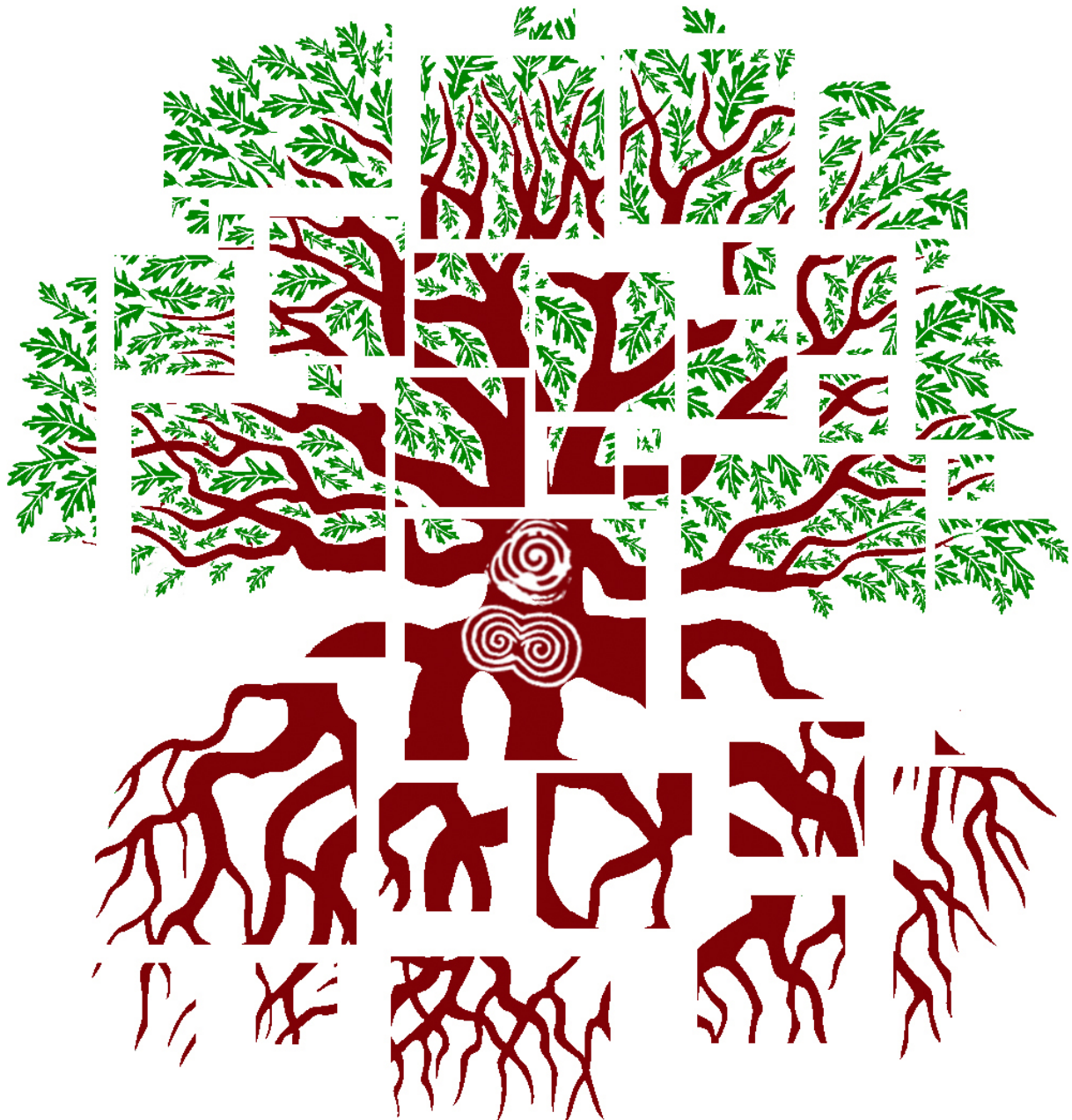


anthraco2019 – 7th International Anthracology Meeting
Charcoal Science in Archaeology and Palaeoecology

University of Liverpool – Central Teaching Hub, 2-6 September 2019

Hosted by the [Department of Archaeology, Classics and Egyptology](#)



Conference Programme & Abstracts Volume

anthraco2019 - 7th International Anthracology Meeting

Charcoal Science in Archaeology and Palaeoecology

University of Liverpool, 2-6 September 2019

Central Teaching Hub (CTH), Liverpool, L69 7BX

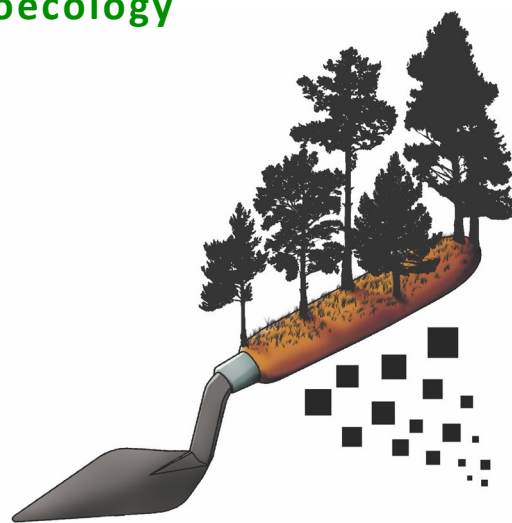
Campus zone: Central Campus

[Campus map](#) reference: F6, buildings 221 and 802



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Edited by Eleni Asouti

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Members of the Organising Committee

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Ellen Grice
Georgia Hetherington
Federico Poggiali

anthraco2019 - List of Sessions

Session 1: New Developments in Charcoal Science

This session incorporates contributions addressing the development of new methods in anthracology through the lens of related disciplines such as wood anatomy (e.g., the development of new charcoal reference collections and atlases, new developments in charcoal identification including previously unreported charcoal taxa), charcoal taphonomy (e.g., through multivariate statistical analyses, and/or actualistic and/or experimental studies), geochemistry (e.g., stable isotope science), sample selection protocols for wood charcoals, new microscopy, imaging and metrical analysis methods, etc. Presentations in this session demonstrate a strong methodological focus.

Session 2: Charcoal Science and Human Palaeoecology

Session 2 is entirely devoted to the presentation of new results from archaeo-anthracological projects focusing on palaeoenvironmental reconstruction, past wood fuel and timber uses, human landscape impacts, and/or experimental and anthropological/ethnographic studies conducted independently or in conjunction with an ongoing archaeological project. Any type of archaeological context and any period and geographical region are considered. Presentations in this session demonstrate a strong palaeoecological and/or anthropological focus.

Session 3: Dendro-Anthracology

This session focuses on recent theoretical and methodological advances in the study of tree rings in archaeological charcoals and related developments in tree ring science and ecological wood anatomy. Archaeological case studies focusing primarily on the reconstruction of fuel/timber wood exploitation strategies, woodland growth conditions and ancient woodland management regimes are included. Presentations in this session demonstrate a strong focus on dendro-anthracology and related disciplines.

Session 4: Interdisciplinary Studies

This session addresses interdisciplinary topics aiming to integrate the study of archaeological wood charcoal macro-remains with data categories derived from other sub-disciplines of environmental archaeology (e.g., the archaeobotany of plant macro- and micro-remains such as seeds, phytoliths, starch and pollen; vegetation modelling, etc.) Presentations in this session demonstrate a strong interdisciplinary focus.

Session 5: The Anthracology of Kilns and Charcoal Burning

This session focuses on recent research of charcoal production sites, and the use of charcoal as fuel in domestic and industrial contexts (e.g., metallurgy, pottery and glass kilns, etc.) Papers dealing with all aspects of charcoal production and use as fuel, their multifaceted impacts on woodland ecology and past landscapes, and/or related methodological issues and advances in these fields, are included. Presentations in this session demonstrate a strong focus on the study of charcoal production and use as fuel.

Session 6: Palaeobotany and Pedoanthracology

This session includes the study of charcoal remains originating in non-archaeological (off-site) assemblages (e.g., pre-Quaternary charcoal fossils, micro-charcoals from lakes and peat bogs, soil and sediment charcoal/ pedoanthracology). Presentations in this session deal with specific case studies as well as methodological issues, demonstrating a strong palaeobotanical and/or pedoanthracological focus.

Conference programme

Oral presentations (Lecture Theatre B, CTH)

Monday 2 September 2019

08:30 – 10:30 Conference registration
(Coffee will be available in the reception area from 9:30; delegates with posters will be directed to the poster presentation space in the GFlex Teaching Space)

10:30 – 11:00 Welcome address & Conference info

Session 1: New Developments in Charcoal Science

11:00 – 11:35 Keynote talk: **Data analysis in anthracology – Challenges and prospects**
Ceren Kabukcu, Lucie Chabal

11:40 – 11:55 **An effective sampling method for charcoal-rich layers: a case study from the Later Stone Age of Bushman Rock Shelter, Limpopo Province, South Africa**
Elysandre Puech, Christine Sievers, May Murungi, Marion Bamford, Isabelle Théry-Parisot

12:00 – 12:15 **New climatic approaches to Middle Palaeolithic sequences: combined methodology of taxonomic and isotopic charcoal analyses on two Neanderthal settlements: “Les Canalettes” (Aveyron, France) and “La Combette” (Vaucluse, France)**
Benjamin Audiard, Liliane Meignen, Pierre-Jean Texier, Thierry Blasco, Giovanna Battipaglia, Isabelle Théry-Parisot

12:20 – 12:35 **Foraging behaviours and fuel wood selection: insights from pre-agricultural habitations in the Eastern Mediterranean**
Eleni Asouti

12:40 – 12:55 **Firewood gathering strategies in Parc Nacional d’Aigüestortes i Estany de Sant Maurici (Central Pyrenees). Some proposals**
Laura Obea Gómez, Ermengol Gassiot Ballbé, Ignacio Clemente Conte, Sara Díaz Bonilla, David Garcia Casas, David Rodriguez Antón, Guillem Salvador Baiges

13:00 – 13:55 Lunch & coffee break (lunch provided at the conference venue)

14:00 – 14:15 **Investigating growth habit and stem height: applications of vessel diameter measurements in anthracology**
Ceren Kabukcu

14:20 – 14:35 **Atlas and identification key of xylophagous traces**
Magali Toriti, Aline Durand, Fabien Fohrer

14:40 – 14:55 **A new approach to digitizing and imaging the Harvard University herbaria wood slides**
Madelynn von Baeyer

15:00 – 15:15 **Comparative wood anatomy as an aid to identification of *Prunus brigantina* Villars**
Nicolas Dieudonné, Brigitte Talon

15:20 – 17:00 Open posters session (GFlex Teaching Space)

Tuesday 3 September 2019

08:30 – 08:55 (Conference reception desk open)

Session 2: Charcoal Science and Human Palaeoecology I

- 09:00 – 09:15 **A step forward into tropical regions anthracology. Vegetation and wood uses in ancient Sri Lanka based on the charcoal record from Mantai, Kirinda and Kantharodai**
Ethel Allué, Charlene Murphy, Eleanor Kingwell-Banham, Wijerathne Bohingamuwad, Gamini Adikari, Nimal Perera, Nicole Boivin, Dorian Q Fuller
- 09:20 – 09:35 **An analysis of charcoal from Sibudu cave (South Africa) for a ‘volcanic winter’ associated with the Toba super-eruption**
Bongekile Zwane, Marion Bamford
- 09:40 – 09:55 **People-plant interactions during the Late Stone Age at Wonderwerk Cave: Charcoal from the Holocene Stratum 3b, Wonderwerk Cave, South Africa**
Joseph Chikumbirike, Marion Bamford
- 10:00 – 10:15 **Woody taxa in Middle Stone Age charcoal from Rose Cottage Cave (Free State)**
Sandra J. Lennox
- 10:20 – 10:35 **Cultivated Landscapes – The case study of Mege, Nigeria**
Alexa Höhn
- 10:40 – 11:10 **Coffee break**
- 11:15 – 11:30 **Land management and wood use at Joya de Cerén, a Late Classic Maya Village**
Venicia Slotten
- 11:35 – 11:50 **Exploitation of wood resources and tropical fruit trees in the Islamic South-East Arabia: insights into plant economy of the ancient harbour city of Qalhât (XIVth-XVIth c. AD)**
Vladimir Dabrowski, Margareta Tengberg
- 11:55 – 12:10 **Vegetation, land and wood use at the sites of Bat and Al-Khashbah in Oman (4th-3rd millennium BC)**
Kathleen Deckers, Conrad Schmidt, Stephanie Döpfer
- 12:15 – 12:30 **Wood use at Chalcolithic Çamlıbel Tarlası, Turkey**
John M. Marston, Peter Kováčik
- 12:35 – 12:50 **Fuelling urbanisation: the analysis of charcoal from Late Neolithic sites along the Central Yellow River region in China**
Marvin Demicoli
- 12:55 – 14:00 **Lunch & coffee break (lunch provided at the conference venue)**
- 14:05 – 14:20 **Not just charcoal: Analysis of wood remains from aboriginal communal granaries of Gran Canaria (Canary Islands, Spain)**
P. Vidal-Matutano, J. Morales, P. Henríquez-Valido, Á. Marchante, M.A. Moreno-Benítez, A. Rodríguez-Rodríguez
- 14:25 – 14:40 **Fuel management and landscape in the context of the first occupations of the Balearic Islands: charcoal analysis at Cova des Moro (Manacor, Mallorca, Spain)**
Yolanda Carrión Marco, Jaume Conesa Coll, Damià Ramis
- 14:40 – 14:55 **Woodland species diversity and impact on the firewood exploitation strategies. An exploratory approach applied to Neolithic lacustrine sites of the French northern alpine arc**
Alexa Dufraisse, Sylvie Coubray

- 15:00 – 15:15 **Choice or chance? Use of wood resources by Neolithic lake-dwelling societies in pre-alpine SW-Germany**
Oliver Nelle, Doris Jansen, Hannes Knapp
- 15:20 – 15:35 **Contrasting the charcoal assemblages of Late Iron Age and Roman roadside settlements in north-eastern England**
Jonathan Baines
- 15:40 – 16:45 **Open posters session (GFlex Teaching Space)**
- 17:00 – 19:00 **Anthraco2019 Wine Reception at the Victoria Gallery & Museum**
Campus map reference: D 7 (building no 421)
-

Wednesday 4 September 2019

08:30 – 08:55 (Conference reception desk open)

Session 2: Charcoal Science and Human Palaeoecology II

- 09:00 – 09:15 **Fuel procurement during the Upper and Late Palaeolithic in Central Europe: analysis of wood charcoal sequences from archaeological sites from Poland, Slovakia and Hungary**
Magdalena Moskal-del Hoyo, Jarosław Wilczyński, Lengyel György, Małgorzata Kot, Damian Stefański, Magdalena Sudół-Procyk, Tadeusz Wiśniewski
- 09:20 – 09:35 **Vegetation change in southeastern Greece from the Middle Palaeolithic to Late Neolithic. The wood charcoal record from cave sites in the Peloponnese**
Maria Ntinou
- 09:40 – 09:55 **Environmental change and prehistoric landscape practices in the south-west Italian peninsula during the Pleistocene-Holocene transition**
Federico Poggiali, Domenico Lo Vetro, Fabio Martini, Eleni Asouti
- 10:00 – 10:15 **Climate versus human-driven disappearance of *Fagus sylvatica* (European beech) extra-zonal stands at low altitude in central and southern Italy: insights from archaeo-anthracological data**
Mauro Paolo Buonincontri, Gaetano Di Pasquale
- 10:20 – 10:50 **Coffee break**

Session 3: Dendro-Anthracology

- 10:55 – 11:10 **Dendro-anthracology and anthraco-typology: how does it work? A user's guide**
Sylvie Coubray, Alexa Dufraisse
- 11:15 – 11:30 **Dendro-anthracological tools applied to pinewood (*Pinus tp. sylvestris*) exploitation as fuel during the Mesolithic-Neolithic transition in NE Iberian Peninsula**
Marta Alcolea, Alexa Dufraisse
- 11:35 – 11:50 **Firewood and timber collection and management strategies from Medieval sites in Eastern England. Initial results from the anthraco-typological analysis of oak charcoal remains**
Robert Francis, Alexa Dufraisse
- 11:55 – 12:10 **Dendro-anthracology of *Pinus halepensis* Miller in prehistoric and protohistoric Mallorca (Balearic Islands, Western Mediterranean)**
Llorenç Picornell Gelabert, Alexa Dufraisse, Martín de Luís Arrillaga, Maurici Mus Amézquita

Session 4: Interdisciplinary Studies I

- 12:15 – 12:30** **Harvesting the Mediterranean forest: wood, wild fruits and crop management during the Neolithic and the Bronze Age in Corsica. New archaeobotanical data**
 Claire Delhon, Isabel Figueiral, Laurent Bouby, Thomas Perrin, Pascal Tramoni
- 12:35 – 12:50** **Charcoal macro-remains analysis in an integrated landscape research: land-use in a long-term and multidisciplinary perspective (Ter High Mountain Valleys, Eastern Pyrenees, Spain)**
 Josep Maria Palet, Valentina Pescini, Massimiliano Fossati, Lídia Colominas, Arnau Garcia, Hèctor A. Orengo, Tania Polonio
- 12:55 – 14:00** **Lunch & coffee break (lunch provided at the conference venue)**
- 14:05 – 14:20** **Food for the dead, fuel for the pyre: symbolism and function of plant remains in the Roman cremation necropolis of Bracara Augusta (Portugal)**
 Filipe Costa Vaz, Cristina Braga, Cláudia Oliveira, João Pedro Tereso, Luís Fontes, Manuela Martins
- 14:25 – 14:40** **The history of pines and pinewoods in western Iberia: a revision of archaeobotanical data**
 João Pedro Tereso, Cláudia Oliveira
- 14:45 – 15:00** **Long-term history of woodland under human impact: archaeo-anthracological synthesis for lowlands in the Czech Republic**
 Jan Novák, Petr Kočár, Romana Kočárová, Vojtěch Abraham
- 15:05 – 15:20** **Blooming of the Byzantine sustainable agricultural society in the Negev desert (Israel) and its abrupt decline**
 Dafna Langgut, Yotam Tepper, Mordechai Benzaquen, Guy Bar-Oz
- 15:25 – 15:40** **Ritual and routine: distinguishing activities from fuelwood**
 Dana Challinor
- 15:45 – 17:30** **Charcoal open lab demo session (CTH Environmental Sciences lab; 1st floor)**
 Open posters session (GFlex Teaching Space)
- 18:00 – 20:00** **Anthraco2019 Scientific Committee meeting**

Thursday 5 September 2019

- 08:30 – 08:50** (Conference reception desk open)
- 09:00 – 09:30** **Keynote talk: Beyond wood anatomy**
 Alan Crivellaro

Session 5: The Anthracology of Kilns and Charcoal Burning

- 09:35 – 09:50** **Forest dynamics of the Euganean Hills (Padua, Italy): when the anthracology of charcoal kilns and historical cartography explain the origin of forest landscapes**
 Sandrine Paradis-Grenouillet, Giuseppe Bazan
- 09:55 – 10:10** **A review of 2000 years of charcoal production in the Low Countries**
 Koen Deforce, Bert Groenewoudt
- 10:15 – 10:30** **Searching for the charcoal burners heritage - Interconnecting forest history, anthracological research and local people**
 Thomas Ludemann
- 10:35 – 11:05** **Coffee break**

- 11:10 – 11:25** [The analysis of archaeological charcoal assemblages from Chigaramboni archaeo-metallurgical sites, south eastern Zimbabwe](#)
Joseph Chikumbirike, Marion Bamford, Amanda B. Esterhuysen
- 11:30 – 11:45** [Anthracological analyses of charcoal kilns at a high spatial resolution: a way to better understand the charcoal production and the related forest history?](#)
David Gocel-Chalté, François Guerold, Hannes Knapp, Vincent Robin
- 11:50 – 12:05** [The need for dendrochronology to improve the temporal resolution of charcoal manufacturing activity in the French Eastern Pyrenees: the case of the ancient charcoal-production forest of Bernadouze \(Suc-et-Sentenac, Haut-Videssos\)](#)
Léonel Fouédjeu, Mélanie Saulnier, Vincent Labbas, Mathieu Lejay, Sandrine Buscaino, Vanessa Py-Saragaglia

