. nudum)	39 - 12 BC AD 2 - 126	Iron Age

Fig. 1. Map of Quantum with plant macro, charcoal and dating results.

Fig. 2 Naked Barley (*Hordeum vulgare* spp. *vulgare*).

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Agriculture in Northwest Iberia in the 2nd and 1st millennia BC in its cultural and environmental context

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Keywords: Archaeobotany, Fruits and seeds, Bronze Age, Iron Age, NW Iberia

Significant changes in agriculture took place in NW Iberia during the 2nd and 1st millennia BC. These are related to the introduction of new crops but also to transformations in settlement and environment (Tereso *et al.* 2016, Teira-Brión 2019, Tereso 2020, Seabra 2023). NW Iberia has a vast carpological record from distinct bioclimatic areas, influenced by Atlantic and Mediterranean climates. This provides an excellent opportunity to examine such changes and integrate them into the environmental, social, and economic dynamics of the Bronze and Iron Ages.

This presentation will provide an overview of the carpological data from NW Iberia in the 2nd and 1st millennia BC and interpret it on an Iberian level. This perspective will highlight the specificities of this region, in which millets (*Panicum miliaceum* and *Setaria italica*) and spelt (*Triticum aestivum* subsp. *spelta*) played a particular role, while the presence of rye (*Secale cereale*), which is exclusive to this region, requires further enquiry (Seabra *et al.* 2023). We will interpret agrodiversity as a strategy to build resilience without inhibiting accumulation, showing how, by the end of the 1st millennium BC, communities were able to gather crops in large, fortified storage areas whose management was likely crucial for their social and economic structure.

Furthermore, an analysis of the ample palaeoecological and archaeological records available will allow us to understand the relation between the expansion of agricultural areas, the development of new forms of territorialization and the loss of forested areas. The 2nd and 1st millennia BC were turning points in vegetation history leading to unprecedented deforestation and high-impact erosion events that shaped the region's landscapes (Muñoz-Sobrino *et al.* 2005, Mighall *et al.* 2023). At the same time, settlements became larger and more complex, as a result of demographic growth and socioeconomic changes in which agriculture played an important role (Bettencourt 1999).

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From Small to Large Scale: Biomolecular Trends of Guinea Pig Remains to Understand Household and Environmental Dynamics in 1st Millennium CE Nasca, Peru

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Keywords: Zooarchaeology, Andes, Households, Nasca, Isotopes

Environmental factors impact human societies in both long-term and short-term time scales. Our work often examines wide ranges of time to realize large-scale trends in climatic cycles that influence the way that human societies manage subsistence strategies and intergroup interactions. In this presentation, we examined the way that household dynamics at the Late Nasca (500-700CE) site of Cocahuischo (Fig. 1) were transforming over this period to respond to environmental transformations and sociopolitical changes (Whalen 2014; Whalen, González La Rosa 2014). An often-overlooked proxy for nuanced changes in human responses to these factors is the life cycle of domesticated guinea pigs (*Cavia porcellus*).

Guinea pigs are a commensal species that were and continue to be raised for their meat (defrance 2006; Lord *et al.* 2020; Morales 1994). They reside and are managed in households, often fed vegetal food scraps. At the site of Cocahuischo, clear zooarchaeological patterns between houses and a public building attest to the central role of guinea pig husbandry in domestic contexts (Fig. 2). We posit that guinea pig isotopic compositions can serve as an important way to approximate many of the plant species incorporated into human diet. By examining the way that the zooarchaeological and isotopic profiles of guinea pigs shifts through the Late Nasca period at Cocahuischo provides us with the opportunity to consider how dietary shifts among guinea pigs reflect transforming human subsistence and agricultural strategies to mitigate the impact of climate and interregional complexity emerging with the expanding Wari state from the highlands.

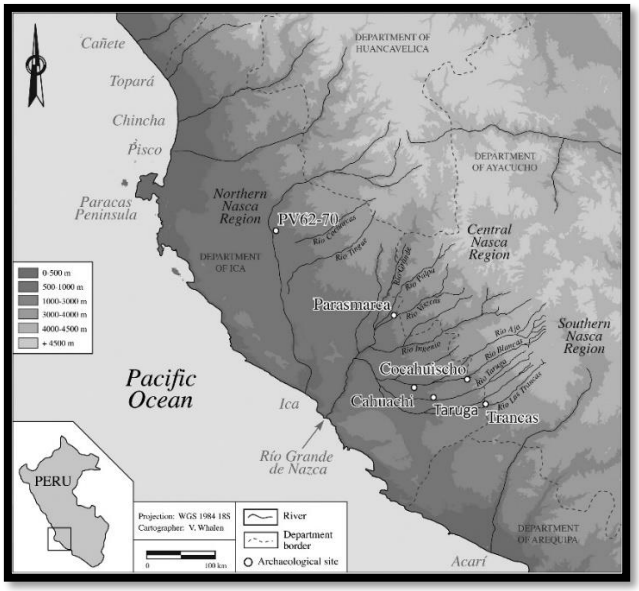

Fig. 1. Map of the Nasca region with the site of Cocahuischo demarcated in the Tierras Blanca Valley (Whalen, Gonzalez 2014, Figure 1).