Session 4: Interdisciplinary Studies II

- 12:10 – 12:25** [The xylophagi of the wooden floor of Camelin block \(Fréjus, France\): interdisciplinary approaches through archaeology and anthraco-entomology](#)
Magali Toriti, Pierre Excoffon, Aline Durand, Fabien Fohrer
- 12:30 – 12:45** [Charcoal hearth soils as environmental archives. A case study from Central Italy \(Poggio di Montieri\)](#)
V. Pescini, G. Certini, G. Mastrolonardo
- 12:50 – 13:55** Lunch & coffee break (lunch provided at the conference venue)
- 14:00 – 14:15** [Reconstructing past multiple land use systems: the 5T.ERA \(5 Terre Environmental Resource Archaeology\) multi-proxy project](#)
R. Cevasco, N. Gabellieri, B. I. Menozzi, C. Montanari, A. Panetta, V. Pescini
- 14:20 – 14:35** [Fire use and agroforestry in tropical forests \(Guatemala\)](#)
L. Dussol, L. Purdue, B. Vannière, M. Testé, S. Morell-Hart, I. Théry-Parisot, A. Garnier, E. Lemonnier, C. Castanet
- 14:40 – 14:55** [Preliminary charcoal and phytolith analysis from an early Swahili daub house at Unguja Ukuu, Zanzibar \(c. 7th-14th century AD\)](#)
Welmoed Out, Stephanie Wynne-Jones, Peter Mikkelsen, Federica Sulas
- 15:00 – 15:15** [Herod the Great royal Roman gardens come alive: charcoal remains and pollen analysis](#)
Dafna Langgut
- 15:20 – 17:30** Charcoal open lab demo session (CTH Environmental Sciences lab; 1st floor)
Open posters session (GFlex Teaching Space)
- 19:00 – 22:00** Conference Dinner (The Pen Factory, 13 Hope Street, Liverpool, L1 9BQ)
<https://www.pen-factory.co.uk>

Friday 6 September 2019

08:30 – 09:30 (Conference reception desk open)

Session 6: Palaeobotany & Pedoanthracology

09:35 – 09:15 **A case of Medieval deforestation in southern Tuscany (850-1050 AD): an isolated local event or the onset of wide-ranging socioeconomic growth?**

Mauro Buonincontri, Marta Rossi, Gaetano Di Pasquale

09:20 – 09:35 **Assessing the function of Palaeolithic hearths: experiments on intensity of luminosity and radiative heat outputs from different fuel sources** [Session 2 Oral Presentation]

Sally Hoare

09:40 – 09:55 **Pedoanthracological data to understand the past and current fir (*Abies alba*) distribution in NE Iberian Peninsula**

Raquel Cunill Artigas, Albert Pèlach Mañosa, López Soriano, Manuel Joan; Jordi Nadal Tera, Marc Sánchez-Morales, Ramon Pérez-Obiol

10:00 – 10:30 Coffee break

10:35 – 10:50 **Typology of soil charcoal assemblages in the forest-steppe zone**

Elena Ponomarenko, Ekaterina Ershova, Pille Tomson

10:55 – 11:10 **Ecological niches of oaks versus beech forest trees documented by pedoanthracology in forests of the Lorraine Plateau (France)**

Thomas Feiss, Vincent Robin, Delphine Aran, Thierry Paul, Jean-Luc Dupouey

11:15 – 11:30 **Assessment of past fire regime in northern central Europe based on a multiscale and multi-archive paleo-signal**

Vincent Robin, Oliver Nelle

11:35 – 12:05 Plenary Session – Anthraco2023

13:30 – 15:00 Tour of the Archaeology labs & the Garstang Museum of Archaeology (meeting point: Abercromby Square Garden - [Campus map](#) reference: E 3)

Poster presentations

(all posters will be on display for the duration of anthraco2019 in the GFlex Teaching Space, adjacent to the conference lecture theatre)

Looking for the invisible: anthracological analysis to reveal ritual action in the Eneolithic cremation of Apulia (SE Italy)

Giorgia April, Girolamo Fiorentino

Dendrological studies application on two charcoal kilns in Madonie Park (Palermo, Italy). Preliminary results about the exploitation of *Fagus sylvatica* in 14th century A.D.

Sabrina Bianco, Sandrine Paradis-Grenouillet, Ethel Allué, Forgia Vincenza, Josep M. Vergès

Wood technology of Patagonian hunter-gatherers: selection and use of woody resources as raw material

Laura Caruso-Fermé

Woodworking technology during the Early Neolithic: first results of the site of La Marmotta (Italy)

L. Caruso-Fermé, M. Mineo, M. Ntinou

Spatial analysis of firewood charcoal fragments in archaeological levels: issues for palaeoecological interpretation in anthracology

Lucie Chabal

Climatic signals in the wood anatomy of *Quercus pyrenaica* Willd. and *Pinus pinaster* Aiton from northeast Portugal: Baseline for continuing studies

Leonardo Da Fonte

Wood exploitation between Kura and Araxes valley (Southern Caucasus) from the Neolithic to Early Bronze Age

Alexa Decaix, Reinder Neef

Vegetation reconstruction in the ClaSS (Climate, Landscape, Settlement and Society: Exploring Human-Environment Interaction in the Ancient Near East) Project

Katleen Deckers, Simone Riehl, Michelle De Cruchy, Valentina Tumolo, Dan Lawrence

Reconstructing the history of the *silva carbonaria*, an enigmatic charcoal-burners-forest in Central Belgium

Koen Deforce, Jan Bastiaens, Johan De Grave, Philippe De Smedt, Elke Ghyselbrecht, Nasrin Karimi Moayed, Erwin Meylemans, Sara Schalbrock, Kris Vandekerckhove, Dimitri Vandenberghe

Morphometric and dendrometric observations on waterlogged wood: the case study of a 4th century BC well at Taranto "Torre Montello", Salento, Italy

Lou Godefroy

The anthracological results from la Cova del Sardo (Parc Nacional d'Agüestortes i Estany de Sant Maurici, Central Pyrenees)

Laura Obea Gómez, Mireia Celma Martínez, Ermengol Gassiot Ballbé, Ignacio Clemente Conte, Sara Díaz Bonilla, David Rodríguez Antón, Guillem Salvador Baiges

Burning wood over 2300m a.s.l. in the Central Pyrenees. Anthracological results from Abric de l'Estany de la Coveta I and Abric de les Obagues de Ratera (Parc Nacional d'Aigüestortes i Estany de Sant Maurici)

Laura Obea Gómez, Mireia Celma Martínez, Ermengol Gassiot Ballbé, Ignacio Clemente Conte, Sara Díaz Bonilla, David Rodríguez Antón, Guillem Salvador Baiges

Charcoal identification of the semi-deciduous and deciduous oak species of the Salento Peninsula (SE Italy) and their relevance to archaeological contexts: a metric approach

A.M. Grasso, E. Vaccab, G. Fiorentino

Charcoal analysis of kiln terraces to reconstruct practices and wood uses' temporalities for charcoal manufacturing activity: the case of the Bernadouze forest (Suc-et-Sentenac, Haut-Vicdessos)

Léonel Fouédjeu, Mélanie Saulnier, Raquel Cunill Artigas, Sandrine Buscaino, Vanessa Py-Saragaglia

Sustainable management of wood for charcoal manufacturing activity in the Northern Pyrenees: dendro-anthracological study of charcoal kilns in the Bernadouze forest (Suc-et-Sentenac, Haut-Videssos)

Léonel Fouédjeu, Sandrine Paradis-Grenouillet, Mélanie Saulnier, Raquel Cunill Artigas, Sandrine Buscaino, Vanessa Py-Saragaglia

Fire and forest management: an anthracological approach to relative dating of suspected pit kilns containing coppice

E. van Hees, M. van Zon, J. Pijnnaken-Vroeijenstein

A charcoal study to better understand lynchet construction and lynchet landscape history

Benjamin Keller, Vincent Robin, Pierre-Alexis Herrault, Damien Ertlen, Dominique Schwartz

Neolithic wood use and forest exploitation. Comparison of anthracological and xylotomical data from three Neolithic wells from the Czech Republic

Romana Kočárová, Petr Kočár, Jan Novák, Michal Rybníček

Wood management in the ceremonial building of the Na Galera islet (Balearic Islands, Western Mediterranean): fuel, timber and coastal vegetation at the end of the first millennium BC

Yolanda Carrión Marco, Llorenç Picornell Gelabert, Alexa Dufraisse, Ramón Martín Gordon, Jorge Argüello

Bronze Age and Middle Ages in the Southeast of the Iberian Peninsula (Spain): New Approaches to Sampling in Number of Wood and Charcoal Analysis and Fraction Size

Mireia Celma Martínez

Wood as structural element at the houses of Akrotiri, Thera. The anthracological evidence

Antigoni Mavromati

Wood charcoal assemblages from the loess upland zone of western Lesser Poland

Magdalena Moskal-del Hoyo

Vegetation changes around Sarakenos Cave (Boeotia, Greece) from the late Pleistocene to the mid-Holocene: the study of charred wood and non-wood plant macro-remains

Magdalena Moskal-del Hoyo, Lina Karathanou, Maria Ntinou, Małgorzata Kaczanowska, Janusz K. Kozłowski, Antonia Tsourouni, Adamantios Sampson

Combining charcoal and magnetic susceptibility analyses: evaluation of post-depositional processes in unit IV from Abric del Pastor (Middle Palaeolithic, Iberia)

P. Vidal-Matutano, Á. Carrancho, C.M. Hernández, C. Mallol, B. Galván

Ship ahoy! Evaluation of waterlogged wood remains from El Burrero shipwreck (Gran Canaria, Canary Islands, Spain)

P. Vidal-Matutano, J. Mata-Mora, J. Guillén-Medina

Pedoanthracological records as tools for revelation of the forest history in the Khan Khentii Mts. (northern Mongolia)

Jan Novák, Antonín Kusbach, Tadeáš Štěrba

The Late Holocene forest transformation in sandstone landscapes of the Czech Republic

Jan Novák, Petr Šída, Jiří Svoboda, Petr Pokorný

Woodlands and farmlands in Bronze Age central Greece. Insights from archaeobotanical assemblages from the sites of Agia Paraskevi, Kynos and Mitrou (Phthiotida)

Maria Ntinou, Aggeliki Karathanou, Clemence Pagnoux, Sultana-Maria Valamoti

Automatic detection of ancient charcoal production platforms through LiDAR observations: is it an effective method?

Cláudia Oliveira, Pierre-Alexis Herrault, Vincent Robin, Simon Devin

Charcoal and coal: charcoal: energy resources with a strong impact on the past environment and ongoing stakes for energy transition

Cláudia Oliveira, Vincent Robin, Simon Devin

Firewood selection strategies for combustion events during Late Holocene hunter-gatherer occupations in South America (Córdoba, Argentina)

Andrés Robledo

Crossing molecular study of ashy sediment and taphonomy to date and to reconstruct fuel management strategies and paleoenvironments at Le Rocher de l'Impératrice (Plougastel, France) during the Lateglacial Azilian occupation)

Isabelle Théry-Parisot, Samuel Abiven, Erwan Messenger, Nicolas Naudinot

Mid-Holocene archaeobotanical record from the Atlantic band of Cádiz (SW Spain) based on pollen and charcoal data

Paloma Uzquiano, Blanca Ruiz-Zapata, José Gil-Garcia, Eduardo Vijande, José Ramos

Anthracological analysis of charcoal from the Bronze Age site of Erlitou (Henan province, China)

Shuzhi Wang, Haitao Zhao, Guoliang Chen, Xu Hong, Marvin Demicoli

Abstracts

Oral presentations

Session 1: New Developments in Charcoal Science

Data analysis in anthracology – Challenges and prospects

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This paper seeks to provide new insights into issues relating to data analysis and quantification in anthracology as applied to the remains of wood fuel waste found in archaeological sites. Following on from over four decades of research and debate into the quantification potential of anthracological remains, we revisit fuel waste discard patterns and taphonomic considerations based on observations from archaeological case studies. Our aim is to provide a review of the methodological considerations pertinent to the field sampling, laboratory analysis and quantitative analysis of anthracological remains. Finally, we examine some new avenues for data analysis in anthracology, including multivariate analyses, with the aim to stimulate future debate on this issue.

An effective sampling method for charcoal-rich layers: a case study from the Later Stone Age of Bushman Rock Shelter, Limpopo Province, South Africa

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The prehistoric site of Bushman Rock Shelter, situated south of the Limpopo River, yielded a well-stratified c.7m thick archaeological sequence extending from the Middle Stone Age to the Iron Age periods. The stratigraphic deposits are predominantly anthropogenic alternating between diffuse ashy layers and charcoal-rich lenses interpreted as the remains of combustion structures. The anthracological analysis focuses on the well-dated Later Stone Age occupations dated between ca. 15,6 kyr and 10,7 kyr cal BP, including one of the rare archives of the Late Pleistocene/Holocene transition (LPHT) in the Summer Rainfall Zone (SRZ), a critical yet still poorly understood period. A first diagnosis reveals a high number of macro-charcoals with a high degree of preservation of up to >600 fragments per “decapage” and per sub-square for the most charcoal-rich layers, for which the larger pieces could measure more than 2cm long. Since identification of wood anatomical features and signatures can be time-consuming, especially in species-rich woodland environments, this observation raises the issue of the best methodology to adopt in terms of effectiveness and depending on the research question. We have selected 3 stratigraphic units with charcoals scatters resulting from long-term deposition and mixing, dated to the beginning of the Holocene at c. 11 kyr BP, that are associated with an Oakhurst lithic industry as well as seeds, faunal remains and ornaments. Charcoal fragments from each “decapage” were separated into 5 size-classes with meshes ranging from 3-5mm, 5-10mm, 10-15mm, 15-20mm and >20mm, were weighed and counted,

and then analysed until reaching the saturation curve for each size-category. Depending on the spatial diversity and the inter-species fragmentation of the assemblage, an adapted sub-sampling strategy is recommended for determining the most effective and reproducible method for each of the units of the Later Stone Age sequence. The main purpose is to obtain a manageable sub-sample size and assess the degree to which the richness of the sample adequately reflects the richness of the underlying deposit, and how the sampling method chosen may affect the representation of the past woodland vegetation.

New climatic approaches to Middle Palaeolithic sequences: combined methodology of taxonomic and isotopic charcoal analyses on two Neanderthal settlements: “Les Canalettes” (Aveyron, France) and “La Combette” (Vaucluse, France)

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During the last decade several works have pointed out the potential of the $d^{13}C$ isotopic signal as an additional proxy to taxonomic charcoal identification for palaeoclimatic/palaeoenvironmental reconstruction. These studies mainly focused on archaeological charcoal from Holocene series but the potential of the method for Pleistocene sequences is still debated. Understanding climate-driven variability in stable carbon isotope ratios of modern samples is fundamental for the accurate characterization of past climate information based on the $d^{13}C$ of charred material. In a previous study, we had laid out the methodological basis for applying the method to Pleistocene contexts. In this paper, we present the $d^{13}C$ isotopic signal from *Pinus* spp. wood charcoal in two different well-stratified middle Palaeolithic sites with two approaches: (i) the site of “Les Canalettes” (Aveyron, France) involves the analysis of individual charcoal fragments, and (ii) the site of “La Combette” (Vaucluse, France) involves the analysis of pooled charcoal specimens. We demonstrate that the use of isotopic analyses on ancient charcoal of the genus *Pinus* from the Quaternary period provides an important and reliable palaeoclimatic marker. In both case studies the importance of an accurate field sampling procedure for obtaining accurate data is emphasised.

Foraging behaviours and fuel wood selection: insights from pre-agricultural habitations in the Eastern Mediterranean

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This paper provides a commentary on the differences observed in charcoal taxon representation between pre-agricultural (i.e., Palaeolithic and early Pre-Pottery Neolithic) and later Neolithic agropastoral habitation sites in the Eastern Mediterranean. The presence of a persistent diachronic trend in charcoal assemblage composition is demonstrated, characterised by increasing taxon diversity through time. A range of possible explanations are explored, centred on a re-assessment of the classic model of the Principle of Least Effort (PLE), alongside their pertinence for interpreting the impact of environmental and/or socioeconomic parameters on prehistoric fuel wood selection.

Firewood gathering strategies in Parc Nacional d'Aigüestortes i Estany de Sant Maurici (Central Pyrenees). Some proposals

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The occupation of High Mountain environments by humans since the beginning of the Holocene has been demonstrated by different disciplines in the last decades alongside the impact the different activities documented have had on the landscape. Thanks to the research developed by the Grup d'Arqueologia d'Alta Muntanya (GAAM) in the Parc Nacional d'Aigüestortes i Estany de Sant Maurici (PNAESM) c. 350 sites of archaeological interest have been fully recorded. Three of these sites have been completely excavated showing a sequence of intensive occupations since the Mesolithic. In this paper we highlight the constant need of heat and light by the groups of people who lived in those sites for a while and, thus, how firewood management might have constituted an important activity for them in terms of time and effort. Since some of the sites are located above the tree line, the integration of anthracological, dendrological, palynological and geographical data stands out as an interesting way to approach firewood management in the past. The evidence we have permits presenting some hypotheses about how firewood gathering was carried out by the groups living in those sites between the ninth and second millennia BP and how the Principle of Least Effort might represent a simplistic explanation of firewood gathering. Provided the flexibility it has, added to the particularities of high mountain environments, we believe that collecting wood might have been linked to other productive activities such as hunting or farming, thus proposing a more holistic approach to landscape management.

Investigating growth habit and stem height: applications of vessel diameter measurements in anthracology

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Over the past two decades observations of tree-ring morphology alongside minimum log diameter estimations on anthracological remains have offered important methodological developments for the investigation of woodland management practices in the past, log size selection and (to a certain extent) woodland growth habit. One particular issue is determining age and position along the tree in order to infer stem/log cutting practices. One wood anatomical feature which may easily be incorporated into qualitative and/or quantitative estimations of log diameter is earlywood axial conduits. From the apex to the base of the stem, along the same growth ring, earlywood vessels/tracheids widen; similarly, across the transverse plane of the trunk earlywood conduits are narrower close to the pith while they widen towards the outer annual growth rings. This paper presents preliminary results of the application of earlywood axial conduit measurements. I discuss the findings in the context of inferring stem/tree height and growth habit (e.g., determination of dwarf/stunted growth) in a case study from a Medieval site in the Lake District (UK).

Atlas and identification key of xylophagous traces

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The xylophagous insects are the predators of wood. Depending on the species, they attack live trees, dead branches on the ground, stored logs and even timber. Some feed on a particular wood species, while others are less specialised. Lignivorous fungi can facilitate and accelerate wood infestation by pests. In anthracology and wood anatomy the only method currently available to detect them, is through the analysis of the remains left by the larvae after their passage through the wood tissue. The identification of these traces (galleries and frass), different for each species, allows several new interpretations: a better knowledge of the lifecycle (and death) of a tree or timber structure; apprehending the condition of archaeological wood; highlighting the choices of past populations; and, providing environmental indicators. This paper presents a new reference set, in the form of an atlas and an identification key. This tool consists of an insect file with functional macroscopic and microscopic characteristics. Finally, a small set of examples of archaeological applications are presented in order to demonstrate the interpretative potential of this methodology (timber, craft, funerary, re-use, waterlogged wood, etc.) A new project is in the process of development for acquiring new data on different species of xylophagous pests depending on the chronology and their localization. The principal objective is to obtain information on the evolution of pest species and on human choices such as the use of dead wood across different archaeological contexts.

A new approach to digitizing and imaging the Harvard University herbaria wood slides

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This paper presents an ongoing project digitizing and imaging the wood slide collection from the Harvard University Herbaria. The HUH wood slide collection is a diverse repository comprising primarily tropical wood species from all over the globe numbering >30,000 microscope slides collected approximately between 1890 and 1975. The goal of this project is to raise awareness of this fantastic collection to myriad disciplines and to develop a system that utilizes cutting edge technology to make this resource available to all researchers. This paper outlines the workflow created for imaging and digitizing this collection, as well as highlighting some of the unique challenges this collection poses.

Comparative wood anatomy as an aid to identification of *Prunus brigantina* Villars

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An attempt has been made to characterise the wood anatomy of an endemic species of plum, *Prunus brigantina* Villars, in order to be able to distinguish it from other ecologically related *Prunus* species, in particular *Prunus spinosa* L. Nothing is known about the origin of this southern inner French Alps endemic tree. We aim to conduct a pedoanthracological study in order to know a little more about the history of this taxon, on the condition that its charcoal can be anatomically differentiated from other *Prunus* spp. charcoals likely to be present in sediments from the same sites. To our knowledge, the anatomy of the secondary xylem of the Briançon plum tree has never been described before. We harvested and charred the wood of 9 different individuals of *P. brigantina*, which we have described according to the IAWA codification and also compared to the wood of 5 individuals of *P. spinosa*. A statistical analysis permits isolating discriminant intraspecific anatomical criteria, and testing the interspecific variability of these criteria. This first comparative wood anatomical study will be tested and continued with other *Prunus* spp. such as *P. padus* and *P. domestica*.

Session 2: Charcoal Science and Human Palaeoecology

A step forward into tropical regions anthracology. Vegetation and wood uses in ancient Sri Lanka based on the charcoal record from Mantai, Kirinda and Kantharodai

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The aim of this study is to present the anthracological results from three archaeological sites located at the north and southeast of Sri Lanka. Kirinda, Kantharodai and Mantai were recently excavated and sampled for archaeobotanical remains including charcoal (Murphy et al. 2018, Kingwell-Banham et al. 2019). This study is based on the observation of 1866 charcoal fragments using the support of the reference collection of South Indian wood at the Institute of Archaeology (UCL), the Kew Garden wood anatomy collection and several wood anatomy atlases (Asouti and Fuller 2008, InsideWood 2004 onwards). Kirinda (500-900 AD), a fishers' settlement, has yielded 24 taxa including Fabaceae (*Dalbergia*, *Acacia*) and Rubiaceae belonging to deciduous forest and open savanna woodlands. Kantharodai (170-400 BCE), an urban site, has yielded 19 taxa from arid zones (Fabaceae, Rubiaceae), mangroves (Rhizophoraceae) and dune zones (cf. *Cocos nucifera*). Mantai (200 BCE-850 AD), another urban site, has yielded 25 taxa with significant presence of cf. *Cocos nucifera* amongst other taxa. With this dataset, we attempt to identify patterns related to the use of the ecological interfaces between the forest and the open plains used and actively managed by humans, and assess whether this changed with an increase in maritime trade and the adaptation of agriculture. This study provides evidence on differences in the vegetation and on specific uses of wood for fuel or other purposes at each site. It also throws light on tropical anthracology regarding the issues of quantification and accuracy in taxa identification.

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An analysis of charcoal from Sibudu Cave (South Africa) for a 'volcanic winter' associated with the Toba super-eruption

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The super-eruption of Mount Toba c.74,000 years ago (ka) in the Sumatra Island, Indonesia, remains one of the most significant events that shaped human prehistory. It has been hypothesised that the aftermath of this super-eruption resulted in a long 'volcanic winter' that disturbed the ecosystem and drove the late Pleistocene human populations to near extinction. While this disaster may have been catastrophic in some parts of the world, there are archaeological sites in southern Africa that have evidence of continuous human occupation spanning the time of the Toba super-eruption and may thus provide clues about how late Pleistocene hunter gatherers survived this event. This ongoing study investigates the presence of 'volcanic winter' conditions in KwaZulu Natal, South Africa, using archaeological charcoal from the Sibudu and Border caves. In this paper we present the preliminary results for the qualitative analysis of charcoal from the Middle Stone Age layers of Sibudu cave. Fifty-one charcoal types have been identified from the Sibudu charcoal assemblage derived from a 30cm archaeological deposit that is dated through Optically Stimulated Luminescence (OSL) between 72.5 ± 2.0 ka and 73.2 ± 2.3 ka, corresponding to approximately 1000 years after the eruption of Mount Toba. The species diversity in the wood collected within this period changes slightly through time, with a greater number of charcoal pieces and species diversity found at the bottom of the sequence, dated to c.73 ka. Some taxa, such as *Podocarpus*, occur throughout the sequence and in varying proportions. The results indicate that the Sibudu landscape was populated by bushveld, forest and scrubland vegetation types which commonly featured evergreen woody vegetation, as indicated by taxa belonging to the Celastraceae and Podocarpaceae families. A closer look at the charcoal fragments, however, shows that many species were collected as dead wood at this time. This follows the notion that 35% of the charcoal types as well as several unidentified fragments have signs of attack by insects before their wood was burnt, suggesting a long-lasting outbreak of pests in the local landscape. Furthermore, towards the end of the 1000-year period (c. 73-72 ka) the people at Sibudu cave burnt wet wood. Deep surface checks or internal radial cracks are seen in the charcoal of ~30% of the species identified at this site. We argue that, following the super-eruption of Mount Toba, there may have been unfavourable conditions in KwaZulu Natal that resulted in the death of many woody species. Although the intensity of these conditions cannot be confirmed at this stage from charcoal data, they may have prompted late Pleistocene hunter gatherers to burn wet or very young wood by c. 72 ka.

People-plant interactions during the Late Stone Age at Wonderwerk Cave: Charcoal from the Holocene Stratum 3b, Wonderwerk Cave, South Africa

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Wonderwerk Cave is situated in the Northern Cape Province of South Africa at the edge of the Ghaap plateau in the Kuruman Hills. The current vegetation biome is savanna woodland, but the cave is very close to the grassland biome. The study focuses on anthracology for understanding human-plant relations in the past. Well-preserved charcoal from Stratum 3b dating to 4416-2800 cal BP was studied as a palaeoenvironmental proxy. In addition, a modern vegetation reference collection was established by collecting tree species at Wonderwerk. A sample of 342 charcoal fragments were analysed. The species found in Stratum 3b are compared to those from the earlier Holocene Strata 4 and 5 at the cave, which span the time period c.14,000-4400 cal BP, in order to assess changes over time in wood exploitation at the cave and palaeoenvironmental conditions in the surrounding region. The study shows that the diversity of taxa is relatively low, and is likely to reflect firewood collection close to the site.

Woody taxa in Middle Stone Age charcoal from Rose Cottage Cave (Free State)

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A vegetation record for the Rose Cottage, RCC area from the Middle Stone Age (MSA) layers dated to about 96,000 to 35,000 years ago (ka) was produced from anthracology. The aim was to botanically identify charcoal from the sequence, and investigate transitions between plant communities through time. The hypothesis was that interglacial and glacial phases encouraged the establishment of different vegetation communities; thus, relatively frost-sensitive plants should occur in the 96-75ka interglacial period while *Protea* and *Erica* are likely to have been predominant in the vegetation during the Rose Cottage glacial occupations post-75ka. The oldest assemblages from about 96 to 70ka contain a pre-Howiesons Poort lithic assemblage, while the Howiesons Poort Industry was between about 70-60ka and the post-Howiesons Poort assemblages studied here have ages between about 60 and 35 ka. The anthracological analysis revealed that before 70ka ago, charcoal specimens represented *Celtis africana*, *Erica caffra*, *Kiggelaria africana*, *Searsia* cf. *dentata* and *Vitex* cf. *rehmannii*. Thereafter, the younger layers yielded charcoal specimens representing *Buddleja salvifolia*, *Canthium* cf. *ciliatum*, *Erica caffra*, *Leucosidea sericea*, *Protea caffra* and *Vangueria* cf. *infausta*. The vegetation from relatively warm Marine Isotope Stage (MIS) 5 seems more diverse than the later vegetation of MIS 4 and MIS 3.

Cultivated Landscapes – The case study of Mege, Nigeria

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Human agents have shaped the West African savannas with intentional fires, pastoralism and eventually food-production in such a manner that cultivated landscapes constitute large areas of this biome today. However, grasping the timing of and characterizing the nature of vegetation changes after the beginning of the Late Holocene and eventually leading to the present situation remains difficult. Palynological archives are rare, especially in the drier parts of the savannas, and separating climatically induced changes from human impact using pollen spectra remains challenging. Here, the analysis of archaeological charcoal offers the potential to generate new insights into these outstanding questions. It is ubiquitously present in most archaeological sites in West Africa and often well preserved. For the most part, these charcoal remains are derived from fuel wood, which had been collected in the cultivated landscape, in fields and fallows. This archive is thus well suited to tracing how human land use directly shaped the woodland vegetation in the vicinities of the sites. Based on the analysis of charcoal from archaeological sites in several key regions in West Africa, the project “Cultivated Landscapes” aims to develop a model which relates past formation, propagation, and development of these cultural landscapes to land-use practices and their connected social processes, such as the adoption of certain livelihoods and innovations, as well as to the environmental settings. The selected sites are located between the Atlantic coast in Senegal and Lake Chad, date between 1000 BCE and 1500 CE and differ in cultural contexts, adopted land use strategies, environments and time depths. Analysing similarities and differences between the sites’ charcoal assemblages is expected to enable the merging of local information to gain insights on the supra-regional level. The first case study is conducted on the charcoal assemblage of Mege, a site in the western Chad Basin. Vast flooding and restricted space during the rainy season characterized and still characterize today the mostly treeless environment. Starting in 800 BC, the site spans more than 2000 years of occupation. In the first millennium BCE mainly wild plants were gathered, but the presence of domesticated pearl millet and okra attest to cultivation as a supplementary strategy. The Common Era witnessed a more diversified use of plants, integrating several new crops into the subsistence economy but still relying on the collection of wild plants as well. Changing land use and intensification, culminating in the advent of cotton cultivation around 1500 CE, are expected to have modified the woody vegetation. Additionally, pastoral activities influenced the vegetation throughout the occupation of the site. Charcoal assemblages are currently analysed with the aim of tracing vegetation changes. The focus is to identify the beginning of the impoverishment of the local savanna and to link it to changes in or duration of subsistence practices as evidenced in the carpological record.

Land management and wood use at Joya de Cerén, a Late Classic Maya Village

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The Late Classic Maya village of Joya de Cerén has extraordinary preservation due to the eruption of Loma Caldera around 650 CE. The preservation resulting from the rapid deposits of volcanic ash allow for a unique opportunity to recover organic material and therefore understand what plant species ancient commoners in Mesoamerica utilized in their daily lives for food consumption, medicinal applications, fuel, and construction purposes. The diverse plant assemblage identified from this site shows the wide array of foodstuffs readily accessible to these humble village inhabitants on a daily basis. While Cerén has spectacular preservation of earthen-made household structures, gardens, and extensive outfields growing maize, manioc, and numerous weedy species, this paper will focus on the anthracological remains recovered from excavations in various forms. The physical remnants of trees that used to grow within the village have preserved through (a) entire branches recovered carbonized within the maize fields, and (b) plaster casts of branches, pods, and seeds found within the village centre. The assemblage of wood remains reveal a variety economically significant trees that were cultivated surrounding the domestic structures and also within the agricultural fields including avocado (*Persea americana*), calabash (*Crescentia alata*), cacao (*Theobroma cacao*), guava (*Psidium guajava*), rubber tree (*Castilla elastica*), matapalo (*Clusia* sp.) and nance (*Byrsonima crassifolia*). Wood charcoal recovered via flotation samples taken throughout the archaeological site reveal the surrounding ecosystems that Cerenians would have visited regularly to obtain their wood resources such as dry savannas, moist-mixed forests, wetlands, swamps, or even distant seashores. Wooden beams recovered directly from domestic structures also reveal what material the Maya favoured for construction purposes. The data collected from the long history of archaeobotanical research at Cerén suggests that these ancient rural agriculturalists practiced sustainable land management strategies which today we would consider to be agroecological.

Exploitation of wood resources and tropical fruit trees in the Islamic South-East Arabia: insights into plant economy of the ancient harbour city of Qalhât (XIVth-XVIth c. AD)

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Until today no anthracological study concerning the Islamic period in the Arabian Peninsula has been published. Recent results from the site of Qalhât in Oman thus provides us with a unique opportunity to get a first glimpse of the exploitation and use of wood resources by the population of this major harbour city dated from the 14th to the 16th centuries AD. The analysis of charcoal assemblages from a housing complex (B94) as well as from a craft workshop (B39) shows that different plant communities in the site environs were visited for fuel collection. Thus, open thorny woodlands surrounding the site, mainly composed of acacia (*Acacia* sp.), jujube tree (*Ziziphus* sp.), prosopis (*Prosopis* cf. *cineraria*), capper (*Capparis* sp.) and *Maerua* sp. as well as plant communities of saline habitats like tamarisk (*Tamarix* sp.) have been exploited as fuel resources. Some taxa attested in the assemblages grow today only in more elevated areas in the close al-Hajjar mountains such as *Dodonaea viscosa*, *Periploca* sp., *Prunus* sp. and wild olive tree (*Olea europaea*). Moreover, mangrove ecosystems seem also to have provided fuel since one taxon (*Avicennia marina*) characteristic of this environment has been identified in the charcoal assemblages. All these elements may imply that people have been able to travel certain distances in order to obtain wood for different purposes. These wood acquiring strategies may have been coupled with herding activities during which people were gathering fuel in the same time as fodder. Fruit trees cultivated in date palm gardens, maintained more or less close to the site, have constituted important wood resources such as date palm (*Phoenix dactylifera*) and pomegranate tree (*Punica granatum*). The ligneous part of the former seems to have been used as building material as suggested in a fire destruction layer while the latter could have been involved in craft activities as it has been found in the workshop. Other woody taxa may have been grown within date palm gardens but, for some of them like fruit trees (jujube tree, *Prunus* sp.) and hygrophilous taxa (tamarisk), it is difficult to assert if they correspond to cultivated trees or wild individuals. Given the importance of Qalhât in the Indian Ocean trade networks, the presence of wood from two tropical fruit trees, mango (*Mangifera indica*) and *Citrus* sp., is of particular interest. Attested for the first time in Arabia, their presence raises questions about the role of exotic wood in trade versus their introduction into existing cultivation systems. In this matter, the wood properties in terms of furniture making will help us to solve this question. In support of textual references, their presence may also testify to diversification for local arboriculture during the medieval period. The requirements for their cultivation and the consequences of their acclimatization into date palm gardens will be discussed.

Vegetation, land and wood use at the sites of Bat and Al-Khashbah in Oman (4th-3rd millennium BC)

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About 4200 charcoal fragments have been identified from the 4th-3rd millennium BC archaeological sites of Bat and Al-Khashbah in order to gain understanding into plant resources available at the sites. *Acacia* sp., *Ziziphus* sp. and *Tamarix* sp. are the main taxa identified at both sites and indicate a similar vegetation composition as today. Phoenix sp. (date palm) charcoal also has been found at both sites. Whereas the cultivation of date palm for the 2700-2300 BC layers from Bat is likely, given other circumstantial evidence (i.e., local cereal cultivation and floodwater irrigation), it is unclear whether date palm was cultivated at Al-Khashbah. Especially for the older periods (3300-2700 BC) it is possible that nomadic pastoralists were exploiting and/or managing wild date palms. The find of *Avicennia marina* at Al-Khashbah indicates long distance contacts with the coast.

Wood use at Chalcolithic Çamlıbel Tarlası, Turkey

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The Late Chalcolithic site of Çamlıbel Tarlası, in north-central Anatolia, provides a rare glimpse into the economy and landscape of a small, short-lived prehistoric community. Measuring less than 0.25ha and occupied for roughly 120 years (c. 3590-3470 cal BCE), Çamlıbel Tarlası includes four distinct occupation levels, allowing us to distinguish specific activities associated with features used for only a decade or two. We present the wood charcoal assemblage recovered from flotation of 73 soil samples that span the occupation of the site and the range of features used. We aim to reconstruct fuel acquisition strategies used for both domestic activities and metal production at the site. Abundant wood charcoal represents the primary fuel input, with little evidence for dung fuel use. The charcoal assemblage consists nearly entirely of hardwoods, with deciduous oak (likely Turkey oak - *Quercus cerris*) providing the majority of fuel burned. Notably, small twigs representing easily collected dead wood comprise a large percentage of the assemblage, suggesting that fuel collection was generally low effort and represented selective procurement of high-quality fuel wood. We give preliminary insights into whether differential deposition of wood exists among features, which may suggest that different fuel sources were accessed for specific purposes.

Fuelling urbanisation: the analysis of charcoal from Late Neolithic sites along the Central Yellow River region in China

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This study aims to bridge a gap in Chinese anthracological research. Although, several wood anatomy reference atlases exist in Chinese, many are not easily accessible outside of China. This has made wood charcoal identification difficult, more so given the rich vegetation diversity of China. As a result, despite a slight increase in published research in recent years, anthracology in China has received little attention, with only sporadic research being published in English. By creating a reference database key summarising and transcribing wood anatomical data from Chinese wood anatomy atlases and reference collections into IAWA standard feature codes in English, this study is a first step into making Chinese anthracological research accessible to a wider audience. The key produced by this study was applied in the study of

anthracological samples from central China mostly dated to the Longshan Neolithic period (2500-1900 BC). The Longshan period is characterised by increasing settlement hierarchy and the rise of large walled urban centres. The studied samples come from the Yufenhe valley in North Shanxi, including a large walled site at Bicun; Zhoujaizhuang a large 'mega-city' site in southern Shanxi province; and Pingliangtai, a medium-sized walled urban centre in Henan province. Results from the preliminary anthracological analysis show a wide diversity of taxa in all three zones, suggesting wide catchment zones, and different climatic and vegetation conditions than the present ones. Moreover, a wide variety of fruit tree taxa were identified, bringing up the question whether tree management was practiced in the Chinese Neolithic.

Not just charcoal: Analysis of wood remains from aboriginal communal granaries of Gran Canaria (Canary Islands, Spain)

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Anthracology has a great potential to provide meaningful data about the availability of woody resources in the environment and the human acquisition strategies in the past. In fact, wood has been one of the most used resources with different purposes. However, due to its perishable nature, wood is usually preserved by carbonization. The aim of this paper is to discuss archaeobotanical data from desiccated wood fragments recovered at communal granaries (La Fortaleza, Temisas, Cuevas Muchas) dating to the pre-Hispanic period (c.500-1500 AD) in Gran Canaria, an island of the Canarian archipelago. For this purpose, non-destructive sampling from these materials was carried out followed by microscopic observation of the ligneous cellular structure. Besides this, analysis of scarce wood charcoal assemblages from these contexts has also been performed indicating different uses of wood, i.e. wood as an element of space management inside the silos and wood charcoal as part of the mortar used to seal and protect them (Vidal-Matutano et al. in press). Canary Island pine (*Pinus canariensis*) is the most abundant taxon and its use could be related to its abundance in the environment and its suitability as wood raw material. Monocots have also been identified evidencing the use of plant fibres for ropes, matting or basketry. Finally, other woody resources such as *Laurus novocanariensis* (laurel) suggest the use of green branches of this plant with the leaves still inserted as insecticide to avoid pests (Morales et al. 2018). Beyond botanical identification and selection criteria, our data stress microanatomical features observed related to biodegradation by fungi and insects. Thus, our data will provide new insight into the use and management of wood in communal granaries by indigenous groups from Gran Canaria

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Fuel management and landscape in the context of the first occupations of the Balearic Islands: charcoal analysis at Cova des Moro (Manacor, Mallorca, Spain)

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Cova des Moro is a karstic cavity excavated 10m asl on the cliffs of Falcó Bay (eastern Mallorca). The cave is about 30 meters wide by 60 meters long, compartmentalised by several speleothems. The main entrance was manipulated by humans, with big flagstones arranged as a Talayotic corridor towards the interior. The sequence of the site is one of the first evidences of occupation of Mallorca, prior to 2023 cal. BC, dated on human bones and on a mandible from a non-native caprine (Ramis and Alcover 2001, Ramis et al. 2002), thus being one of the undeniable proofs of the earliest human presence in the Balearic Islands. Cova des Moro is an archaeological, but also a paleontological site, which allows the study of levels with endemic fauna (the extinct Caprinae *Myotragus balearicus*) before the arrival of humans and, therefore, their first contact with the island's pristine environment (Ramis and Bover 2001). Wood charcoal is a good indicator to approach relationship between humans and landscape, especially interesting in the case of the earliest occupation of an area. First results of charcoal analysis at Cova des Moro provide information about the natural plant formations exploited by humans to be compared with later sequences which allow to evaluate how first farmers managed this territory through time. Results point to the exploitation of Mediterranean woodlands with wild olive tree (*Olea europaea*), mastic (*Pistacia lentiscus*), Phillyrea, Aleppo pine (*Pinus halepensis*), rosemary (*Rosmarinus officinalis*), juniper and rockrose species, among others; these taxa will be the main elements of Mallorca's coastal landscape in later times, and they are proved to be already present as the island's natural flora at the arrival of humans.