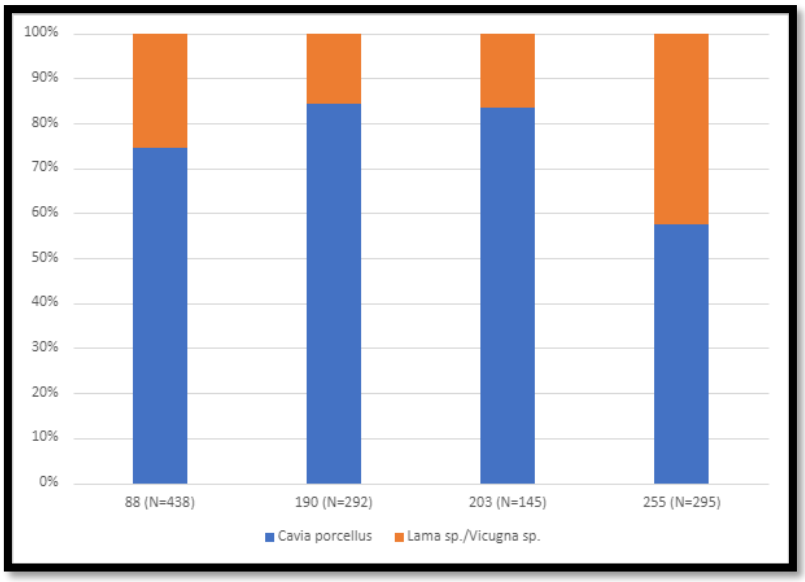

Fig. 2. Proportion of guinea pigs (*Cavia porcellus*) and camelids (*Lama* sp./*Vicugna* sp.) comparing houses (88, 190, 203) and a public building (255).

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Food and agriculture in Medieval Islamic Iberia: an archaeobotanical approach

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Keywords: Archaeobotany, Agriculture, Medieval, Islamic Iberia.

My work focuses on the role of plants in medieval Iberia. It is part of an ERC project titled: Medieval Appetites: plant foods in multicultural Iberia between the 6th and the 11th centuries coordinated by Leonor Peña-Chocarro from the Spanish National Research Council.

My research develops around the idea that plants were a key element in Medieval life. They were part of many daily and seasonal activities around producing, processing, cooking and consuming food but also, plants were used in crafts, clothing, healing, rituals, etc. (van der Veen 2018; Harstof 2017).

However, despite this important role in society, the number of medieval sites in Spain where archaeobotany has been applied is very limited.

Most of the available information comes from written sources. Christian sources offer information which in many cases relates to the elites, gathering data on rents, uses of the land, agricultural infrastructures (the presence of mills, for instance), while Islamic sources, particularly the well-known Agricultural Treatises, are more informative. They include data on crops, agricultural techniques and agronomic practices. But neither the Christian sources nor the Islamic texts provide data on the daily routines of the rural areas. As for the archaeobotanical data, there is a compilation (Peña-Chocarro *et al.* 2019) of data published a few years ago which included only 40 medieval sites, 21 Christian and 19 Islamic.

Within this framework my research aims at exploring the role of plants in medieval Iberia, focusing on the Islamic period and mostly in the southern part. The general objectives are to explore the role of plants in medieval diet and investigate how agriculture evolved after the Islamic conquest: which crops were cultivated, which novelties were introduced, what range of productive spaces were exploited (home gardens, forests, etc.).

In particular, I try to understand how medieval communities managed plant resources giving particular emphasis to farmers, to their daily activities and consumption patterns.

So, during my first year I have analyzed different sites spread throughout southern Iberia which include Islamic farms, larger settlements and other archaeological sites, which are providing very interesting results.

The dominant species are the cereals including different types of wheat (*Triticum aestivum/durum*), barley (*Hordeum vulgare*) (Fig. 1), rye (*Secale cereale*) and millets (*Panicum miliaceum*). Of particular interest is the identification of a new cereal whose presence in Iberia was unknown until now. This is the pearl millet (*Pennisetum glaucum*).

Islamic communities also cultivated legumes: broadbeans (*Vicia faba*) (Fig. 2), lentils (*Lens culinaris*), pea (*Pisum sativum*), and several vetches.

Fruits were also widely used among the Islamic communities, and in my sites we have evidence of figs (*Ficus carica*), grapes (*Vitis vinifera*), olives (*Olea europaea*), cherries (*Prunus avium*).

As for the garden plants, there are less presence but we have species like rosemary (*Rosmarinus officinalis*) or coriander (*Coriandrum sativum*).

In addition, there is also what seems to be food fragments that will be analyzed later by a specialist.

Results are still preliminary, and we need more studies from other sites, but data is very promising and I hope this research will be able to provide detailed information on the use of plants in Medieval Iberia not only to fill the existing gap but also to understand the processes of transformation and change that affected Iberian local communities under Muslim rule.

Fig. 1. Cereal crop (*Hordeum vulgare*).

Fig. 2. Legume (*Vicia faba*).