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Woodland species diversity and impact on the firewood exploitation strategies. An exploratory approach applied to Neolithic lacustrine sites of the French northern alpine arc

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In this study we propose to assess the firewood collecting patterns according to the state of the exploited woodlands as established by the ethnological study, the model of the “Principle of Least Effort”, originally published by Shackleton and Prins (1992). Accordingly, we suggest that species diversity recorded in the firewood and timber assemblages and in worked wood related activities, is a relevant proxy to discuss strategies of firewood exploitation. In this perspective, we compare the anthracological spectra to those of the wood intended to other uses in a French northern alpine context of lacustrine Neolithic sites (excellent preservation of organic remains). In addition to specific diversity, each identified taxon of the investigated sites is characterised by some biological and behavioural descriptors. The “Ancient-Forest Species” (AFS) concept is also introduced. Our results highlight two main firewood management strategies. The first is selective, takes place in undisturbed environments with a high species diversity and is associated with pioneer or post-pioneer occupation phases. The second is non-selective and is associated with a decrease in a species diversity, forest opening and fragmentation. It corresponds to phases of increased settlement density and continuity. Such management patterns relate to changes of the forest environment, themselves linked to economic changes, especially an increase in pastoral production.

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Choice or chance? Use of wood resources by Neolithic lake-dwelling societies in pre-alpine SW-Germany

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Pre-alpine Neolithic lake settlements exhibit an exceptional preservation of organic material due to waterlogged conditions at lake shores or in peatlands. A large dataset on wooden piles and wood remains from cultural layers has been accumulated since the 1980s by dendroarchaeological works from sites in Baden-Württemberg (SW-Germany), at the dendro lab in Hemmenhofen. Thus, knowledge about construction timber is very detailed, concerning taxa, dimension, dating and dendroecology. However, wood charcoal was only analysed at a few sites (e.g., Torwiesen II). Here, we present new anthracological data from fireplaces in three Neolithic settlements, accompanied by further charcoal data from cultural layers from two other excavations, and compare them to the waterlogged wood spectra of these sites. At some sites, charcoal spectra can be interpreted as being a result of wood selection, while at others no such evidence is obvious. Therefore, so far, no common pattern concerning fuel wood selection, or its absence, emerges; hence the discussion on the question of choice or chance in wood procurement for energy will continue. As for waterlogged wood, there is clear evidence for the selection of woody taxa for woodworking and for the use of timber in house and palisade/fence construction.

Contrasting the charcoal assemblages of Late Iron Age and Roman roadside settlements in north-eastern England

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This paper examines the similarities and differences in the charcoal assemblage recovered from an indigenous (pre-contact) roadside settlement, the Roman arrival and their subsequent occupation. Samples taken from strip field systems, structures bordering a road junction, a bridgehead and a vicus are explored for signs of woodland exploitation for fuel, craft and construction. Changes in composition over time are interpreted as reflecting pressure on the local availability of preferred tinder, settlement development, demolition and refurbishment. The recovered charcoal assemblage is mostly the product of deposition of those taxa that are most numerous on site – due to their usefulness as fuel or in construction. The distinct proportion of less common taxa in mature stands – lime, elm and maple – evince opportunistic collection of firewood from further afield, or local manufacture of objects and tools. The abundance of smaller, dense tree cover evinces an open landscape of pastoralism interspersed with cultivation plots enclosed by ditches and hedges. This proposal investigates a broad data set from about 800 archaeological features, spanning approximately 300 years of habitation, and illustrates anthracology's capacity to spatially and temporally plot particular wood usage and obtainability from the surrounding woodlands.

Fuel procurement during the Upper and Late Palaeolithic in Central Europe: analysis of wood charcoal sequences from archaeological sites from Poland, Slovakia and Hungary

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Hunters and gatherers of the Upper Palaeolithic were highly dependent on the natural environment. This also applies to the fuel supply used in fireplaces, which was determined primarily by the availability of a particular type of fuel in the immediate vicinity of the sites. A study of fireplaces with fuelwood remains from various archaeological sites in southern Poland, western Slovakia and north-eastern Hungary (dated to the Middle and Late Pleniglacial) indicated regional differences regarding phases of relatively stable and favourable climatic conditions for human settlement and for the development of arboreal vegetation (from woodland to a presence of at least sparse clusters of trees in the vicinity of these sites) and woodless phases. The former provided evidence for the use of wood as fuel, while the latter coincided with a significant cooling of the climate at the beginning of the Last Glacial Maximum and thus gave only remains of bones of large mammal specimens (especially mammoths) that were used as fuel in fireplaces. In addition, in the light of the radiocarbon dating results, the importance of a taxonomic identification of charcoals prior to ¹⁴C measurements is highlighted, in order to detect and understand some taphonomic problems at the studied sites.

Vegetation change in southeastern Greece from the Middle Palaeolithic to Late Neolithic. The wood charcoal record from cave sites in the Peloponnese

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The late Pleistocene and early Holocene vegetation of southeastern Greece is coming to light through the study of well-preserved wood charcoal assemblages from cave sites in the Peloponnese dating from the Middle Palaeolithic to the Late/Final Neolithic. New anthracological results from the Palaeolithic Kephalaria and Klissoura Caves in the Argolid are presented. These, alongside the recently published Palaeolithic, Mesolithic and Neolithic wood charcoal sequences from Franchthi (Asouti et al. 2018) and Alepotrypa (Ntinou 2018) caves are integrated in a synthetic presentation which tracks the changes in the vegetation and the environment throughout the late Pleistocene to the early/middle Holocene. Specific markers of vegetation change are looked for in the anthracological record, with special reference to *Juniperus* sp., *Amygdalus*, *Maloideae*, *Pistacia* and the thermophilous *Olea europaea*, and evergreen *Quercus*. The aim is to approach the vegetation characteristics of the palaeohabitats managed by Palaeolithic and Mesolithic foragers and the first Neolithic farming communities in coastal and hinterland areas of southeastern Greece. The role of plant resources (fruit trees) in subsistence is discussed against the carpological evidence when available. The environmental setting of the first farming communities and its transformation through time is tackled in the cases of Alepotrypa and Franchthi caves.

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Environmental change and prehistoric landscape practices in the south-west Italian peninsula during the Pleistocene-Holocene transition

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The southern Italian peninsula was an important flora and fauna refuge during peak of the Last Glacial Maximum (LGM). At the Pleistocene-Holocene transition important environmental changes occur in the Mediterranean driven by the climatic oscillations that followed the LGM. The long and detailed stratigraphy of Grotta del Romito (Calabria, SW Italy) and its relevance in the chrono-cultural framework of the Palaeolithic-Mesolithic of the Central Mediterranean provide a solid framework for exploring how climate impacts on past vegetation affected the evolution of the regional landscapes and the subsistence strategies of human communities between c.15 -10 kyr cal BP. This paper presents the preliminary results of anthracological analyses undertaken at Grotta del Romito. They provide the environmental context for the Late Pleistocene and early Holocene hunters-gatherers landscape practices. The expansion and adaptation of the Epigravettian human communities in the postglacial landscape is discussed with the use of quantitative analyses on fuelwood waste and are integrated with other palaeoecological and palaeoclimatic records from this site and the broader region.

Climate versus human-driven disappearance of *Fagus sylvatica* (European beech) extra-zonal stands at low altitude in central and southern Italy: insights from archaeo-anthracological data

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Fagus sylvatica is the most widely distributed beech species and one of the most representative trees in the deciduous broadleaf forests of the Europe. In the Mediterranean basin, the beech forests of the sub-Mediterranean Italian peninsula are at the southern latitudinal limit of the species. The Mediterranean climate sets clear limits to the tolerance of beech to water stress and high temperatures. However, the hilly Sub- and Anti-Apennine chains show extra-zonal stands of beech or isolated trees below 400m asl with local moister climatic conditions. The progressive rarefaction and disappearance of beech at lower altitudes are attributed to warm climatic phases and redistribution of precipitation regimes during the mid and late Holocene. Beech was mostly restricted to the modern mountainous areas, stressing the relic character of the modern extra-zonal stands or small isolated populations. In the Tuscan Anti-Apennines (central Italy), charcoal analysis in an Etruscan settlement (300-100 BC) of the Chianti region has identified the dominant presence of beech as fuelwood collected in a habitat currently characterized by *Quercus cerris* forest (697m asl). The archaeo-anthracological record has provided an opportunity to gain insights into the late Holocene history of beech woodland at low altitude, with a review of the wood/charcoal data from the archaeological sites in central and southern Italy. Compared with the historical extra-zonal stands of beech, the analysis has allowed: (1) to identify the mid and late Holocene *F. sylvatica* distribution at low altitude, (2) to understand the human use of the beech wood, and (3) to define the recent biogeographic history of this species. *Fagus* remains are mainly attested outside the current extrazonal beech stands at c. 3700-3000 cal BP, 2300-1400

cal BP, and 1100-600 cal BP, falling in the warmer and drier climatic phases of the mid and late Holocene recorded in the central Mediterranean basin. The presence of *Fagus* is widely associated with plant remains of thermophilous and mesophytic deciduous species. The scarce presence of light-demanding species typical of open-habitat and forest edges suggests the occurrence of forest communities characterized by a (relatively) closed canopy. Extra-zonal beech stands at lower altitude may have found in the closed forests the conditions required to overcome the most arid climatic phases in the Mediterranean bioclimate. Archaeological wood evidence indicates the use of beech wood mainly as a fuel; the thermophilous and mesophytic deciduous forests with *Fagus* were used by the local archaeological sites as coppice woods. Under higher light levels and lower water availability, beech stops being dominant. Light-demanding and drought-tolerant tree species outcompete the shade-tolerant beech by a much higher resprouting strategy at the adult stage and they persist in disturbed environments predominating in wood cutting. Intense forest uses would have favoured suckering thermophilous species, compromising the renewal of the beech and therefore its persistence in the dynamic of the forest.

Assessing the function of Palaeolithic hearths: experiments on intensity of luminosity and radiative heat outputs from different fuel sources

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Assessing the function of Palaeolithic hearths is a key research issue that can benefit from the application of experimental approaches when examining whether the behaviourally related purposes of fire (e.g. heat, light and cooking) could be correlated with combustion features in the archaeological record. This paper examined the light and heat properties of 9 different types of fuels (8 individual species of wood and fresh bone) by assessing intensity of luminosity and radiative heat outputs using a lux meter and a thermal imaging camera. Results show that there is significant variation between bone and wood in terms of light and heat output and between the individual species of wood. In order to assess whether heat efficiency may vary seasonally, experiments were repeated at ambient temperatures of 11-13°C and 0-3°C temperature ranges overnight. Results show that that in the current dataset fuels that emit lower to intermediate heat outputs are more efficient at colder temperatures in terms of warmth. This represents a preliminary step towards attributing behaviourally relevant functions such as lighting and heating to Palaeolithic combustion features with regard to fuel selection.

Session 3: Dendro-Anthracology

Beyond wood anatomy

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Ever since Malpighi, anatomists have interpreted plant anatomical structures. Vessels, tracheids, fibres, and parenchyma cells pattern in wood, bark, and pith: each cell, tissue and their variations have always been used as tool to understand the plant and the environment surrounding it. The knowledge gained so far allows anatomical wood species identification and deepens our understanding of wood properties and their variations among species and provenances. To explore new wood anatomical research trends and their application in archaeological sciences, I combine centuries-old available knowledge with recently developed lines of evidence to set a new light on wood anatomy. The new wood anatomical picture brings us towards unexpected fields such as book design and art, the cold limits of plant distribution, and plant height estimation from charcoal remains, among others. In conclusion, it will be clear how wood anatomy is moving towards ecological plant stem anatomy, to be considered in future studies of plant ecology, archaeobotany, cultural heritage artefacts and social sciences.

Dendro-anthracology and anthraco-typology: how does it work? A user's guide

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The archaeological charcoal remains, at the wooded environment/societal economy interface, testify the nature of the natural and/or anthropic exploited forestation processes. By providing information about the extent, physiognomy, composition and exploitation patterns of the forests, anthracology allows the characterisation at a local scale of the forestry component of past landscapes. Nonetheless, this approach implies the development of new analytical tools. Our methodological work concerns the procedures (measurement techniques, assessment of the minimum number of fragments, exclusive criteria, etc.) and the contribution of different dendro-anthracological tools developed on modern-day woodland stands and then applied to the archaeological record. More specifically, the anthraco-typological study considers three main aspects: (i) the tree-ring width, (ii) the assessment of the distance between the charcoal fragment and the estimated centre of the stem, and (iii) the quantification of tyloses within the deciduous oak vessels. We applied anthraco-typology to the main taxa identified within some archaeological assemblages. Oak charcoals suitable for characterisation by the three parameters are subdivided into eight anthraco-groups. Among the other taxa, such as ash and beech, given the lack of reliable anatomical criteria for identifying the heartwood only the growth pattern and the charcoal-pith distance are considered, thus allowing the assessment of four anthraco-groups.

Dendro-anthracological tools applied to pinewood (*Pinus tp. sylvestris*) exploitation as fuel during the Mesolithic-Neolithic transition in NE Iberian Peninsula

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This work focuses on the reconstruction of fuelwood exploitation strategies during the Mesolithic-Early Neolithic transition in NE Iberian Peninsula. The study is based in the use of dendro-anthracological tools as the restitution of wood diameters based on trigonometric method tool (ADmodel) (Dufraisse and Garcia-Martínez 2011, Dufraisse et al. 2018) in combination with the study of annual growth rings and the presence/absence of reaction wood. *Pinus tp. sylvestris* identifies a group of species that include the cold-loving montane European pines (*Pinus sylvestris* L., *Pinus nigra* ssp. *salzmanni* (Dunal) Franco and *Pinus uncinata* DC). Having the present-day greater area of distribution in the northern hemisphere, they have been played a fundamental role in the European vegetation since the Pleistocene, surviving throughout the Holocene in some inner areas of NE Iberia, specially the Ebro valley (Alcolea 2017). These trees has been chosen for applying dendro-anthracological tools due to (i) its representativity in anthracological spectra, (ii) an anatomy with clearly identifiable growth rings, (iii) the own architecture of the tree that favours the distinction between trunks and branches, (iv) its abundance in Iberian forests of inner mountainous areas during the onset of the Holocene. Studied archaeological sites contain representative sequences of human occupation during early-middle Holocene (10000-6500 cal BP) that allow an approach to changes and continuities in the human-environment interactions of the last hunter-gatherer societies and the first farmers. First results suggest the majority use of small calibre branches that could be related with the natural pruning of non-functional branches characteristic of these conifers.

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Firewood and timber collection and management strategies from Medieval sites in Eastern England. Initial results from the anthraco-typological analysis of oak charcoal remains

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This project focuses on oak charcoal remains from three Medieval rural sites in eastern England: the previously published sites of Higham Ferrers in Northamptonshire, Flixborough, in north Lincolnshire and the unpublished site of Dando Close in Northamptonshire. Material from these sites dating from the 5th to the 9th centuries was examined so as to identify the firewood and timber growth patterns and possible collection and management strategies. This research has allowed drawing comparisons between the three contemporary sites, as well as expanding the archaeobotanical record to a more detailed understanding of the environment around these settlements. Additionally, exceptional material from Flixborough has provided a unique insight into the possible long-term woodland management strategies undertaken in the area during the mid 8th-9th centuries. The paper highlights key initial findings based on the analysis of >200 fragments from eight contexts from the three sites. Results are discussed with regard to the economic and environmental context, demonstrating the value of the method in adding detail to the sites of Flixborough and Higham Ferrers as well as facilitating a new understanding of the site of Dando Close.

Dendro-anthracology of *Pinus halepensis* Miller in prehistoric and protohistoric Mallorca (Balearic Islands, Western Mediterranean)

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In this paper we present the results of the dendro-anthracological analysis of Aleppo pine (*Pinus halepensis* Miller) charcoal fragments from different prehistoric and protohistoric sites in Mallorca (Balearic Islands). We have analysed charcoal fragments recovered from 5 different contexts in 3 archaeological sites of the island dating from the Late Bronze Age to the Late Iron Age. Aleppo pine trees are present in Mallorca's woodlands since the early Holocene and at the moment of the human population of the archipelago (Burjachs et al. 2017). Pine is documented in the anthracological analysis of prehistoric sites from the earliest analysed samples, but anthracological data show that it is specifically targeted exploited during the Late Iron Age. Our aim is to further interrogate pinewood exploitation during these periods and evaluate potential variations of its management strategies. Our methodology involves the systematic measurement of 2 different features on archaeological charcoal fragments of Aleppo pine: the charcoal-pith distance and ring width.

Charcoal-pith distance is measured with the trigonometric pith location tool, based on measurements of the angle and the distance between 2 rays observed on the last preserved ring of each fragment. The data offer an estimation of the wood diameters exploited in the past, expressed in diameter classes (Dufraisse et al. 2018). This information is complemented by the measurement of the ring width of all the complete rings preserved for each fragment. The combination of both dendro-anthracological parameters (diameter class and ring width) permits the organization of the results on different anthraco-typological categories referring to both diameter (small wood and/or internal part of mature wood) and growing conditions (fast/slow growth) of the Aleppo pine trees. This information has been compared with the results of the analysis of the ring width and growing conditions of trees in 3 different contemporary forest formations in Mallorca representing the environmental variability of the Aleppo pine forests on the island. In each station 5 trees were sampled, obtaining 2 cores of the trunk and 3-4 branches of different diameter, allowing the comparison of the annual growth on both trunk and branch wood of the same tree for the same cambial age. The results permit interrogating different exploitation modes of pinewood, referring to firewood and/or timber procurement, the growth conditions of the Aleppo pine woodlands, and the overall management strategies of this important Mediterranean arboreal species in the past.

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Session 4: Interdisciplinary Studies

Harvesting the Mediterranean forest: wood, wild fruits and crop management during the Neolithic and the Bronze Age in Corsica. New archaeobotanical data

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Corsica seems to have experienced no significant human settlement before the early Holocene. Repeated occupations by Mesolithic hunter-gatherers occurred from the 9th to the 7th millennia BC, before an apparent abandonment until the arrival of early Neolithic farmers, one millennium later. The impact of human settlement on the insular fauna is well documented, but very little is known about the relationship between the first permanent dwellers of the island and the Mediterranean vegetation cover. While the general palaeoenvironmental evolution of post-glacial vegetation was drawn by pollen analysis, our knowledge of the exploitation and management of vegetal resources by Neolithic populations is still very patchy. Our work provides new data, based on the analysis of plant macroremains (charcoal, seeds/fruits), from 2 low-altitude coastal sites, which point to the importance of the prehistoric exploitation of forest resources. Basi, at Serra-di-Ferro, in Southwestern Corsica (Corse-du-Sud), is an open-air site, which lies on the slopes of a small hill dotted with granite blocks. Some of these blocks, shaped by weathering processes, offer natural shelter and were used from the early Neolithic to the Bronze Age, as part of the large open-air habitat. Since the late 1960s, when the first excavations occurred, this was rapidly acknowledged as a key site for the understanding of the Mediterranean Late Prehistory. Fieldwork resumed recently, under the supervision of Th. Perrin, after several decades of interruption, and provided valuable archaeobotanical material studied by L. Bouby (carpology) and C. Delhon (charcoal analysis). Stabielle at

Monticello, in NW Corsica (Haute-Corse) is a large late Neolithic open-air settlement dedicated to copper metallurgy, only partially excavated by preventive archaeology. Fieldwork carried out by P. Tramoni in 2015 allowed the recovery of charred plant macroremains studied by I. Figueiral. Archaeobotanical data from Basi (Early-Middle/Recent Neolithic, Bronze Age) and Stabielle (Late Neolithic) show that diverse habitats (riparian forests, deciduous and evergreen oak forests, 'matorral', but also the highlands) were exploited for fuel and food. From the middle Neolithic onwards, wild fruits (acorns and olives) were gathered, while olive wood also begins to be exploited as fuel; during the Late Neolithic a sharp increase in the exploitation of evergreen oak wood, suggests a possible shift in the management of this species. Acorn and wild olives were probably exploited as food, along with cereals (naked wheat and barley) and pulses (red/grass pea, faba bean and pea). Other possible uses of plants can also be considered, particularly concerning the wild olives; were they cured to eat, pressed for oil (which has medicinal properties) or used as fuel?

Charcoal macro-remains analysis in an integrated landscape research: land-use in a long-term and multidisciplinary perspective (Ter High Mountain Valleys, Eastern Pyrenees, Spain)

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Since 2010, an integrated archaeological and palaeoenvironmental research programme has been developed in Ter High Mountain Valleys (Eastern Pyrenees), with the aim of studying the long-term landscape shaping of these Mediterranean high-mountain environments. This programme has integrated archaeological extensive surveying, GIS, excavation and radiocarbon dating of archaeological structures, palaeoenvironmental research, as well as archaeobiological and micromorphological analyses. Settlement dynamics discontinuities, from the Middle Neolithic-Late Neolithic transition (~3600 cal BC) until modern and contemporary periods, have been characterized alongside changes in landscape and in environmental resource management practices. Fuelwood use and selection have been characterised through the analysis of charcoal macroremains; its results permit reconstructing a densely exploited landscape and show the ancient occupation activities shaping the Pyrenean high montane spaces through time. A strong presence of alpine and subalpine vegetation communities (mountain pine, birch, willow) has been detected during the Neolithic period in some of the analysed sites, while an increase in juniper has been highlighted during the Roman period and the early Middle Ages. Actually, Roman times witnessed a significant expansion of pastoral activities, especially from the 2nd-3rd centuries and during Late Antiquity. Landscape dynamics show a new expansion from the early Middle Ages (9th-10th c.) with the reuse of Roman structures and the construction of new more specialized ones (cheese production). The importance of livestock management practices (including fire-driven forest openings and grazing activities) together with forest exploitation in these areas, especially during the Medieval and post-Medieval periods, are among the principal causes of timberline suppression. Finally, archaeological data attest to a new phase of pastoralism expansion from the 14th-15th c. through to the modern and contemporary periods.

Food for the dead, fuel for the pyre: symbolism and function of plant remains in the Roman cremation necropolis of Bracara Augusta (Portugal)

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Roman funerary rituals were far more than a mean of disposing of the dead: they were specialized and complex rites of passage, mediating the world of the living and the dead and ran by strict sets of rules and protocols. They were one of the most important and complex social, political and religious events in Roman society and for the most part of their history, cremation was the standard funerary practice. In the last couple of decades, archaeobotanical research has brought to light the importance of food and plant remains in these contexts and their potential in better understanding how these rituals took place. The Roman city of Bracara Augusta (modern-day Braga, northern Portugal) was founded in the early 1st century AD as the capital of the conventus Bracaraugustanus. As the most important urban centre in the Roman administration of the NW Iberia, the city later became the capital of the province of Gallaecia and between the 5th and 7th centuries, capital of the Suebi Kingdom. Between 2007-2009, emergency excavations in a city centre quarter, revealed one of the largest Roman funerary complexes in the Iberian Peninsula. The necropolis, located outside the walls along Via XVII, is not only the largest among the six known necropolises found in the city but also the one with the longest occupation, spanning from the 1st to the 7th century AD. More than 190 funerary depositions, including primary and secondary pits and inhumations, were identified. Sediment samples were recovered in 174 cremation primary and secondary contexts. The anthracological analysis of 42,500 charcoal fragments, originating from the combustion of the wood from the cremation pyre, resulted in the identification of a diverse set of 44 taxa, including *Quercus* sp. type deciduous (55% of the total), *Buxus sempervirens*, *Castanea sativa*, *Pinus sylvestris* and *Fagus* sp. The proposed criteria for the wood collection would have been its availability in the region, although symbolic factors cannot be discarded nor proven. Several other archaeobotanical elements associated with the funerary feast or with funerary offerings to the deceased were also identified, such as fragments of a *Buxus sempervirens* comb, *Prunus* spp. endocarps, *Juglans regia* shells, pulses with evidence of having been cooked, possible bread-like material and animal bones. Evidence of particular plant remains recurrently associated with Roman funerary contexts have also been identified, such *Pinus pinea* cones and *Cupressus sempervirens* galbulus. The paper discusses several ritual and socio-economic aspects regarding firewood provisioning and plant resource management in a medium-sized city at the periphery of the Roman Empire. Data from the characterization the firewood and carpological macroremains found in the necropolis will be complemented by text sources and ethnographic and historical data. Particular emphasis will be paid to firewood catchment area, transport, storage and use, and to the meaning of individual botanical elements in the standard Roman cremation ritual.

The history of pines and pinewoods in western Iberia: a revision of archaeobotanical data

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The history of pines – *Pinus pinaster*, *Pinus sylvestris*, *Pinus pinea* – in western Iberia has been addressed by several authors, based on charcoal and palynological analyses. However, since the ground-breaking studies of Isabel Figueiral (e.g., Figueiral 1995, Figueiral and Carcaillet 2005) and Paula Queiroz (1999), new sites have been studied in mainland Portugal, as a result of new research projects and the great development of contract archaeology. These have provided a wider set of charcoal assemblages, carpological remains and pollen sequences, as well as new radiocarbon dates, allowing a better understanding of the distribution and evolution of pines by confirming but also contradicting some of the conclusions that previous studies have reached. Archaeobotanical studies have demonstrated that the 3 above mentioned pine species are native to present day Portuguese territory although in some literature this is still disputed, mostly regarding *P. pinea*, often considered a Roman or Phoenician introduction. *P. pinaster* is frequently, and wrongly, considered autochthonous only to coastal areas. The history of the spread of *P. pinaster* and *P. pinea* throughout the Holocene is now becoming clear and seems to be related to a combination of direct and indirect human actions and

environmental trends. At the same time, there was a great decrease in the distribution of *P. sylvestris*. Still, contrary to what was previously considered (Mateus 1992) its presence in the southernmost areas continued at least until the mid-Holocene, when human pressure eventually led to its local extinction. Today, spontaneous populations of *P. sylvestris* are restricted to small patches in the northwest. The archaeobotanical identification of *Pinus halepensis* will also be addressed. In this presentation, onsite and off-site archaeobotanical data from Portugal will be presented in detail and the archaeological record will be examined in a critical manner. Through a constructive perspective, data will be evaluated in order to link previous approaches to more recent studies.

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Long-term history of woodland under human impact: archaeo-anthracological synthesis for lowlands in the Czech Republic

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The first anthracological analysis in the Czech Republic was performed 86 years ago; however, the quantitative and qualitative shift occurred at the beginning of the 21st century. Charcoal data from archaeological sites have been widely used for reconstructing woodland vegetation, but usually only on the local level. Most anthracological research is concentrated in the lowland and upland regions (140–550m asl), because the prehistoric agricultural sites are closely associated with areas of the most fertile land. The quantity of published data plus our unpublished work from the Czech Republic (over 800 prehistoric agropastoral sites comprising >230,000 identifications) is thus unique on the international scale. Our research project attempts the first systematic evaluation of anthracological results from archaeological sites in the Czech Republic. The aim is to reconstruct the middle-and upper- Holocene history of woodland in the surrounding of human settlements from the Neolithic (7300 BP) to the Migration Period (1450 BP) in the lowland areas of the Czech Republic. Another study aim is to compare the archaeo-anthracological data to other environmental aspects in the vicinity of archaeological sites (e.g. topography, altitude, geology, soil, climatic conditions) thus trying to reveal regional differences and diversity in the anthracological record.

Blooming of the Byzantine sustainable agricultural society in the Negev desert (Israel) and its abrupt decline

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Taxonomic identification was conducted for charcoal samples retrieved from three Byzantine settlements located in the Negev Desert, Israel: Elusa, Nessana and Shivta. Many of the analysed specimens were found to be local desert elements. This suggests that during the Byzantine period a broadly similar arid environment prevailed in the vicinity of these sites.

Yet, a flourishing agriculture is attested based on the occurrence of charcoal remains and/or pollen of the following trees: olive, grape, date palm, doum palm, common fig, pomegranate, carob, Syrian pear and *Prunus* (almond/apricot). The mechanisms of the ancient agricultural features, such as terraced wadis and channels for collecting runoff rainwater are still visible in the nearby landscape. Other trees with a Mediterranean vegetation zone origin (such as cypress and Aleppo pine) were most probably used in construction and crafts and maybe also as ornaments. The wood charcoal assemblages and the palynological spectra also point to the importation of trees such as the cedar of Lebanon, boxwood, European ash and hazelnut from other regions. The high frequencies of the two desert trees, tamarisk and boxthorn, point to their likely use as fuelwood. Tamarisk is considered a mediocre source whereas boxthorn, with its high wood density, is considered a superior one. From the early to late Byzantine period, a marked increase in tamarisk is observed together with a decrease in boxthorn, suggesting a possible depletion of quality firewood through time. This inference is also supported by the exclusive presence of other select fuel sources such as white broom during the early phase of the Byzantine period.

Ritual and Routine: distinguishing activities from fuelwood

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This paper considers some of the issues in attempting to distinguish activities based on the selection of fuelwood. Is it possible to recognise ritual behaviours through fuelwood selection? Is it valid to differentiate between ritual and routine activities? Two discrete case studies will be used. The first is an examination of fuelwood assemblages relating to funerary practice focussing on Bronze Age cremations in England. The analysis of a large body of cremation assemblages clearly shows that the majority are dominated by a single taxon, which has often been ascribed to ritual motives. The second case study will examine the role of fuelwood in making sacred offerings to the Roman household gods. Burnt deposits found in gardens of houses in Pompeii have been identified as the remains of whole foodstuffs (plants and animals) burned as part of daily votive offerings to the household gods (Lares). Was the fuelwood used in these offerings merely the conduit for the food offerings or was the selection of taxa ritually significant? This paper will seek to examine the role of fuelwood in ritual and whether notions of sacred trees or associations can be inferred from anthracological deposits.

The xylophagi of the wooden floor of Camelin block (Fréjus, France): interdisciplinary approaches through archaeology and anthraco-entomology

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It was during preventive excavations of a block of homes in the ancient city of Forum Iulii in the south of France in 2013, that a very well-preserved carbonized wood floor was discovered. Established in a house during the first half of the 1st century AD, this structure serves as a floor for a room decorated with painted plaster and was destroyed by a fire around 70 AD. The anthracological analysis highlighted the woody species used (Aleppo pine, beech and fir) as well as numerous traces of xylophagous insects and fungi. Their identification, their number and their distribution within the floor raise many hypotheses for the anthracologist and the archaeologist: about the timber's condition, the source of the infestation and the building history. This study is a direct application of the key to identify traces of xylophagous (presented in another paper in anthraco2019 titled: "[Atlas and identification key of xylophagous traces](#)") on charred remains of the Roman period. The Camelin block site was used to set up field sampling and microscopic observation protocols adapted to anthraco-entomology.

Charcoal hearth soils as environmental archives. A case study from central Italy (Poggio di Montieri)

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One of the most widespread forest exploitation activities in Europe was charcoal production, whose legacy is a plethora of abandoned charcoal hearth sites (CHs). The interest on these sites is increasing over time and different disciplines (i.e. geography, history, anthracology, landscape ecology, archaeology, pedology etc.) approached their study with different aims. In this contribution we present the first results of an ongoing multi-proxy project on CHs carried out at Poggio di Montieri (central Italy), a hill strongly exploited for silver production during the Middle Ages (11th-14th c.) and later managed using a multiple land-use systems based on pasture until the 19th century. Combining an archaeological survey with dendro-anthracological analyses, pedological investigations and information from historical texts and maps, this research succeeded in reconstructing the environmental and social dynamics occurred at Poggio di Montieri in recent and historical times. Between the 16th and 18th centuries, a multiple land use system was applied at this site, based on an ovine, caprine, cattle and pig rearing system strongly integrated with chestnut growing, temporary sowing in woodland, viticulture, agriculture (wheat, flax and hemp) and charcoal production. As revealed by anthracological and dendro-anthracological analyses, charcoal production was possible thanks to the use of wood resulted from shredding and pollarding/pruning practices that characterized on one hand beech wood and, on the other hand, chestnut wood. These agro-sylvo-pastoral practices, regulated according to the local common land system, gradually disappeared during the 19th century, after a deep change in the political, economic and social patterns in Tuscany, opening to land privatization. Different soil erosion phases have also been highlighted by pedological investigation: in particular, the last erosion phase at Poggio di Montieri is due to the abandonment of any woodland management practices and multiple land-use systems since the first half of the 20th century. Beyond the outcomes of this specific case study, this research stresses the importance of a historical characterization of an area under investigation, which allows a more realistic identification of the applied woodland management practices and the complexity of their environmental effects over time.

Reconstructing past multiple land use systems: the 5T.ERA (5 Terre Environmental Resource Archaeology) multi-proxy project

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The results of a multidisciplinary research held at the Punta Mesco cape, a terraced landscape in the Cinque Terre National Park (NW-Italy) are presented. The multiproxy project titled “5 Terre Environmental Resource Archaeology” (5T.ERA) has been developed including archaeological investigations, charcoal and pollen analyses, vegetation surveys, radiocarbon chronology, historical ecology observations, in association with documentary and cartographic studies and the collection of oral sources. The 5T.ERA project aims to reconstruct, in a Mediterranean coastal environment, the local agro-sylvo-pastoral systems and their changes through time, focusing in particular on the environmental effects caused by the present phase of abandonment. Our research has documented local production practices and environmental changes that have affected the promontory since the late Middle Ages up to the present time. A multiple use of the environmental resources between 1450-1850 AD has been identified: transhumant and stable caprine (sheep, goats) grazing activities were dominant and were integrated with cultivation (vineyards, olive growing) and woody and shrubby species selection for charcoal production. Through the reconstruction of the historical landscape dynamics and past environmental

resources management, we suggest opportunities for a new approach to sustainable rural development and landscape management policies.

Fire use and agroforestry in tropical forests (Guatemala)

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The development of agroforestry techniques in tropical environments, their role in the decline or resilience of human societies and their long-term impact on biodiversity remain controversial issues in scientific research. As an emblematic case, the assumption that slash-and-burn (swidden) agriculture was one of the main techniques used by the pre-Hispanic Maya and that it caused major environmental degradation in the Yucatan Peninsula is increasingly challenged. However, it remains difficult to assess the actual extent of swidden in ancient subsistence economy, especially because of the lack of detailed datasets and of a robust methodology to track fire-related proxies in tropical soils. Our research project aims to understand the formation and evolution in depth of swidden fire signatures, to better document ancient agroforestry practices and their role in tropical ecosystem sustainability. We adopt an ethno-archaeological approach, comparing contemporary fields with pre-Hispanic horizons in northern Guatemala. Through the combination of multiple botanical indicators such as (1) microscopic soil charcoal quantity, (2) macro-remains identification, and (3) micro-remains (starch granules and phytoliths), and their contextualization in pedological records via micromorphology, the construction of a baseline for swidden signatures serves as a critical tool for the interpretation of archaeobotanical datasets in ancient horizons. This innovative multi-disciplinary method provides a new framework for addressing still unresolved questions in Maya civilization history and human ecology in tropical forests.

Preliminary charcoal and phytolith analysis from an early Swahili daub house at Unguja Ukuu, Zanzibar (c. 7th-14th century AD)

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Unguja Ukuu is an early medieval settlement site along the seashore of the Menai Bay on Zanzibar Island. The site has long been known as an important trading centre linked to coastal settlement and urban dynamics along the Eastern African coast, while it also central for the understanding of Indian Ocean trade connections. Previous studies have defined a broad occupation sequence for the site and uncovered rich assemblages of local and imported finds. However, how people lived here and what local resources were available is poorly understood. In this paper, we present the preliminary results of

integrated archaeobotanical analyses from the first house deposits investigated at the site. In 2017, contextual excavations exposed the remains of packed-earth floors associated with domestic occupation, encompassing the broad chronology of the site. Systematic sampling of these contexts has enabled the recovery of plant remains across space and stratigraphic deposits. Charcoal analysis from all the contexts detected the presence of three general taxonomic groups, and recorded important details concerning site formation processes. Phytolith analyses targeted floors and occupation surfaces. Taken together, the charcoal and phytolith results offer complementary evidence for distinct indoor and outdoor spaces, and possible activities taking place there.

Herod the Great royal Roman gardens come alive: charcoal remains and pollen analysis

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During the Early Roman period ancient Judea (Israel) was controlled by the Roman client king - Herod the Great (74/73-4 BCE). Herod was known as the greatest builder in ancient Jewish history and was responsible for several colossal building projects throughout the region. One of the most impressive among them is undoubtedly the artificially conical mountain of Herodium, rising in the Judean Desert. The importance of the Herodium to Herod is clear, as it is the only place that he built which he named after himself and was also his chosen place of burial. Gardens were identified in the spectacular palace/fortress atop the mountain and at the tomb complex located on the northern slope of the mountain. Until recently, the botanical component of these royal gardens remained unknown. The cultivated plants which Herod grew in the Herodium gardens are reconstructed through the retrieval and analysis of macro-botanical remains (mainly wood macrofossils) and micro-botanical remains (such as fossil pollen grains and microcharcoals) from the soil of the gardens. Thus far, the archaeobotanical assemblage comprises local trees and shrubs such as cypress, pine, olive, rose and palm.

Session 5: The Anthracology of Kilns and Charcoal Burning

Forest dynamics of the Euganean Hills (Padua, Italy): when the anthracology of charcoal kilns and historical cartography explain the origin of forest landscapes

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Euganean Hills landscapes are, as all forests in Europe, linked to the close relationship between human activities and forest dynamics. Indeed, this volcanic massif offers very varied pedoclimatic contexts allowing the coexistence of forest formations close to alpine environments with more Mediterranean formations. This mosaic of forest landscapes is also reinforced by a very high heterogeneity of management methods linked to the presence of many small private plots. THISTLE programme (H2020-MSCA-IF-2014 grant agreement No 656397) was designed to better understand the place these forests occupy in the lives of their users, while taking stock of the local knowledge on the forest history. At the same time, thanks to a regressive and multidisciplinary approach, the aim of THISTLE programme is to examine the centuries-old relations between local people and forests. This work is based on a regressive approach, starting from the composition and structure of current forests and going back in time from different documentary collections (historical documents, ancient maps, archaeological and archaeobotanical remains). Historical mapping has revealed a wide dominance of coppices in 19th century forests. Thanks to the accounting records of San Giovanni del Venda and the "Estimi" of 1668, it

is possible to trace the presence of coppice woods back to the 17th century for some areas. While it is possible to ensure the presence of coppices in the past on the basis of this data, the absence of references to the taxa used prevents us from attesting the use of chestnut trees in these areas. The use of anthracology on charcoal platforms complements this historical mapping process. 10 platforms have been analysed. 15 radiocarbon determinations date this charcoal production at least to the 14th century, and bear witness to an activity that continued over time, since some charcoal platforms date back to the 15th, 16th, 17th and 19th centuries. In addition, anthracological and dendro-anthracological results provide valuable information on the composition of these charcoal forests in the past. These studies show a very good correspondence between current and past vegetation. Indeed, the results obtained on the southern slopes reflect a vegetation associated with Mediterranean pseudo-maquis formations, while the northern slopes offer a vegetation associated with cooler environments. Species identified in anthracological assemblages are still present near the sampling sites. These observations attest to the forest continuity in these areas. Anthracological data may also indicate a particular silvicultural management of chestnut trees. In fact, thanks to dendro-anthracological data, it is possible to speculate about the forestry management methods. Indeed, the morphology of histograms seems to resemble the coppices measured on the current stands.

A review of 2000 years of charcoal production in the Low Countries

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During the last 20 years >1000 archaeological remains of charcoal production structures from c. 100 different sites have been found during rescue excavations in the Low Countries (Belgium, The Netherlands). Most of these are pit-kilns, dating to the late iron age, Roman times and early or high middle ages. In addition, several mound kiln structures have been studied, all dating to the late and post medieval period. This paper presents a review of the information that can be drawn from the analysis of these structures, including changes in charcoal production techniques and the impact of charcoal production on former forest composition. Problems regarding the identification and age determination of archaeological remains of charcoal production structures are also discussed. Finally, a typology and chronology of charcoal production features is suggested, based on a dataset of >300 radiocarbon-dated charcoal kiln remains, and the analysis of the size and outline of these structures through time.