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First paleoenvironmental and archaeological investigations in the Gulf of Guinea Islands and their potential to reveal land use change and human impacts

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Keywords: Gulf of Guinea Islands, Archaeology, Paleoenvironment, Landscapes, Human Impact

The Gulf of Guinea Islands (Fig. 1) present diverse natural and historical contexts but remain a blind spot in archaeological and paleoenvironmental research. Written documents starting in the 15th century describe the landscapes encountered by Europeans, but rarely mention the deep changes caused by such encounters. The earliest and most detailed account of São Tomé and its settlement, for example, comes from the mid-16th century and describes an island covered by a thick forest of unfamiliar tree species that "seemed to touch the sky" and how Europeans cut and burned trees and vegetation to make way for a town and sugar plantations (Loureiro 1989: 29). This account is a small window into human impacts driven by colonial encounters; however, prior to the initiation of our research efforts, one could only speculate about the full scope of environmental changes in the Gulf of Guinea Islands. Our research highlights the potential of multi-disciplinary collaborations - in this case, integrating archaeological and paleoenvironmental (coring-based) research - to shed light on changes through time, generate new data, and bring this area to the attention of the scientific community, while fostering local participation through capacity-building.

The biologically and culturally diverse group of Gulf of Guinea Islands present contrasting contexts: one has a prehistoric settlement (Bioko), while others were settled only in modern history (São Tomé, Príncipe, and Annobón). However, they share crucial roles as major nodes in the colonial Atlantic empires and as locales of climatic and human driven environmental transformations. Bioko (Fernando Pó) and Mandji (Corisco) have received archaeological attention (e.g., Clist, de Maret 2020; Lorente *et al.* 2016), with Corisco resembling the adjacent mainland occupation (Cameroon and Gabon), and Bioko being culturally distinctive. The oceanic islands (São Tomé, Príncipe, and Annobón) are now starting to be investigated (Ceríaco *et al.* 2022; Castilla-Beltrán *et al.* 2023; Cruz *et al.* 2023).

São Tomé is currently the object of the country's first archaeological project (Fig. 2), which examines daily life and the environmental impact of the sugar complex on the locale where race-based slavery plantation was first implemented on a large scale in the 16th century (Cruz *et al.* 2023). A recent paleoecological study there was also the first of its kind (Fig. 3), producing a 14,000-year record of changes in montane forest composition through the Holocene associated with increase temperature and humidity, and the introduction of species associated with land clearing through fire during the last 200 years BP (Castilla-Beltrán *et al.* 2023). The study shows how São Tomé's montane forests responded to both climate change and human disturbance. Likewise, on Principe ongoing paleoecological research and exploratory archaeological survey indicates significant transformation following the colonial arrival of the Portuguese. Both islands foreground a wide variety of archaeological material, including imported and locally-made ceramics, and artifacts of possible continental origin.

The AEA paper summarized published and ongoing research, reviewing historical sources to create a base for different scenarios of human interactions with island landscapes, and arguing for expanded research on the Gulf of Guinea.

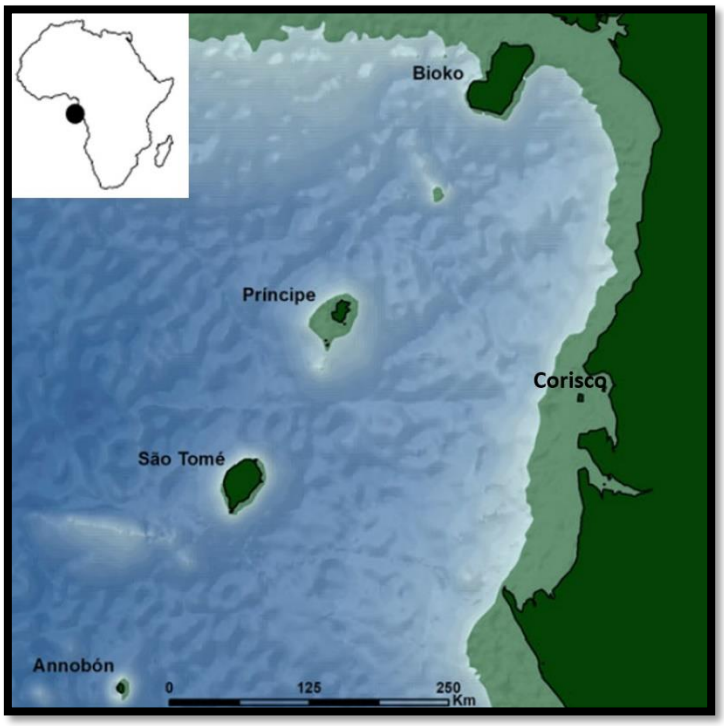

Fig. 1. Map of the Gulf of Guinea Islands: dark green, current terrestrial areas; light green, their extent during the last glacial maximum. Adapted from Ceríaco *et al.* (2022).

Fig. 2. Sugar mill and estate house of Praia Melão (São Tomé; Photo M. Dores Cruz).

Fig. 3. Lagoa Amélia (São Tomé; Photo Ricardo Lima).

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