Searching for the charcoal burners heritage - Interconnecting forest history, anthracological research and local people

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Historical activities and knowledge are of great importance for both (1) the tradition of the local people, their identity and identification with forests and landscapes, and (2) different fields of science - studying traditional land use practices and forest history has social, economic and ecological dimensions. Within a transdisciplinary research project (Real-world Laboratory "Knowledge Dialogue Northern Black Forest") we study select questions of land use and forest history closely related with the local people. Wood charcoal production was one of the most frequent and most important activities in the region of consideration, the northern part of the Black Forest with the first UNESCO-national park of Baden-Wuerttemberg, SW Germany. Charcoal burning sites (CBS) with their macroremains contain comprehensive information about the historical forests and the human influences therein. Therefore, CBS studies are a main key for high resolution forest and land use history at the stand-scale level of consideration. Unfortunately, such sites generally are not recorded

in written sources or in historical maps and they are not visible in the common aerial photographs. Usually time-consuming field work is necessary to record their exact geographical position. Aiming on a reduction of the field work and on the visualization of the spatial dimension of these historical activities on a landscape level but with fine spatial resolution, in our study we use two additional approaches, (1) the knowledge of the local citizen as well as (2) airborne laser scanning (LiDAR; cf. Ludemann 2011, 2012). Hundreds of indications to potential CBS have been provided by the first "tool" (oral history), of which a large number already have been evaluated successfully by field survey. These results are used to save the traditions and to establish a new effective anthracological research program in the field of CPS anthracology (Ludemann and Nelle 2017a: 3f, 2017b: 134-232).

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The analysis of archaeological charcoal assemblages from Chigaramboni archaeo-metallurgical sites, south eastern Zimbabwe

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Charcoal was the fuel universally employed in both the smelting and forging of metals. Special hardwoods with high caloric content were employed in most African prehistoric metallurgical industries. The focus of this paper is charcoal recovered from Chigaramboni archaeo-metallurgical sites in order to identify the wood fuel choices of precolonial industrialist workers at the site. The identification and analysis of archaeological charcoal assemblages from Chigaramboni was achieved by using a reference collection of trees from Great Zimbabwe and Chigaramboni. A small range of taxa were selected by the iron workers including *Dichrostachys cinerea*, *Faurea saligna*, *Brachystegia spiciformis*, *Burkea africana* and *Acacia cf. polyacantha* at Chigaramboni. It is concluded that specific hardwood taxa were sustainably selected from a wide range of local trees so that the historic miombo forest has not changed significantly despite evidence of extensive iron working.

Anthracological analyses of charcoal kilns at a high spatial resolution: a way to better understand the charcoal production and the related forest history?

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Charcoal Production Sites (CPS) are valuable archives for reconstructing forest history. An increasing number of European regions present high spatial densities of CPS, but the determinants of their spatial distribution remain poorly documented. Our study aims to unravel the influence of environmental variables on both the distribution of CPS and on past distributions of tree taxa, at a high spatial resolution. CPS were localized and sampled by field inventory in 4 headwater catchments in the Northern Vosges Mountains (France). Topographical data were computed at each CPS using an elevation numeric model. 233 CPS were registered. 14 arboreal taxa were identified in charcoal records of 121 CPS, linked

to 20 radiocarbon dates. CPS densities appear to increase close to streams. Charcoal sample composition, dominated by *Fagus* and *Quercus*, is mainly influenced by altitude and slope's azimuthal exposure. These results show that historical wood supplies were highly dependent to local environmental conditions. Thus, high spatial resolution study of charcoal kilns appears to be a powerful tool to deal with past ecological niches of forest tree species. Therefore, we used this approach to understand the impact of intensive charcoal production's legacy on forest soils and headwater streams.

The need for dendrochronology to improve the temporal resolution of charcoal manufacturing activity in the French Eastern Pyrenees: the case of the ancient charcoal-production forest of Bernadouze (Suc-et-Sentenac, Haut-Videssos)

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Improving the temporal resolution of charcoal production through the dendrochronological study of charcoal sampled from kilns is feasible. Recent studies, although few in number, have demonstrated the high dendrochronological potential of charcoal. Although subject to a very rigorous protocol, the main lock faced by the researcher remains the difficulty of obtaining sections of charcoal with sufficient growth rings. An experimental protocol carried out on oak showed that measurements on 50 to 60 rings improve the dating potential of charcoal and reduce errors (Blondel et al. 2018). In order to identify with high temporal resolution rapid and complex dynamics of forest ecosystems, we decided to apply the dendrochronology to charcoal kiln sites. Our objective is to go beyond the limit of radiocarbon dating in order to better locate the functioning of charcoal kiln over time, particularly those located on the modern radiocarbon plateau. We tested this approach on a kiln site that operated during the contemporary period in the forest of Bernadouze. This proposal for a communication presents the main steps of this experimental study as well as the expected results. It required three main steps. The first was to build a reference chronology based on 49 beech discs collected during a logging operation carried out in the autumn of 2016. Secondly, charcoals were sampled in the latest charcoal kiln site used in the 1930s, accurately located by the great-nephew of the last charcoal-maker of Bernadouze. Subsequently, a new reference chronology was constructed at the charcoal kiln scale using dendrochronological measurements of charcoal with a sufficient number of growth rings. Finally, the last step consists in crossdating the reference chronologies obtained from the two types of samples studied (live wood and charcoal). This final step will make it possible to assign the exact year of formation to the growth rings of the charcoal and date the charcoal's operating period. Up to now, the chronology on living wood, which is about 160 years long, is under construction. The 1930s charcoal kiln was partly excavated by an archaeological survey (5mx1m). Three samples were collected directly in the stratigraphic cut for micromorphological studies for detecting the number of terrace re-uses. The selected charcoals were prepared for dendrochronological measurements. This paper presents the first results of this analysis and proposes a suitable methodology for the dendrochronological study of the charcoal kiln terraces dated to the modern radiocarbon plateau (16th-20th c.)

Session 6: Palaeobotany & Pedoanthracology

A case of Medieval deforestation in southern Tuscany (850-1050 AD): an isolated local event or the onset of wide-ranging socioeconomic growth?

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The history of a landscape is the sum of events influenced by climatic and ecological changes as well as local sociopolitical decisions. A complete analysis of past environmental changes must include ecological processes and historical and archaeological sources. Hosted by the University of Siena, the nEU-Med project is part of the Horizon 2020 programme in the ERC Advanced project category. The project aims to document and analyze the form and timeframe of economic growth between the 7th and the 12th century AD in southern Tyrrhenian Tuscany (central Mediterranean). Central to this is an understanding of the processes of change in human settlements, in the natural and farming landscapes in relation to the exploitation of resources, and in the implementation of differing political strategies. The archaeobotanical researches integrate off-site and on-site charcoal records. Specifically, sediment charcoal and archaeo-anthracological analyses were carried out in the Medieval palaeochannel of the Pecora river and the archaeological site of Vetricella, respectively. Sediment charcoal data identify clearance activities by anthropogenic fires, involving riparian and floodplain forest with *Alnus*, *Salix*, *Fraxinus oxycarpa* and *Ulmus*, between 850 and 1050 AD. From 950 AD, the growing consumption of the forest floor by fires improved the downstream gravel-rich deposits of Pecora river. Archaeo-anthracological data show the exploitation of the *Quercus* deciduous forest for timber and fuelwood from 750 to 1150 AD. To ensure the wood supply during 400 years, the coppice management ensured a renewal of the woodland, probably in the form of coppice-with-standards. The coppice was present together with standard and mature trees of deciduous *Quercus* for the soil protection and seed production for the renewal of the forest. The considerable use of *F. ornus* suggests a sparse and open forest with wide areas suitable for the grazing of pigs, which, in accordance with archaeozoological data, was practiced between the 9th and 10th centuries AD. From 950 AD, the increasing use of frugal and pioneer trees, *F. ornus* and *Ulmus*, is correlated with new ecological conditions of lower fertility and higher degradation of soil in the *Quercus* woodland, according to sediment charcoal analysis. In fact, by a comparison with regional sedimentary charcoal and pollen records (Drescher-Schneider et al. 2007; Vannièrè et al. 2008), fire clearance, logging, wood harvesting and livestock grazing progressively attacked the forest cover from 850 AD and open habitats became new well-detectable agricultural landscapes from 950 AD. This planned use of the forest resources followed from well-defined public strategy of creating locally new arable lands and key economic sites from the 850 AD. In fact, central Italy was strongly involved in late-Carolingian sociopolitical transformation between 850 and 900 AD (Schoolman et al. 2018). Environmental changes were closely linked and the activities represented a considerable impulse for the development of rural landscapes during the later centuries. In southern Tuscany, the open-habitats in the valley and the deciduous *Quercus* coppice-with-standards on the hills were successful until the modern era.

Pedoanthracological data to understand the past and current fir (*Abies alba*) distribution in NE Iberian Peninsula

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In the south face of the Pyrenees, the current silver fir (*Abies alba*) distribution area is spread almost exclusively in the northern slopes of high- and mid-mountain areas. Despite this, its distribution area could potentially be much wider according to the suitability indexes determined by topoclimatic models. In addition, there are palaeobotanical data that show a wider distribution during different periods in the Holocene. With the aim of shedding some light on the past and current distribution of fir, a pedoanthracological study has been carried out. Four investigation sites have been sampled at present time across a transect from de axial Pyrenees to the Mediterranean Sea (180km): Montnegre, Montseny, Vall de'n Bas and Valencia d'Àneu. Every site is composed of several sampling points located in different topographical locations (bottom of the valley, north face or south face). The high spatial resolution of the soil charcoal analysis allows to complete

regional transect information with local topographical information. The first results show a past wider extension of fir during Mid-Holocene. *Abies alba* was present in sites where today it is non-existent and, at the local level, it spreads in areas such as the sunny slopes. However, these areas do not fit with the current understanding of topographic and microclimatic paradigms in Pyrenees. Climatic and anthropic elements have unleashed fir forest disturbances during key periods like Bronze Age, Romanization and Middle Ages.

Typology of soil charcoal assemblages in the forest-steppe zone

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In this paper we present type charcoal assemblages that were repeatedly documented in the paleosols buried under colluvial fan deposits, alluvial deposits, and anthropogenic embankments of the forest-steppe zone of European Russia in the last 5000 years. The typology of soil charcoal assemblages was built based on fuel fractions, rather than on the taxa affected by fires. These type assemblages were further compared with reference charcoal assemblages collected from the sites with well-documented history of land use. The latter included permanent fields, swiddens, pastures, forests, and archaeological hearth features. The comparison allowed us to formulate some diagnostic signatures of each type of land use in soil charcoal assemblages. Our first attempt to “barcode” soil charcoal assemblages indicated a need for building strong reference collections from a variety of sites with documented pre-fire conditions.

Ecological niches of oaks versus beech forest trees documented by pedoanthracology in forests of the Lorraine Plateau (France)

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In central European temperate deciduous forests, *Fagus sylvatica* is among the most competitive tree species. However, locally oak stands (*Quercus petraea* or *Q. robur*) are often dominant and beech remains sporadic. These two species are potential trees of the natural forest dynamics, but their distribution and frequency are influenced by ongoing and past forest management. On the Lorraine plateau, we find oak trees on well-drained soils where theoretically beech should be dominant, while it is supposed to be limited on hydromorphic soils according its autecology. The actual ecological niches of these forest species remain unclear. To explore this key issue for forest management we defined two research hypotheses: (i) oak species have been favoured by past and present forest management, (ii) beech has been limited in its expansion. To test these hypotheses, we conducted a soil charcoal analysis on the Lorraine Plateau. We sampled 19 sites using a single trench (10m) dug to determine the pedological context and for sampling purposes, and 6 auger cores regularly distributed over a 42m² area (i.e., at the stand scale). Macroscopic charcoal assemblages were extracted from the soil samples by sieving and sorting before botanical identification. The results of the examination of 5062 charcoal fragments clearly highlight the potential of this approach for addressing our research questions. *Quercus* is dominant (54% of the identified assemblage) while *Fagus* (7%) is identified in almost all sites. Other taxa present include *Carpinus* (10%) and *Prunus* (3%). 44 radiocarbon dates indicate that oak and beech were growing alternately in this area for millennia. Pedoanthracology brings new insights into the natural potential of mature temperate lowland forests and the significant influence of the historical management regimes on the present-day distribution of forest species at stand scale.

Assessment of past fire regime in northern central Europe based on a multiscale and multi-archive paleo-signal

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Information about past fire regime provide valuable insights for the understanding of past landscape dynamics. However, in Europe past Human activities strongly influenced vegetation dynamics and fire history. Therefore, to identify clear and solid patterns of fire history and potential influences on landscapes trajectories it is relevant to use combination of proxies that might provide highly significant complementary data to assess past fire regime relevantly. This is what we illustrate here with study cases in northern Germany. We conducted comparative assessment of various charcoal records from large spatial scale (i.e., micro-charcoal signals from peat bogs) to high spatial resolution (i.e., soil charcoal signals). This latter proxy also permitted us to assess the type of fuel of the local fires. Such dataset was complemented by pollen data that provided insights about human presence, climate constraint, and vegetation responses to fire disturbances. Overall, we illustrate that our comparative assessment of various paleo-signals permits detecting the spatial patterns of fire occurrences. Also, soil charcoal data combined with pollen data provide valuable information about the fuel type of the detected fire events. Thus, we propose a relevant and innovative approach leading to a better understanding of past fire regimes.

Poster presentations

Looking for the invisible: anthracological analysis to reveal ritual action in the Eneolithic cremation of Apulia (SE Italy)

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This paper presents the results of a multidisciplinary study on the funeral mounds of Salve (Lecce-south Apulia). The mounds were used as funerary monuments from the mid-4th millennium to the middle of the 3th millennium BC. Both cremation and burial are attested. The discovery of anthracological remains in the cremation burials of Salve provided an opportunity to study the role of plants in the funerary rituals of the Eneolithic communities of Apulia. The anthracological analysis aimed at reconstructing the phases of the cremation ritual apparently not visible on the site, such as the ignition in the pyre, and the collection and transport of the burnt remains. The identified wood species belong to the local Mediterranean vegetation, including primarily evergreen oak (*Quercus* sp. *ilex*), deciduous oak (*Quercus* sp. *robur*) and olive (*Olea europaea*). Given their high thermal value, it is possible that these species were used to sustain funeral pyres over prolonged periods of time. Other wood species include evergreen shrubs (*Rhamnus/Phillyrea*) and prunes, which could have been used as kindling. Differences among the mounds are evidenced in the selection of the fuel; such differences are, in part, reflected in the building technique and the disposition of the bodies inside the funerary structures. The results of the anthracological analysis offer new insights into prehistoric funerary rituals and provide a new perspective on the burial customs of the Eneolithic communities of Apulia.

Dendrological studies application on two charcoal kilns in Madonie Park (Palermo, Italy). Preliminary results about the exploitation of *Fagus sylvatica* in 14th century AD

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The mountains of Madonie Park in Sicily currently host, situated between 1500 and 1979m asl, one of the most southerly beech forests in Europe (Brullo et al. 2012). In this context two charcoal kiln sites have been excavated during recent survey campaigns led by the University of Palermo and IPHES at Piano Cervi (1504m asl) and Zottafonda (1750m asl), the latter dated from the 14th century AD. During this period in Sicily, the ancient Norman forest system, maintained for the King's hunt, began to be offered to private contractors and started to be massively exploited. In fact, from the 14th until the 16th century, the growing cane sugar industry near Palermo and the associated production of ceramic sugar containers (formae zucarorum), required large quantities of wood fuel (Bresc and Pescarmona 1983). However, little is still known about the woodland management strategies and the exact destinations of the charcoal produced in Madonie Park through the historical periods. Dendrological analyses of wood charcoals could help to better understand the coppicing

practices and provide an image of the landscape in the past. After the taxa identification work resulted that almost 100% of the fragments analysed from Piano Cervi and Zottafonda come from *Fagus sylvatica*. It was then decided to utilize AnthracoloJ software in order to reconstruct the minimum wood diameter of the trunk employed in the kilns (Paradis-Grenouillet 2012). Moreover, growth rings measures were carried out on fragments from two subsamples, in order to make hypothesis about the growing conditions and ecology of the trees.

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Wood technology of Patagonian hunter-gatherers: selection and use of woody resources as raw material

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In the Patagonian archaeological record, the preservation of wooden artefacts is very limited. The taxonomic, technological and functional analysis is a way of approaching to the production processes of wood artefacts. This poster presents the results of the taxonomic analysis of the recovered wooden objects in the sites of Cerro Casa de Piedra 5 (6780±110, 2805±105 BP), Cerro Casa de Piedra 7 (10,690±120, 3400 BP) and Cueva Milodón 1 (7982±45, 1950±30 BP) in the province of Santa Cruz and the botanical identification of museum wooden artefacts from the province of Tierra del Fuego. The botanical identification of the wooden artefacts provides evidence for the use of the same woody shrub taxon: *Berberis* sp. The wood of *Berberis* sp. was chosen for the manufacture of different types of artefacts by the different groups that inhabited the Argentine Patagonia from at least 10,690 BP uncal until European contact. Historical sources on hunter-gatherers from the southern tip of America also mention the use of this shrub for woodcrafts.

Woodworking technology during the Early Neolithic: first results of the site of La Marmotta (Italy)

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The archaeological site La Marmotta (Italy) is unique for its excellent preservation and recovery of wood remains. The exceptional preservation of organic material at the site allowed the recovery of five canoes and numerous objects related to navigation, agricultural and hunting activities, instruments used for the processing of raw materials and construction posts, remains of ropes and textile elements, as well as numerous macro-remains (charcoals and seeds of numerous crops and wild plant species). This poster summarizes the results of the study of harvesting tools (sickles). The morphology and the size of the wooden sickles, as well as the anatomical characteristics, provide an excellent image of the selection of tree taxa. Deciduous *Quercus* sp. is the most important taxa according to the number of sickle individuals identified. However, other species were also used. Woodworking implies a deep knowledge of the natural environment and the characteristics

of the wood. The sets of wooden objects found in La Marmotta site reflect the meaning of this raw material for Neolithic societies. Undoubtedly, it is the reflection of a high technological society.

Spatial analysis of firewood charcoal fragments in archaeological levels: issues for palaeoecological interpretation in anthracology

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In anthracology, taxon saturation curves enable optimal sample sizes (at least 250 charcoal fragments per stratigraphic level) to be determined from the domestic fuel dispersed from hearths; however, a broad spatial sampling of these scattered fragments, recorded using an excavation grid, is necessary for the frequency spectrum of taxa to be reliable; the synchronous levels of a site, therefore, provide the same frequency spectra of taxa, within confidence intervals; in other words, the observations are reproducible, which is a requirement of palaeoecological interpretation. Using sites in southern France, including Lattara and l'Abeurador (Hérault), I propose to further exploit the spatial distribution of taxon frequencies in archaeological levels, with the aim of obtaining information on the heterogeneity of ancient woodlands. Spatial analysis relies on levels of charcoal fragments which have been well sampled through sieving and avoiding charcoal concentrations. At first sight, the frequency distribution of taxa may look remarkably uniform, due to numerous stochastic processes including wood collection, hearth management, combustion, dispersion, burial and fragmentation; typically, the average taxon frequency is used for palaeoecological interpretation. However, the frequencies of most taxa have a unimodal distribution in the grid squares, close to the normal distribution, which is why I hypothesise that the frequency distribution of each taxon (per grid square) might represent its sampling distribution in its past environment. Taxon proportions fluctuate in each firewood assemblage due to its probability of collection, which is relative to its distribution heterogeneity (or accessibility) in the environment. The ratio s^2/m (variance/mean), labelled "distribution index", which estimates the regularity of the taxon distribution in the grid squares, can be used as a proxy of past environmental heterogeneity. Other taxon frequencies have a plurimodal distribution in the squares, meaning that they likely derive from several populations of data. In this case, for taxa identified to genus level, I discuss the possible existence of several species with different frequencies derived, or not, from independent habitats.

Climatic signals in the wood anatomy of *Quercus pyrenaica* Willd. and *Pinus pinaster* Aiton from northeast Portugal: Baseline for continuing studies

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Analysis of archaeological charcoals is frequently used to obtain environmental information on the archaeological site of their provenance, with characterization of climate as one among different types of data obtainable. Long-term processes such as climate change, however, can be difficult to study properly using traditional charcoal analysis, the wide temporal horizon requiring a larger amount of diachronic data points than are typically available in most archaeological sites. The climate history of these sites is thus typically reconstructed through palynological analysis. While generally satisfactory, pollen curves often give regional climate signals, which tend to mask local microclimates. Comparing and contrasting other sources of climate information is therefore useful. Owing to its conditions, the site of Baixo Sabor in northeast Portugal is suitable for such an analysis, possessing a long anthracological sequence ranging from the Neolithic to the early modern period. It is also located in one of the many river valleys that run through the elevated penneplains of the region, possessing a microclimate that is distinctly different from the surrounding highlands. Samples of modern Pyrenean oak (*Quercus pyrenaica* Willd.) and maritime pine (*Pinus pinaster* Aiton) were collected from an analogous site in the region, and their anatomical characters analysed and recorded. Mapped against recent climate records, these characters will

serve as the baseline for comparison with archaeological charcoals of *P. pinaster* and *Q. pyrenaica* sampled from Baixo Sabor and will be used to reconstruct its long-term climate history.

Wood exploitation between Kura and Araxes valley (Southern Caucasus) from the Neolithic to Early Bronze Age

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So far, there have been few studies undertaken on anthracological assemblages from the southern Caucasus. This poster presents the results of anthracological studies from archaeological sites in Azerbaijan and Georgia, located between Kura and Araxes valley dating from the Neolithic to the Early Bronze Age. Results show that riparian forests were the main habitat type where people collected their firewood. But several other types of environments were also exploited such as more or less open shibliak woodlands as well as mixed deciduous forests. Combining the results of the charcoal fragment studies with other archaeobotanical macroremains retrieved from the sites (seeds and fruits) and local palynological studies, permits the reconstruction of a more humid and densely vegetated environment in the northwestern part of the study area, whereas the southeastern part seems to have been more dry with a rather open vegetation.

Vegetation reconstruction in the ClaSS (Climate, Landscape, Settlement and Society: Exploring Human-Environment Interaction in the Ancient Near East) Project

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The ClaSS project, funded by an ERC Starting Grant awarded to Dan Lawrence, investigates the relationship between climate fluctuations and settlement history over the last 8000 years. As part of the project, anthracological data (amongst other archaeobotanical data) will be collated for the entire Near East. Within the anthracological part of the project we aim to reconstruct the vegetation and understand the impacts of humans and climate on the environment. We will also investigate the boundaries of human adaptation to changing environments. The anthracological research in this project uses a combination of database collection of published charcoal identifications, new charcoal identifications, diameter measurements and dendrological studies. Eventually, archaeobotanical data, settlement data and climate simulations will be combined to investigate the question: What factors have allowed for the differential persistence of societies in the face of changing climatic and environmental conditions?

Reconstructing the history of the *silva carbonaria*, an enigmatic charcoal-burners-forest in Central Belgium

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The Sonian forest, situated south of Brussels, is one of the last remnants of a vast forest likely covering the larger part of central Belgium up to at least the end of the Early Medieval period and which is mentioned as *silva carbonaria* (Latin for 'charcoal burners forest') in early historical texts. Since 2017, parts of this forest, together with several other European old growth beech forests, have been listed as a UNESCO world heritage site. Extensive archives allow us to reconstruct its history over the last 500 years, yet, little is known on the extent, composition and exploitation of this forest before that time. Here we present preliminary results of an interdisciplinary study of ancient charcoal and metal production sites from the forest, providing novel information on its history and evolution. Combined use of LIDAR and geophysical methods allows revisiting the intensity and type of activities in the Sonian forest. OSL and radiocarbon analysis provide a detailed chronology of these activities. Anthracological analysis allows the reconstruction of past forest composition and its changes resulting from charcoal production activities. These analyses also provide new insights into the role of beech in the natural forest vegetation in the lowlands of NW-Europe.

Morphometric and dendrometric observations on waterlogged wood: the case study of a 4th century BC well at Taranto "Torre Montello", Salento, Italy

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In 2010 rescue excavations at Taranto "Torre Montello" (Salento, Italy) brought to light a settlement situated in the Chora Tarantina. The excavated area revealed an occupation from the Archaic to Hellenistic periods. The campaign reflects the singularity of the site: several sectors revealed traces possibly belonging to an agricultural holding. A well feature contained a high concentration of plant macro-remains the importance of which was quickly established. Indeed, it constitutes the only waterlogged context available for the Apulia Region and for this particular period. In tandem with seeds, a high quantity of waterlogged wood was revealed. Surprisingly, the only species identified was fig (*Ficus carica*). But how to deal with one species in term of interpretation? In this poster I will open the dialogue about the potentialities of morphometric and dendrometric observations (wood diameter estimations, cut marks) as parameters with which the use of this type of organic material prior to its deposition could be reconstructed and understood. Indeed, the wood present in this feature presents several modifications due to natural and anthropogenic causes. The main goal is to investigate how these types of method can help us to highlight transformation processes and practices.

The anthracological results from la Cova del Sardo (Parc Nacional d'Agüestortes i Estany de Sant Maurici, Central Pyrenees)

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Thanks to the research developed in the Parc Nacional d'Aigüestortes i Estany de Sant Maurici (PNAESM) by the GAAM group (Grup d'Arqueologia d'Alta Muntanya) since the early 2000s, more than 350 sites of archaeological interest have

been documented. Most of them are related to grazing activity and, although its intensity must have changed through time, some of them show large sequences of occupations. In this poster we present the anthracological data from the prehistorical phases in the Sardo Cave (Parc Nacional d'Aigüestortes i Estany de Sant Maurici, Central Pyrenees), a small settlement facing south at 1790m asl, in the middle of the slope in the Sant Nicolau valley. It was intensely occupied between 4600-2500 cal BC with, usually, two or three hearths per phase. It seems that firewood would have been collected around the site although nowadays, some of the taxa identified grow a little bit far from the site, some meters below as it is the case for deciduous *Quercus*. Since wood was also used as building material, the forest around the site was strongly altered by human activities becoming a more open space full of *Juniperus communis*.

Burning wood over 2300m a.s.l. in the Central Pyrenees. Anthracological results from Abric de l'Estany de la Coveta I and Abric de les Obagues de Ratera (Parc Nacional d'Aigüestortes i Estany de Sant Maurici)

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For several millennia, fire has been the source to provide heat and light to human habitations and so, gathering firewood might have been important for human societies, in particular, for those living in colder places like high mountain environments. Archaeological and paleoenvironmental studies on both sides of the Pyrenees have provided a large dataset confirming that human activities have been constant through the centuries in those places although their intensity and economic purposes have changed in time. Those actions have been historically related to stockbreeding but also mining, and charcoal production for industrial purposes. The consequences of which have had a primary impact on the landscape that can be tracked from the Neolithic to the recent past. Thanks to the research developed in the Parc Nacional d'Aigüestortes i Estany de Sant Maurici (PNAESM) by the GAAM group (Grup d'Arqueologia d'Alta Muntanya) more than 350 sites of archaeological interest have been documented. Most of them are related to grazing activity. In this poster, we present the anthracological results from Abric de l'Estany de la Coveta I and Abric de les Obagues de Ratera, two rock shelters located above the tree line at 2300-2400m asl.

Charcoal identification of the semi-deciduous and deciduous oak species of the Salento Peninsula (SE Italy) and their relevance to archaeological contexts: a metric approach

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Oaks (*Quercus* spp.) comprise trees and shrubs found throughout the northern hemisphere; Italy probably hosts more oak species than any other European country. According to Pignatti (1982) up to 15 species are present, most of which are found in the Puglia region. Being widespread, generally large and possessing important chemical and physical properties, oaks have had numerous applications in ancient times: the acorns have been used for making medicinal drinks and for tanning hides, as well as in human and animal diets, while oak wood has been used for carpentry and as firewood. Their remains are thus frequently found in archaeological contexts in Puglia. The most widely distributed part of the oak discovered here is the wood (most frequently charred). Anatomically it is generally possible to discern only whether wood belongs to evergreen, semi deciduous or deciduous species. In order to define the species, the present study examines the

anatomical patterns of modern semideciduous and deciduous oaks and those of the semideciduous and deciduous oak charcoals found in archaeological contexts in the Salento Peninsula (dating from the Bronze Age to the Medieval period). Furthermore, because Puglia is characterised by a diverse climate zones, we used only modern vegetation samples and archaeological samples from the Salento Peninsula area, which is a homogeneous sub-region of Puglia. The quantitative characteristics of wood anatomy were determined by examining the lumen of vessels in cross-section. Morphometric and statistical analyses established that pubescent oak was present in Puglia from the Middle Bronze Age (1500-1300 BC) and has characterised deciduous oak vegetation since medieval times. The results also demonstrate that another, as yet unidentified deciduous oak grew in this area during the Middle Bronze Age and the early Middle Ages, but it is now extinct. Finally, we have discovered that different species were used for different purposes. For example, a post in the fortification walls of the Middle Bronze Age site of Rocais belongs to a different species from the wood used to build the monumental gate of the same fortification.

Charcoal analysis of kiln terraces to reconstruct practices and wood uses' temporalities for charcoal manufacturing activity: the case of the Bernadouze forest (Suc-et-Sentenac, Haut-Videssos)

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The High-Videssos valley, a great former Pyrenean multi-century steel centre, includes numerous traces of human activities, which have driven the evolution of environment and landscapes. The profession of charcoal burner is at the heart of mining and metallurgical activities. The study of the archaeological remains of their activity -charcoal kiln terraces- scattered on the slopes of the mountains, has made it possible since the 1980s to reconstruct the main highlights of the history of the Pyrenean forests. We propose to approach charcoal kiln terraces not just as a palaeoecological marker of vegetation changes but also as an ethnobotanical tool for reconstructing with high spatio-temporal resolution, former silvicultural practices and those of charcoal makers. Indeed, charcoal remains from wood collected by human, record the history of vegetation but also human practices and uses in relation to the environment. Thanks to the FODYNA project (OHM Haut-Videssos), new approaches to charcoal have been conducted on the study of the ancient Bernadouze charcoal manufacturing forest. Recent methodological developments have made it possible to combine the classical taxonomic identification of charcoals with the study of wood cells to quantify anomalies and anatomical deformations. These former studies have shown the importance of these indicators for characterising the condition of wood before carbonisation. Basing on these, a protocol was established to study the most frequent anomalies in charcoals from kiln terraces: radial cracks, cell collapses, hyphae infestation (mycelium of wood-rotting fungi). In parallel, we have determinate the felling season through the observation of the bark position in the last growth ring, when it was preserved. We present here the results of the analysis of these “bio-indicators” for 7990 charcoals from 28 charcoal kiln terraces. The results make it possible to enter at the heart of charcoal burner’s profession that is poorly documented by historical documents. Their interpretation allows us to, characterise technical gestures and wood uses of charcoal makers. In particular, it provides a first overview of the annual charcoal making cycle by highlighting the main phases of collecting, storing and/or drying and burning charcoal. Wood harvesting is carried out from the fall and before the recovery of vegetative activity. Then, the felled wood remains stored in the forest for several months, at least 6 months or even more (period covering the passage of a warm season), which makes it possible to obtain partially dry wood that is better suited to charcoal production. The charcoal manufacturing activity begin (1) in the next spring after cutting and/or (2) at the next autumn before the first snowfalls. Wood is rarely charred in winter.

Sustainable management of wood for charcoal manufacturing activity in the Northern Pyrenees: dendro-anthracological study of charcoal kilns in the Bernadouze forest (Suc-et-Sentenac, Haut-Videssos)

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The study of wood diameter has expanded widely in anthracology over the past 20 years. Thanks to recent methodological developments, it is possible to find the initial diameter of charred wood in order to question the historical management of forests and evolution of charcoal manufacturing practices. This poster presents the results of the dendro-anthracological study carried out on 25 charcoal kiln terraces (16 were dated) in the northwestern part of the Freychinède national forest located between 1300-1500m asl. It is an ancient forest marked by strong human pressure linked to successive and/or combined activities of woodland pasture, gathering of fuel and lumber wood. The dendro-anthracological protocol developed by Paradis-Grenouillet was used. The latter is based on a mathematical formula: trigonometry in an isosceles triangle (more reliable and producing fewer errors) combined with AnthracoloJ open source software to automate the measurement of the radius curvature. The protocol has three main steps: (i) the estimation of the radius curvature, i.e. the distance of each charcoal from the heart of the wood (ii) the reconstruction of the initial diameter of wood used and finally, (iii) the restitution of charcoal maker and silvicultural practices. The radius curvature measured on at least 50 fragments of the same species per sampling layer were corrected by a systematic addition of +25% to compensate for the loss of charcoal volumes following carbonisation. The dendro-anthracological results show a systematic use of all calibres in the charcoal kilns, with however, a significant difference according to taxa. The use of small sizes (0-10cm) mainly concerns beech and the largest sizes (10 - >18cm) fir. Radiocarbon dating shows several phases of charcoal production from the Middle Ages to modern times. These main phases show a change in the diameters exploited over time. The transition from the Late Middle Ages to the Renaissance shows a significant rupture in the diameters of the wood used. We observe the progressive decrease of large wood sizes in favour of smaller ones. This rupture can be interpreted as the change in silvicultural practices that are trying to adapt to the intensification of the metallurgical activity. At the beginning of the charcoal production, around the Carolingian period (Early Middle Ages), the data assume that charcoal makers collect wood in a forest probably treated as coppice-with-standard under with short-rotation (20-30 years). Beech is primarily charred, while fir is reserved for timber. Fir is used later, at the time of their maturity (100-120 years) from the Renaissance. The data show a combined exploitation of beech and fir, probably from a beech-fir forest. Dendro-anthracological spectra show first the exploitation of beech associated with fir waste and then, the use of whole trunks in the charcoal kilns. The following phases show that fir is gradually eliminated to make way to monospecific beech coppice which is gradually transformed into a more productive high forest with various ages that is better adapted to the requirements of charcoal production.

Fire and forest management: an anthracological approach to relative dating of suspected pit kilns containing coppice

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The limited presence of botanical remains at an archaeological excavation at Den Bogerd near Udenhout (Brabant, The Netherlands) allowed for a systematic analysis of the charcoal rich contexts to contribute to answering research questions

related to the arrangement of the cultural landscape and the history of the site. Species represented in the charcoal contexts potentially establish a reconstruction of the woody vegetation in the surroundings that signals e.g. a pioneer or climax vegetation. Based on the use of particular species and the presence of other features the remains can point to a specific function of the context, such as a hearth or kiln. The association of the context with a function or activity, as well as the spatial distribution of the contexts and the relation to other excavated features on this site, dating from the Bronze, Iron, and Middle Ages, contributes to the relative dating of the contexts. The combination of changes in the vegetation and dating offers insight into the landscape developments and potential woodland exploitation. Because of the variation in type, fill and spatial distribution all fourteen contexts were analysed. The data set was used to statistically assess the charcoal rich pits in order to seek out a method to define and recognize actual pit kilns, aimed at charcoal production, in the archaeological record. The statistics show similarities and differences which lead to the conclusion that not all contexts can be interpreted as definite pit kilns. Moreover, a trend in the variation of pruning patterns leads to the phasing of certain contexts. These results are confirmed by the outcome of ^{14}C dating of these contexts. This method to phase charcoal contexts on the basis of pruning patterns offers an approach to address the changes in woodland management and therefore the anthropogenic exploitation and alteration of the landscape and its biotic factors.

A charcoal study to better understand lynchet construction and lynchet landscape history

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Our study focuses on the Region Grand Est (France), on a specific type of agrarian microtopography. A lynchet is a kind of bank that appears on slopes, that results in most cases from plot soil erosion caused by colluviation or by tillage erosion and sediments accumulation behind a hedge. Most constructions are parallel to the slope, can be numerous, and are sometimes spaced from <10 meters between each lynchet (we talk about hedge system or lynchet system). Contrary to terraces, lynchets are an involuntary structure and not a construction. Indeed, each lynchet corresponds to one plot whose bank represents boundaries that probably allow spontaneous installation of hedges. The lynchet forms in hedge landscapes since the ancient times. Indeed, in France some of these forms have been dated back to end of the Iron Age (2710±200 BP) for the oldest, in Haut-Rhin others have been dated from the High Middle Age (1370±100 BP) (Froehlicher 2016) and from the Central Middle Age (1120 AD) in Massif Central (Bernard-Allée and Valadas 1992) The study of agrarian forms associated with analyses of the pedological, anthracological, and chronological data determine the dynamics of these landscapes of the past. The study of charcoal can teach us a lot about the history of lynchet and hedge, but it also behaves as a palaeoecological reservoir to study the surrounding environment. For example, the charcoals stored in the bank allows us to define the woodlands composition before clearing of the forest or the composition of the hedge itself. It also allows us to date agrarian forms, thus helping us defining the cycles of cultivation, hedge and landscape history. On a broader perspective, our study should bring a better understanding of the human development dynamic and its consequences on landscapes trajectories.

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Neolithic wood use and forest exploitation. Comparison of anthracological and xylotomical data from three Neolithic wells from the Czech Republic

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Neolithic wells with waterlogged preservation found recently, especially in Central Europe (Saxony, Bohemia, Moravia, Hungary, Austria, Poland), provide a unique opportunity to study the environment and economy of Neolithic societies in this region. In the last 5 years, three new Neolithic wells have been found in the Czech Republic. They were discovered in central Bohemia (Velim), eastern Bohemia (Ostrov) and central Moravia (Uničov). The oaks used for construction of the wells at Velim and Uničov were dated in 5196/5195 BC and 5093–5085 BC, respectively. The well from Ostrov was dendrochronologically dated to 5256–5255 BC. This is the oldest dendrochronologically dated archaeological structure in central Europe. Multidisciplinary environmental research of these archaeological features (archaeobotany, osteology, malacology, insect remains, dendrochronology) included the study of charcoals and waterlogged wood fragments. Studied Neolithic wells provide a unique possibility for comparison anthracological and xylotomical data from one archaeological site. Anthracological taxonomically rich data probably reflect local forest vegetation used more or less non-selectively as firewood: on the fertile loess substrates of central Moravia they indicate mixed oak forests with locally demanding deciduous trees on the poor sandy substrates of central Bohemia, a mixed oak pine forest or pine forests and in eastern Bohemia on gravel terraces of the local river Loučná oak with a significant birch and hazel share. Xylotomic taxonomically poor data in opposition represent a strongly selected set reflecting particular human activities on the site (building construction). The well construction from Velim is a hollowed lime tree trunk. Design of the oak construction from Uničov and Ostrov is similar, formed by four corner posts with longitudinal grooves and inserted horizontal planks. Xylotomic data obtained from the well fill (small fragments of waterlogged wood) corresponded to the taxonomic composition of construction timber from this studied Neolithic sites (oak, hazel, lime).

Wood management in the ceremonial building of the Na Galera islet (Balearic Islands, Western Mediterranean): fuel, timber and coastal vegetation at the end of the first millennium BC

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Na Galera is an islet located 175m off the coast of the Bay of Palma (Mallorca, Balearic Islands) within a network of strategic points for trade routes along Mallorca coast since the 4th century BC. A large building has been excavated at Na Galera, interpreted as a ceremonial centre, the occupation of which lasted until the 1st century AD, after several collapse and rebuilding phases. We present the charcoal analysis of the site, focusing on the collapse levels of this building. *Pinus halepensis* wood is ubiquitous into all contexts, complemented by the use of other taxa, such as *Pistacia lentiscus*, *Olea europaea* and evergreen *Quercus*. In addition to the botanical identification of the woody species used, a dendro-anthracological study has focused on *Pinus halepensis* charcoal fragments from two specific context of the site that presented enough fragments for a dendro-anthracological approach (SU 165 4th-3rd centuries BC, and SU160, 1st century AD). The main objective of this analysis is to estimate the charcoal-pith distance of the charcoal fragments with the trigonometric pith location tool, based on measurements of the angle and the distance between two ligneous rays of the last preserved ring of each fragment. This technique allows to infer the diameter classes of the wood exploited (Dufraisse et al. 2018). These data will be combined with the ring width of all the preserved rings for each fragment in order to correlate growth and diameter classes. With this information we have estimated the diameters of the pine wood used at the site and, subsequently, the potentially differential use of the pine wood: the use of branches, probably linked to fuel

procurement, and the possible use of trunks (timber) to construct architectural elements of the excavated building. These results are integrated into a broad discussion regarding resource use in island territories. The first occupation of Na Galera is contemporary with other Punic occupations (4th century BC) on some islands along the coast of Mallorca that make up a network of strategic points regarding commercial routes. In this context, the main aim of our study is to characterize the wood exploitation practices in each one of the different occupation phases of the islet, its relation with the neighbouring islands (mainly the adjacent island of Mallorca, the biggest of the Balearic archipelago) and its potential changes during the studied timespan.

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Bronze Age and Middle Ages in the southeast of the Iberian Peninsula (Spain): new approaches to sampling in number of wood and charcoal analysis and fraction size

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The outcomes of archaeobotanical research in charcoal analysis are directly influenced by sampling techniques in the field. Afterwards, subsampling in the laboratory aims to optimize the expected results. Therefore, it is necessary to review the resulting differences in each of the decisions made from archaeology, and specifically archaeobotany. The accumulated decisions are consequently resulting in significant differences in the quantity of taxa. This includes the underestimation of the subdivisions to be observed, the recovery method analysed, and the type of context under study. Sample fragmentation, its size, and the number of remains to examine has created a bias statistically evaluated here. It is substantial to determine the amount of charcoal and wood fragments among three distinct types of material recovery (by hand, dry sieving and floatation) which provided individual differences, increasing the negative bias to the analysed remains. The results confirmed the well-known complementary recovery and analysis comparison need within hand-sampling and floatation. In addition, there were more factors under study. The first fragmentation approach determined substantial differences in the 4, 2, 1 and 0.5mm fractions results, where several context showings were confronted to estimate the lack and number of fragments present for each taxon. Because 100% of the fragments of the sites were analysed, it was possible to propose a subsampling methodology review. Low and high fragmentation for each taxon was defined and compared to the provenance context and post-depositional processes over them. The simulation of the different results, according to the number of remains and fractions, will indicate new subsampling proposals, rethink the method and the need to re-evaluate our goals and achievement possibilities through subsampling. The latest results in several archaeological sites have clearly shown such differences. The first data obtained are from the southeast of the Iberian Peninsula for the Bronze Age and the Middle Ages.

Wood as structural element at the houses of Akrotiri, Thera. The anthracological evidence

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The prehistoric site of Akrotiri is located on the island of Thera, the largest of the islands of the Santorini complex. During the later occupational phase of the site dated to the Late Cycladic I period (1675-1490 BC) there existed large buildings which in many cases had three storeys. The architecture of these buildings is characterized by the extensive use of wood, mimicking Minoan prototypes. This material was utilized not only in the infrastructure of the walls of the buildings, in order to prevent them from collapse during earthquakes, but also for the construction of the floors of the upper storeys, doors, and windows (Palyvou 2005). Branches with diameter of approximately 0.05m and length between 0.50 and 0.70m were used for the infrastructure of the walls and the second layer of the floor of the upper storeys. Additionally, larger logs with diameter of approximately 0.12m were used for the construction of the first layer of the upper storey (the one bearing the weight of the structure) and the wooden case of doors and windows. The aim of the present analysis was to study wood charcoal macroremains coming from the interior of the buildings in order to determine which taxa were utilized for their construction and to justify the preference on specific taxa. Anthracological samples collected from Xeste 3, House of the Ladies and 2 other buildings unearthed at the shafts of Pillars 66 and 67 indicate that *Olea europaea* was the most widely used species in all contexts coming from the aforementioned features. The extensive use of this species can be related to its abundance at the surroundings of the site during the Late Cycladic I period (Asouti 2003, Mavromati 2017). Furthermore, *Pinus* type *brutia/halepensis*, *Juniperus* sp., *Quercus* type evergreen and deciduous, and *Prunus amygdalus* were also systematically utilized in constructions. The use of *Pinus* type *brutia/halepensis* and *Quercus* type deciduous, two taxa with low presence at the surroundings of the site during this period, is most likely related to their tall trunks, which are suitable for the construction of the longer beams needed. Last but not least, exceptional is the recovery of fragments of *Cupressus sempervirens* and *Castanea sativa* that have been used as construction material for the floors of the upper storey and for the infrastructure of walls, respectively. This indicates the import of timber for structural purposes and provides information on the form of exotic taxa that were transported into the settlement.

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Wood charcoal assemblages from the loess upland zone of western Lesser Poland

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The loess upland zone of western Lesser Poland was settled by the first farming groups, but this region is still poorly recognized in terms of the postglacial environmental history due to a scarcity of water reservoirs with biogenic accumulation suitable for palaeoecological and especially palynological studies. Therefore, wood charcoal sequences, based on firewood collection, from the Neolithic archaeological sites provide a unique tool for reconstructing past woody vegetation developed near human settlements. The specific objectives of the presentation include: (1) characterization of the environmental conditions, including especially the vegetation cover, with a special focus on testing the hypothesis about the existence of open forests and steppe-like vegetation on the loess-mantled areas and (2) assessment of the impact of first stable settlements on local environments. The data from various archaeological sites from the Early and Middle Neolithic periods was used. The results helped to identify the environmental patterns of the Neolithic settlement, especially supporting the hypothesis of the selection of settlements in regions of azonal steppe-like and open forests vegetation.

Vegetation changes around Sarakenos Cave (Boeotia, Greece) from the late Pleistocene until the mid-Holocene: the study of charred wood and non-wood plant macro-remains

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The Sarakenos Cave (Boeotia, Greece) lies on the eastern slope of the former Kopais lake basin. The cave layers contain unique and rich archaeological evidence of its use by human groups during the Palaeolithic, Mesolithic and Neolithic periods and the Bronze Age. The present study is focused on the archaeobotanical assemblages (mostly wood charcoal) recovered from the stratigraphic sequence of two trenches, A and F. This sequence is dated between 14,000 and 8500 cal BP on the basis of 22 radiocarbon dates obtained from taxonomically identified charred plant remains. Changes in types of vegetation were detected in the anthracological sequence. During the late Pleistocene an open parkland vegetation type with *Juniperus* sp., *Amygdalus* and *Ephedra* sp. may be inferred. The beginning of the early Holocene was marked by the spread of deciduous woodland with *Quercus* sp., *Pistacia* sp. and *Amygdalus*, while during the mid-Holocene the first appearance of thermophilous vegetation with evergreen *Quercus* sp. and *Phillyrea/Rhamnus alaternus* was identified. Charred non-wood plant macro-remains were sporadic in late Palaeolithic and Mesolithic layers, and became more frequent in the early Neolithic, mostly related with cultivated plants. An exceptional finding was wild-type *Pisum* sp. dated to the late Pleistocene.

Combining charcoal and magnetic susceptibility analyses: evaluation of post-depositional processes in unit IV from Abric del Pastor (Middle Palaeolithic, Iberia)

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Hearth-related accumulations are common in Middle Palaeolithic sites, and their spatial characterization is essential to recognize the cultural processes involved in the formation of archaeological sites (Vaquero and Pastó 2001). Although spatial analyses are mostly based on lithic and faunal remains as key elements for the identification of synchronic and diachronic relationships among artefacts resulting from several occupation events, these spatial techniques are being increasingly used in other proxies like archaeobotanical studies, i.e. wood charcoal and seeds (Snir et al. 2015, Vidal-Matutano 2017). Here we present an innovative methodological approach combining the spatial analyses of fuel remains and the magnetic susceptibility values from units IVe and IVf of Abric del Pastor, a MIS 4-3 Middle Palaeolithic site located in southeastern Iberia. Spatial distribution data of these proxies shows coincidences suggesting the spread over the

surface of fuel remains and burnt facies by natural and/or anthropogenic factors. Thus, this work proposes the use of this method as a useful tool for evaluating possible post-depositional processes affecting archaeological surfaces with partially dismantled or poorly preserved combustion features, or anthracological contexts without a clear anthropogenic origin.

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Ship ahoy! Evaluation of waterlogged wood remains from El Burrero shipwreck (Gran Canaria, Canary Islands, Spain)

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Archaeobotanical analyses of waterlogged woods, normally presenting a good preservation degree, are usually performed despite the investment of fieldwork required to recover them. However, waterlogged woods are often exposed to degradation processes considering its organic matter nature (Charles et al. 2016). The rate of decay depends on different parameters such as wood species, chronology, sediment protection, environmental factors or physical damage (Huisman et al. 2008, Knight et al. 2019). In this work we present the analysis of wood fragments from El Burrero shipwreck, the remains of a ship dated to the Modern period and located in eastern Gran Canaria (Canary Islands, Spain) at a depth of 4m. Xylological analysis conducted on several samples from the wooden remnants of the ship’s hull allowed determining the type of wood used in the construction of the ship and contributed to the hypothesis of a European origin. Thus, wood fragments from El Burrero shipwreck have been identified as deciduous oak (*Quercus* sp.), elm (*Ulmus* sp.) and cryophile pines (*Pinus* sp. *sylvestris*), this diversity being likely related to wood selection for specific construction timber properties. Finally, macro and micromorphological analysis of wood fragments revealed evidence of biodegradation by bacteria, fungi and *Teredo navalis* (shipworm) which are also the focus of this work.

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Pedoanthracological records as tools for revealing the forest history of the Khan Khentii Mts. (northern Mongolia)

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Fire events are very important ecologically, and they exert long-term impacts on the boreal forest ecosystems. Evidence of past wildfire events and vegetation changes are assemblages of macro-charcoal fragments that persist in the soil. Our pedoanthracological research was performed along an altitude gradient (700-1414m asl) in the Khan Khentii Mountains (northern Mongolia), where we excavated 18 soil profiles. Soil profiles were dug in four vegetation types: steppe forest on the foothills (lowest part of study region), alluvial spruce forest, light taiga in the upland, and dark taiga in the central and eastern part of the study area. Our results documented a significant correlation between charcoal sample composition, anthracomass value, soil conditions and position of soil profiles along the altitude gradient. The soil profiles from the steppe forest were characteristic by a low anthracomass, while the frequency of fire events was probably relatively high. On the other hand, the soil profiles of higher altitudes have the highest anthracomass values, but we expect less frequency of fire events. The vegetation history on the lower parts of the mountain range has been much influenced by human activities than vegetation in the central part of Khan Khentii Mts. Human impact seems to be the triggering factor for environmental change and the fire regime, especially during the late Holocene. Although pedoanthracological results have documented the history of the local vegetation, the transect of 18 soil profiles has allowed the assessment of differences among vegetation types at a wider geographical scale. Pedoanthracological research reveals a connection between environmental conditions, human impact and the Holocene vegetation history of the study area.

The Late Holocene forest transformation in the sandstone landscapes of the Czech Republic

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We studied transformation of the forest vegetation using fossil charcoal from rock shelters. As a study area, we chose sandstone landscapes in northern Bohemia that appear to be exceptionally suitable for archaeobotanical research due to the fact that many rock shelters offer long-term anthracological archives. The investigation of their long-term (Lateglacial and Holocene) history is facilitated by the presence of a large number of excellent palaeoecological archives: sandy accumulations under rock shelters. The anthracological research was carried out in the context of parallel archaeological investigations. Our research focused on the comparison of the macro-charcoal records from rock shelters with different geomorphological positions. The site-specific records provide insights into long-term changes within different local habitats, from the Lateglacial to the present. The distribution of individual arboreal species was clearly related to the position within local environmental gradients. Our research documented remarkable differences between species-rich assemblages from rock shelters situated in the humid valley bottoms and species-poor assemblages from rock shelters located in the dry upper parts of the slopes. Anthracological results recorded vegetation transformation occurred at the onset of the late Holocene (around 4 ka BP) when species-rich, productive forest communities were replaced by forests with a smaller species pool. Our study documented the effects of increased human activities. We hypothesise that pastoral activities in particular played an important role in woodland vegetation change.

Woodlands and farmlands in Bronze Age central Greece. Insights from archaeobotanical assemblages from the sites of Agia Paraskevi, Kynos and Mitrou (Phthiotida)

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The Bronze Age in Greece is a period of significant transformations in the social and economic realm and there is a long list of studies focusing on aspects of subsistence, production and exchange. However, the record is relatively unbalanced with archaeobotanical studies being under-represented in central Greece, not to mention the meagre anthracological information. Here we present the first results of ongoing archaeobotanical work in the context of the ERC project PlantCult from three Bronze Age sites in Phthiotida, central Greece. Our research integrates analyses of charred wood and non-wood plant macroremains and morphometric analysis of grape pips (*Vitis vinifera*). The archaeobotanical assemblages from the coastal (during prehistoric times) sites of Agia Paraskevi, Mitrou and Kynos, spanning chronologically the entire Bronze Age, provide fresh insights into the vegetation, the management of woodland resources and farming activities with special reference to fruit-tree cultivation and viticulture. Moreover, such an integrated approach permits tracking indications of anthropogenic influence on the production territories of the sites under study.

Automatic detection of ancient charcoal production platforms through LiDAR observations: is it an effective method?

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Airborne laser scanning (LiDAR) is a useful tool to detect charcoal production platforms and other structures or even landforms. On large study scale, this tool appears more powerful than, for example, field survey for assessing the density of platforms per surface area using automatic detection. Indeed, the characteristic shape of these platforms allows a more or less easy distinction. However, the efficiency of the automatic detection remains to evaluate according (1) the quality of the LiDAR data, (2) the relief of the study area, and (3) the method of detection. In this poster, we present the first analysis of very detailed LiDAR for an area in Meuse (France). The study area corresponds to three forest parcels, at low altitude in a generally flat morphology with gentle slopes. To detect these structures, rather frequent in the area, we applied various methods of automatic analysis in order to maximize its detection. Simultaneously, visual and field detection were also performed to compare the efficiency of these methods versus automatic ones. With a past of intense charcoal production in the region, this particular area presents itself as an important and challenging plot to study ancient charcoal production and test new methodologies of image analysis.

Charcoal and coal: charcoal: energy resources with a strong impact on the past environment and ongoing stakes for energy transition

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In this poster we present the concepts and first results of a multidisciplinary research project. The project focuses on ancient charcoal production around three main axes of research: (a) heritage of historical exploitation of wood resources, (b) mining activity heritage in the soil and forest ponds and (c) legacies of ancient resources exploitation in the soils and

forest ponds. The study has two parallel study areas: one regarding charcoal production (Meuse area) and the other related to mining activities (Bischwald area). Our first results show a high density of charcoal production platforms in Meuse area. *Fagus* sp., *Carpinus* sp. and *Betula* sp. were identified in the initial samples analysed and radiocarbon dating was already performed in some fragments. In addition, first forest ponds were cored in Bischwald area. The obtained organic sequences show a relatively long-term vegetation record, relevant enough for assessing potential impacts of mining activity in the region. Using an interdisciplinary and complementary network, the aim of the project is to assess the impact on the environment and the current heritage of the historical exploitation of wood in two areas in eastern France and contribute to upcoming challenges of the energy transition era.

Firewood selection strategies for combustion events during Late Holocene hunter-gatherer occupations in South America (Córdoba, Argentina)

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This poster presents the initial results of a research project focused on the use and management of firewood in Ongamira valley, Córdoba, Argentina (c.1500 and 6000 years BP). In order to understand firewood gathering practices carried out at different times in the late Holocene, samples from 80 combustion features recorded in 10 rock shelters were analysed. The anthracological analysis of 3469 charcoal fragments identified 21 arboreal species belonging to Chaco Serrano forest. The identification of abundant small-sized flat fireplaces projects the picture of activities of short duration and repetitive in time. A detailed analysis of the status of the samples (types of fire pits, alterations during combustion and taphonomic processes) permits inferring a pattern of firewood gathering focused on the environs of the sampled archaeological sites, but also some species belonging to different environmental conditions. Archaeological evidence shows that there was high mobility of the groups, with the establishment of a network of places in the landscape where different activities were performed (woodcrafts, food consumption and pottery production) with fire as a central activity. People in the past constantly used different places in the valley, locating many of their activities in the rock shelters.

Crossing molecular study of ashy sediment and taphonomy to date and to reconstruct fuel management strategies and paleoenvironments at Le Rocher de l'Impératrice (Plougastel, France) during the Lateglacial Azilian occupation

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The development of the Azilian in Western Europe 14,000 years ago is considered a revolution in Upper Palaeolithic Archaeology. Recent work shows that the transformation of human societies between the Magdalenian and the Azilian was more gradual. The recent discovery of Le Rocher de l'Impératrice rock shelter (Plougastel, France) played a major role in the understanding of this process. However, due to the poor conservation of organic matter, palaeoenvironmental data are lacking to date and trace human-environment interactions. By combining a taphonomic field strategy with a new exploratory molecular approach based on Benzene PolyCarboxylic Acid (BPCA) oxidation applied to ashy sediments, we are able to provide accurate dating and crucial palaeoenvironmental data and to approach a better visibility of economic choices made by these prehistoric community.

Mid-Holocene archaeobotanical record from the Atlantic band of Cádiz (SW Spain) based on pollen and charcoal data

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Archaeological investigations in the Cadiz coast and countryside during the last 20 years have revealed a series of human occupations dating between c.7500-3000 cal BP from the late Mesolithic through to pre-Roman periods. Archaeobotanical analyses carried out in these settlements have revealed an open Mediterranean landscape developed under notably dry conditions drifting sometimes to steppic ones. *Pinus*, *Juniperus*, *Olea* and evergreen *Quercus* are the main arboreal taxa. Mesophilous (deciduous *Quercus*, *Ulmus*, *Betula*) and hygrophilous plants (*Salix*, *Alnus*), indicators of the availability of water resources and moist conditions, are present during the Mesolithic. Nevertheless, this presence is discontinuous and exiguous throughout most of the sequence, recovering only during the Bronze Age. The charcoal assemblages reveal the management of diverse plant communities. *Olea europaea*, deciduous and evergreen oak woodlands, Mediterranean pines (*Pinus pinea*, *P. halepensis*) and *Juniperus* appear interspersed in open woodland vegetation given the systematic exploitation of scrub species throughout the period considered (*Pistacia lentiscus*, Fabaceae, *Arbutus unedo*, *Phillyrea* sp., *Crataegus*, *Prunus* spp., *Erica* sp.) The E-W geographical position of some of the sites (Palmones, Retamar) between the Algeciras and Cádiz bays, both separated by a series of mountain chains, determined the early development of the evergreen oak woodlands to the east over the deciduous oak communities which are more abundant westwards. The various sea level fluctuations that occurred during the Holocene in the Cadiz coast also determined the trajectory and the character of the human occupations that settled there, especially in three of the sites considered (Palmones, Retamar, Campo de Hockey).

Anthracological analysis of charcoal from the Bronze Age site of Erlitou (Henan province, China)

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Erlitou site was excavated by the Institute of Archaeology, Chinese Academy of Social Sciences (CASS). 399 charcoal fragments >4mm and 40 charred fruit stones were analysed. These fragments belonged to 21 taxa: *Platyclusus*, *Pinus*, *Picea*, *Armeniaca*, *Amygdalus*, 4 types of *Quercus* (deciduous oaks), *Celtis*, *Zelkova*, *Broussonetia*, *Ziziphus*, *Salix*, *Toona*, *Koelreuteria*, *Sophora*, *Melia*, *Bambusoideae* and 2 unidentified broadleaf species, as well as 39 *Amygdalus persica* stones and 1 *Ziziphus* stone. The results of the charcoal analysis show that different plant associations were distributed around the site during the Erlitou Culture period (1750-1530 BC). These include deciduous forests composed of oak, *Zelkova*, *Salix*, *Toona*, etc., some fruit trees such as apricot, peach and Chinese date, and a few of coniferous trees. Based on ecological features and ubiquity of taxa, this study indicates a vegetation adapted to a warmer and more humid climate in phases 2 and 3 of the Erlitou Culture period (1680-1565 BC), and becoming drier in phase 4 (1565-1530 BC). By the late Erligang period the climate becomes warmer and more humid again. This study also suggests that oak played an important role as firewood and possibly tools and food. The presence of apricot, wild peach, and Chinese date might suggest that fruits were being consumed, while Chinese hackberries could have been used as food or fodder.

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